VISUALIZING COVID-19 WITH DATA: THE EFFECTS OF INDIVIDUAL DIFFERENCES ON PERCEPTION OF DATA IN NEWS

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ABSTRACT

Mass media and public health organizations' efforts play a significant role in disseminating information and reducing the morbidity and mortality of infectious disease outbreaks. The vast amount of data generated about the pandemic led to the enormous spread of various data visualizations and infographics. Visuals served as the main tools that helped experts and journalists explain the consequences of the pandemic, communicate the facts, and persuade people to follow safety measures.

Current research investigates how various formats of news messages such as data visualization and textual content affect an individual's perception of the message, such as message acceptance (positive attitudes about the message, intentions to follow prevention measures, and self-efficacy measure for behavior change), message rejection measures (defensive avoidance, negative attitudes about the message, reactance, anger) as well as credibility and effectiveness of the message. Political partisanship, need for cognition, and graphiacy were used as moderators. Results have demonstrated that the format of the message does not affect acceptance or rejection of the message, while moderators were significant predictors for dependent variables. The computational textual analysis illustrates the differences in topics between partisan groups where Democrats expressed more hope, positive sentiment, and more trust in vaccination, government, media, and science than independents and Republicans who were more prone to conspiracy theory thinking.
Chapter 1: Introduction

A recent outbreak of the COVID-19 pandemic was a primary global concern for governments and public health organizations worldwide, resulting in widespread morbidity and mortality (Worldometer, n.d.). Similar pandemics are classified as 'emerging infectious diseases,' a particular kind of outbreaks that are caused by multiple factors such as increasing mobility, connections of the global society, overpopulated cities with poor sanitation, and ecological changes that lead to transferring viruses from animals to humans (Holmes, 2008).

COVID-19 pandemic has raised additional questions and concerns about building an effective health communication strategy and advising people to follow the rules to confine their habitual way of life. One of the main challenges for health officials during the COVID-19 pandemic was to find an effective communication strategy to encourage people to stay home, wash hands, practice social distancing, or wear a mask outside - practices that would help to eliminate or minimize social contacts in addition to travel restrictions and the cancellation of in-person public events (Mummert & Weiss, 2013). Mass media and public health organizations' efforts play a significant role in disseminating information and reducing the morbidity and mortality of infectious disease outbreaks. International agencies, health organizations, and governments rely on mass media efforts to communicate important information, educate people about the disease and prevention measures, and inform the public about initiatives and interventions (Lee & Basnyat, 2013).

In the field of health communication, many studies investigated the effects of health messages on people's perception and behavior change. There is a substantial scientific agreement that communication strategy plays a significant role in the containment of the pandemic and that journalism and mass media has an enormous impact on the construction of people's attitudes and
intentions as well as changing their behavior (Holmes, 2008; Lee, 2014; Lee & Basnyat, 2013; Lee & Park, 2016; Mummert & Weiss, 2013). As a result, a vast arsenal of channels, including mass media, has been activated in the effort to control and eliminate negative consequences of the pandemic. However, there is a need to investigate the construction of media messages during the time of COVID-19 spread, various factors that affect message acceptance as well as message rejection, and the role of journalistic information and political partisanship in communicating the risk and educating the public about the recent coronavirus pandemic.

The vast amount of data generated about COVID-19 led to the extensive implementation of various data visualization tools and infographics. Those formats serve as the main tools that help experts and journalists explain the consequences of the virus, communicate the facts, and persuade people to follow safety measures. There is so much COVID-19 data around us that lets researchers characterize this time as 'the first data-driven pandemic' (Shelton, 2020). Since then, there was no detailed investigation of whether those forms of data presentations helped persuade people to follow the experts' recommendations. Previous research shows that infographics integrated into the text messages of news pieces can increase audience engagement compared to text-only messages (Lazard & Atkinson, 2015).

However, cognitive psychology researchers found that only participants with higher graphicy skills could generate inferences from the data visualization and are more affected by the data format (Shah & Freedman, 2009). Keller and Junghans (2017) demonstrated the importance of graphicacy and numeracy skills in understanding quantitative graphs. According to their findings, individuals with high numeracy skills can better understand various complex charts. Concerning the news about a pandemic, a persuasion component of the message needs to be investigated. An individual characteristic such as the need for cognition measures how a
particular person is engaged in the cognitive thinking process (Cacioppo and Petty, 1982) and serves as an indicator of message persuasion (Cacioppo, Petty, & Morris, 1983). One of the purposes of this research is to test how graphicacy and need for cognition affect the acceptance or rejection of the message about COVID-19.

In addition, this pandemic has demonstrated the divide on political lines when the population was segmented into groups with different attitudes towards the pandemic that would correlate with the traditional political disposition between liberals and conservatives (Allcot et al., 2020). Researchers found a strong correlation between political polarization and the willingness of people to comply with social distancing directives during the pandemic (Cornelson & Miloucheva, 2020). It is assumed that the perception of news about COVID-19 and the intention to follow the safety measures and get vaccinated is affected by political polarization. It demonstrates a need to investigate the role of motivated reasoning theory and analyze how political preferences affect people's perception of COVID-19 news and whether data visualization impacts that perception.

Data visualization and textual messages contain various thematic frames used by journalists to communicate the idea with particular angles and focus on a specific component of the story (Alieva, 2021; Hullman & Diakopoulos, 2011). In their study, Druckman and McGrath (2019) mentioned that framing could be used as an effective communication strategy with identity-protective reasoning where particular frames connected to the group's political identity could be emphasized to improve the persuasion effect of the message. This strategy helps to ensure that information is seen as non-threatening that allows updating to occur without substantial reactance. An example of Wolsko et al. (2016) has demonstrated that Republicans better accepted the binding morality frame since it was connected to their patriotic values. Thus,
framing presents more opportunities to test whether various frames may increase the acceptance of COVID-19 prevention measures in the news. This research attempts to test several widely spread frames that could be found in data visualization examples from major news media and their COVID-19 coverage.

Previous research also investigated the aspect of reactance that often occurs when people see information that contradicts their previous beliefs and presents a threat to their freedom (Dillard & Shen, 2005). It is necessary to investigate whether it is possible to reduce reactance through various formats of the message, the strength of the argument (adding data to the message), or a particular frame of the message. In case of news about COVID-19, there is a need to address all those components concerning political partisanship and other individual differences, such as graphicy and the need for cognition to see the effect of various strategies on partisan perception. In addition to the traditional scale, computational textual analysis is implemented to help assess the reactance and extract more context from participants' reactions.

As a result, the overall general purpose of this study is to examine audience information processing of infographics, including how information about COVID-19 is processed through various dimensions of infographics in comparison with text-only messages and whether political preferences, need for cognition, and graphicacy variables impact people's reasoning and decision-making process. COVID-19 pandemic has become a controversial issue for the political groups and unexpectedly divided people in the United States by the partisanship line when liberal people are more accepting of the COVID-19 information and willing to follow the necessary measures to prevent the infection while more conservative people neglect the recommendations (Cornelson & Miloucheva, 2020; Hunt et al., 2020). In combination, all these factors increase the relevance of this topic for several fields and areas of expertise such as
political communication, health communication, risk communication, and journalism, particularly data journalism, since its primary goal is to communicate important issues for the audience through data and infographics. This study aims to analyze whether data visualization is an effective way for journalists to communicate health information and news about the pandemic and reveal more insights on how to improve that communicative process.
Chapter 2. Literature Review

Previous pandemics have already attracted attention of researchers leading them to the in-depth analysis of social media usage (Vos & Buckner, 2016), health risk communication strategies during a pandemic (Quinn, 2008; Vaughan & Tinker, 2009), and framing of journalistic coverage (Dudo et al., 2007; Leask et al., 2010; Lee, 2014). However, in most cases, scientists are interested in testing public service announcements (PSA) that health institutions specifically craft to promote healthy behavior among the population. Those studies add a significant contribution, but an enormous amount of information is consumed through mass media – a type of communication that features different strategies and journalistic standards (Leask et al., 2010). There is an urgent need to investigate the effects of the media messages that are being widely disseminated during crisis moments, notably the ongoing COVID-19 pandemic.

Recent COVID-19 outbreak led to emerging of multiple studies about the influence of various factors on people’s intentions to follow pandemic prevention measures, such as trust in scientific knowledge (Brzezinski et al., 2020), partisanship (Allcott et al., 2020; Barrios et al., 2020; Painter & Qiu, 2020), and political polarization (Cornelson & Miloucheva, 2020). As a result, there is a need to reflect on journalism and news media's potential for effective message promotion and figure out what variables affect perception of news media messages.

2.1 Journalism and Pandemic Coverage

Previous research demonstrates that during pandemics and critical situations, journalists are forced to serve additional [non-journalist] roles, such as public health educators (Holmes, 2008) since mass media is a dominant source of information about significant events for the public (Tchuenche & Bauch, 2011; Roche & Muskavitch, 2003). An early academic analysis of
the journalistic traditions for pandemics coverage started with the 1918 Influenza pandemic when journalists in both mainstream and scientific newsrooms such as the New York Times and Scientific American applied the highest standards of objectivity, facticity, empirical observation, and expert sources that shaped the way the influenza story was told during the outbreak (Spratt, 2001).

Since the 1918 Influenza pandemic, journalists have continued to provide essential information and tools to help their audience in practical risk assessment (Coleman, 1993; Dudo et al., 2007; Lee & Park, 2016, Roche & Muskavitch, 2003; Vaughan & Tinker, 2009). Extensive media coverage of previous outbreaks such as SARS and H1N1 demonstrated enormous potential in slowing the course of the epidemics, improving the knowledge, and changing the population's attitudes through the communication of health risks. The effect was identified through reporting the numbers for susceptible, infected, hospitalized, and recovered individuals. This form of communicating quantitative information has potential to persuade people to reduce their social contacts and implement behavioral change (Cui et al., 2008; Lui & Cui, 2008; Mummert & Weiss, 2013; Tchuenche & Bauch, 2011).

According to Mummert and Weiss's mathematical model (2013), media coverage has extensive capacity to significantly decrease the severity of pandemics by providing timely data about the numbers of new infected patients and deaths: "The rate at which individuals choose to employ social distancing measures is an increasing function of the number of current infections reported by the media" (p. 2). As their model illustrated, journalistic coverage can still reduce the prevalence of infected cases even when it was started late during the pandemic. However, it is critical to report updated, not historical, information during the later stages of an outbreak. These
recommendations can all be applied to media and journalists' ability to communicate and construct perceived risk for the audience.

2.2 Communicating Risk

According to Dudo et al. (2007), constructing risk assessment is essential for pandemic coverage. Issues that generate a high level of risk perception are usually those not under the individual's control, have low consensus on risk assessment in the public discourse, and provide benefits and risks that are not equal. As their findings suggested, mediated coverage of risk is most effective when it contains more quantitative information than qualitative facts about the issue's impact and magnitude. It should also include knowledge about the measures that people can implement to increase their self-efficacy and limit their risks, minimal sensational content, examples of similar scenarios that would help the audience to understand the risk, and an equal amount of thematic and episodic frames in the coverage (p. 435).

Coleman (1993) made an attempt to operationalize the risk as real and perceived, where perceived risk can be social-level (risk to others) and personal-level (individual's own risk) and can be measured on a cognitive level through assessment of the perceived chances of getting the disease and affective levels with concerns and worries people feel about risks. According to the author's findings, mass-mediated communication influences both social-level and personal-level risk judgments. The perceived risk may be operationalized as perceived severity and perceived susceptibility (Lee and Park, 2016). They argue that when perceived severity is present, the importance of informing the public about prevention measures and self-efficacy steps increases the influence of media messages. It could be the case that when the argument is strong and has data or statistics in the message, it may increase the sentiments of perceived threat. The current
pandemic presents an opportunity to test this effect in the experiment and observe the influence of individual differences.

2.3 Role of Framing in Pandemics Coverage

Another essential characteristic of a media message that sparked researchers’ discussion is message framing for specific issues by the media. There is no single definition of framing that all researchers would agree upon (Scheufele, 2008). Entman (1993) has called it a "fractured paradigm" while Reese (2007) defined it as a "bridging concept." Lecheler and De Vreese (2019) argued that the definition of the phenomenon is evolving, and the boundaries are constantly redefined. Nevertheless, Gamson and Modigliani's definition usually serves as the basic conceptual understanding. It illustrates a frame as "a central organizing idea or storyline that provides meaning to an unfolding strip of events, weaving a connection among them. The frame suggests what the controversy is about, the essence of the issue" (1987, p.143). The framing process emphasizes selecting particular aspects of the issue and presenting them as more salient to the audience and affecting its attitudes and judgments (Lecheler & De Vreese, 2019).

Previous research has also investigated the framing of the pandemics and related issues and challenges (Leask et al., 2010; Lee, 2014; Lee & Basnyat, 2013; Sandell et al., 2013; Spratt, 2001). Viral respiratory pandemics and infectious diseases coverage contains a greater extent of urgency, uncertainty, and information scarcity. Those challenges are even worse for pandemics compared to other health topics such as obesity, heart disease, or smoking: "the news coverage of viral pandemics is challenged by limited and unverified information, high uncertainties, and a distinctly urgent need for effective communication, interventions and community cooperation in a race against time to contain a deadly virus" (Lee, 2014, p. 295).
The coverage of prevention measures, self-efficacy, and responsibility frames were considered the main factors for newsworthiness for the journalistic content and an effective way for the journalists to communicate the risk (Lee & Basnyat, 2013; Sandell et al., 2013). In one of the studies, Sandell et al. (2013) compared the coverage of the 2009 H1N1 pandemic in Swedish and Australian media. They found that the media frames that constructed the risk in both media environments significantly affected the immunization rates in both countries during the pandemic. Immunization rates were low in Australia, while they have grown high in Sweden. The research demonstrated that in Australia, the media placed responsibility on various organizations, blaming them for the lack of information while in Sweden, responsibility was delegated to the community. Media provided extensive reporting on self-efficacy measures and uncertainties of the pandemic: "The differences between Sweden and Australia around the timing of risk communication and the use of self-efficacy and responsibility frames suggests the importance of these elements of a message in promoting desired community action during a pandemic" (p. 864). Lee and Basnyat found that among predominant frames for pandemic coverage, information updates and prevention messages were primarily used for H1N1 pandemic coverage in Singapore (2013).

Mass media and journalism also serve their democratic function involving its audience in the decision-making process during the crisis, making the public willing to implement appropriate measures in a more voluntary manner (Holmes, 2008). Another fundamental challenge for pandemic coverage is communicating uncertainty while maintaining trust since scientific knowledge, by its nature, is very uncertain. This uncertainty becomes even more salient during emerging infectious diseases when nothing is known about the disease, and novel experience occurs every day (Holmes, 2008).
Research about the previous framing of pandemics such as the West Nile virus and H1N1 has mixed findings. In the analysis of West Nile pandemic coverage, Roche & Muskavitch (2003) found a low degree of contextual precision, lack of quantitative information, and a failure to communicate risks by the print media: "The percentage of articles providing precise risk information was close to zero but also that a majority of articles failed to mention risk-reduction tactics such as source reduction and personal protection" (p. 363). On the contrary, the media in certain European countries such as the Netherlands exaggerated the threat. They overreacted to the severity of the outbreak and misinformed the public about the scale of the pandemic. It led to the waste of money for buying unnecessary vaccines that were not needed and became obsolete (Vasterman & Ruigrok, 2013). In 2010 the Council of Europe issued a report on the H1N1 pandemic where they had emphasized the need for "revising communication strategies related to public health matters" with the purpose "to avoid sensationalism and scaremongering in the public health domain." The media was blamed for producing "a cycle of fear-mongering" (Flynn, 2010, p. 9).

Vasterman and Ruigrok (2013) found that pandemics present several intersections with news values such as unexpectedness, consonance with expectations, intensity increase, negativity, relevance, meaningfulness, unambiguity, continuity, and unpredictability (p. 438). In many cases, those news values trigger the media's tendency to present the worst-case scenarios more often, as these have higher news value. In addition, pandemic coverage is often illustrated with the 'military' language that is also an instrument for alarmist tone and framing of fear (Vasterman & Ruigrok, 2013). However, there is a need to reflect on the levels of perceived threat and fear caused by the risk that is constructed by the media frames.
2.4 Data Journalism and the Role of Infographics in the Coverage of Pandemics

Within journalism and communication about health issues and pandemics, there is a need to examine the role of infographics in human cognitive processes. It is crucial to investigate the effects of data visualization and infographics on the perception, processing of information, and behavior change that is used to persuade people to implement preventive measures. One of the definitions of informational graphics stated that it is "a hybrid presentation of different modalities: text, photos, audios, videos, charts, maps, graphs, illustrations are combined; the interplay of these is more than the sum of the parts. In addition to multimodality, interactivity and hypertextuality are the main characteristics of interactive information graphics" (Burmester et al., 2010, p. 361). Infographics became a convenient tool that was used to visualize information about the COVID-19 pandemic. Therefore, there is a need to investigate the role of data visualization and how various statistical graphs, charts, and interactives help to convey quantitative information to present it to the audience for easier processing. With the recent increase in data and quantitative information, journalism went through new industry changes that led to the emergence of data-driven journalism and new innovative ways to present data to audiences.

2.4.1 Data Journalism: Its History and Influence on Media Perception

Due to the enormous amount of data collected, analyzed, and visualized, the COVID-19 pandemic was proclaimed the first 'data-driven pandemic' (Shelton, 2020). Along with the health organizations, journalists have significantly contributed to disseminating data about COVID-19 and the production of adequate coverage and storytelling to help people stay informed. Data journalists implemented various tools to track the pandemic as well as statistics and numbers of
infected, recovered, and deaths. Reporters analyzed phone data and geolocations of people tracking their everyday movements and checking their compliance with social distancing and self-isolation measures (Glanz et al., 2020). Moreover, they have also investigated credit card data to determine how Americans' expenses have changed because of the pandemic (Leatherby & Gelles, 2020) as well as the accessibility of COVID-19 hospitals (Koeze, Patel and Singhvi, 2020).

Data journalism had its foundations in the early 1960s when Philip Meyer started his "precision journalism" movement. The field went through several stages of development that affected its forms and definition. Initially, precision journalism encouraged implementing empirical methods from social science and statistical analysis to answer journalistic questions (Coddington, 2015). Later this movement was transformed into a more advanced form of data journalism that is often referred to by various terms, such as data-driven journalism, computational journalism, or computer-assisted reporting (Anderson, 2018). Despite the minor differences, they are seen as interchangeable terms with the lack of clear boundaries (Fink & Anderson, 2015; Lowrey & Hou, 2018; Royal & Blasingame, 2015). Finally, data journalism as a field emerged after the concept of computer-assisted reporting in the mid-2000s (Royal and Blasingame, 2015).

As a result of its historical development, data journalism became a practice that stands for openness, transparency, and accessibility of information and data. It places the public as an active participant in communication between journalists and their audience (Coddington, 2015). One of the definitions describes data journalism as "the process of telling stories with data." (Mair & Keeble, 2014, p. 27). Data journalism's primary goal is to explain complex quantitative information in a readable format for the audience. Weber and Rall (2012) defined data
journalism "as a workflow that consists of: digging deep into data, analyzing and filtering the found data, visualizing it, and forming a story" (p. 349). To develop the above-stated definitions, it is essential to add that data journalism is "a form of rich media with an added dimension: it implies a return to the factual, to the investigative. It's about interrogating the data, finding and formatting the relationships" (Mair & Keeble, 2014, p. 28).

Data visualization is an essential component of data-driven stories that help convey and present the results of data analysis. Newsrooms also publish the datasets they produce or links to the datasets they use for their stories to allow their audience to interrogate the data by themselves (Coddington, 2015; Parasie & Dagiral, 2013). Even though data journalism prioritizes scientific knowledge, it rather illustrates a combination of scientific and journalistic standards (Appelgren & Jönsson, 2020). To find a compromise between science and journalism, reporters have to select what to include in the data analysis and how to visualize and frame a particular story to make it clear for the broader public. It leads to the journalists' growing intention to simplify data analysis and infographics, sometimes sacrificing precision to make it more digestible for a more general audience since readers can hardly grasp statistical concepts.

2.4.2 Understanding Data as an Empowerment Tool

In our current reality of constantly streaming data, journalists have an essential purpose of translating the complex world of data and numbers to a broad audience to facilitate the essential democratic participation and decision-making processes (Craig, 2018; Steen, 2001). Numeracy, or ability to understand numbers and data, is a liberating and empowering tool in our contemporary world with the visible "triumph of numbers" (Porter, 1997, p. 1): "The power that numeracy has to liberate derives from the expansion of quantification's power from the natural world into the social world" (Craig, 2018, p. 62). Wiest et al. (2007) noted that numerate
citizenry is also crucial for maintaining social justice to develop public ability to foster equality as well as to be "informed voters and consumers" (p. 47).

According to Peters (2012), "greater numeracy has been associated with reduced susceptibility to framing effects, less influence of non-numerical information such as mood states, and greater sensitivity to different levels of numerical risk" (p. 31). In addition, a high level of numeracy helps to avoid misleading judgments and to have more control over the situation and decision-making process: "Innumerate' individuals may fail to understand critical information or be manipulated by politicians, marketing campaigns, and other persuasive persons and situations" (Wiest et al., 2007, p. 51). Cohen (1999) used numeracy as a modern indicator that separated numerate and innumerate people as powerful and powerless:

Just as the possession of basic literacy once marked a significant dividing line in society, between the powerful and the powerless or between the priests and the people, numeracy is now the basic skill that increasingly establishes a status boundary in the world of work (p. 5).

Numeracy is often presented as a critical ability for people in today's global market. It is considered a competitive advantage for economic success, but it is rarely seen as a necessary element for building an informed and engaged democratic society (Root, 2009). From this perspective, it is possible to find a central point where numeracy and journalism intersect with each other and have common characteristics: Both are socially significant phenomena that help form informed citizens, positively influencing their decision-making process to build a better democratic society.

In this context, it is necessary to mention Schudson's 'information-based model of citizenship' (2004), where citizens must be fully informed and able to make rational decisions on
issues of public concern: "We moved on to an era that held up the informed citizen as the ideal and created a set of institutions to help make individual rationality in politics more possible" (p. 55). Data journalism is considered to be one of the actors in this interaction where journalists have to ensure that their audience extracts the correct inferences from the data and understands numerical information about the current issues. Kreiss (2016) has also defined data journalism as a tool for maintaining the administrative model of journalism that has to provide effective instruments for citizens to help them "to clearly evaluate the dynamics of electoral politics and policymaking, separate empirically grounded arguments from useless prognostications, and ultimately hold pundits, campaigns, and elected officials alike to account for their factual statements and job performance" (p. 60).

2.4.4 Conceptual and Operational Definitions of Infographics and Its Impact on News

Reporters use data visualization to present complex numerical information, sometimes with text, to form new types of content and use data with infographic design elements. Scientific research on data visualization grows, and researchers have already conceptualized various aspects of data visualization (Burmester et al., 2010; Segel & Heer, 2010; Tufte, 1983), including framing in the presentation of visual information (Alieva, 2021; Hullman & Diakopoulos, 2011).

Journalists have noticed that stories with infographics generate 30 times more page views than stories without data visualization or DataViz (Dick, 2020). A complete definition of DataViz includes "a hybrid presentation of different modalities," including text, charts, maps, graphs, illustrations that are combined in one story (Burmester et al., 2010, p. 361). There are other variations of the definition of data visualization, such as one by Smiciklas (2012), who explicated the term as "a visualization of data or ideas that tries to convey complex information
to an audience in a manner that can be quickly consumed and easily understood" (p. 3). Krum (2014) argues that today's definition of data visualization includes "a larger graphics design that combines data visualizations, illustrations, text, and images together into a format that tells a complete story" (p. 6).

Although data visualization is a relatively emerging topic in academia, researchers have established various strategies to study this recent phenomenon (Ausserhofer et al., 2017; Hermida & Young, 2017; Stalph, 2018). There are several approaches towards the definition and understanding of the terms of data visualization and infographic. Cairo (2012) suggested placing two of them on the spectrum from description to explanation; however, I will follow Dick's approach (2020), where both terms are used interchangeably. In his detailed analysis of the history of data visualization in Great Britain, Dick (2020) presents an alternative vision of data visualization as "visual rhetoric used to express the key political messages of the day" (p. 3). He emphasized the influence of our modern visual culture on people's perceptions that were changed through the rise of visual representations and the commodification of the image as a cultural artifact. He argued that infographics have a much more significant impact from a semiotic standpoint rather than just its straightforward functionality: "visual journalists are careful in their use of color, aware of the association of tribal and/or political symbolism, and they create infographics in the knowledge that some infographic forms seem to be less appealing to their audiences than others" (Dick, 2020, p. 9). However, for the operational definition in this study, there is a need to emphasize the element of the argument strength reinforced through the usage of data or statistics in the message. For our purposes, the main element of a data visualization or an infographic should be the data or statistical concept that would add persuasive effect and argument strength to the message (Park et al., 2007).
Segel and Heer (2010) developed the basics of understanding data visualization as an element of framing processes as well as phenomena of visual salience that shows how "visual features such as color, size, and orientation preferentially attract one's attention" (p. 1140). Data visualization was a helpful tool for presenting graphical information to communicate the recent COVID-19 pandemic. Major newsrooms, such as the New York Times and the Washington Post, produced data visualization content for communicating the numbers of deaths and infected cases as well as the influence of prevention measures and vaccination. Through data visualizations, news media attempted to provide directions and updates that inform their audience about the pandemic's effects and help them make decisions of how to deal with the threat of the virus.

Visual information in journalism, such as graphics and interactives, can frame issues and promote particular perspectives (Alieva, 2021; Hullman & Diakopoulos, 2011). Through infographics and data visualizations, mass media form directions that help their audience to understand various processes, including health issues and pandemic: "Early theory emphasizes the analytic nature of graphical displays, as well as automated methods that optimize constraints imposed by human perceptual and cognitive abilities" (Hullman & Diakopoulos, 2011, p.2232).

Data journalists have a great social responsibility as translators of big data and datasets’ technical language through infographics (Boyles & Meyer, 2016). Reporters can formulate clear and concise narratives with interactive and visual elements for strengthening the meanings in social conversation. As with traditional reporting, new forms of data language led to the salience of information. Data graphics and interactives allow readers to not only get involved in the democratic processes and discussions but also to build interpretations through different manipulations with data: "Activating audiences in conversation around data journalism has been most successful when focusing on highly personalized, local-level, policy-driven news products"
(Boyles & Meyer, 2016, p. 949). Hullman and Diakopoulos (2011) have focused on the phenomenon of framing and demonstrated how narrative visualization could affect readers' interpretations of information by using the data, visual representation, textual annotations, and interactivity: "Information representations can influence interpretation in diverse ways, such as by presenting a preliminary statistic before a decision, or by manipulating the anchor points on a survey scale" (p.2232).

2.4.5 Covering Health Issues and Pandemics with Infographics

Previous research found that the presence of statistical or quantitative information influences people's judgment and risk perception as well as makes the message more informative (Steinhardt, 2019; Dudo et al., 2007; Roche & Muskavitch, 2003). As Siricharoen and Siricharoen emphasized, "infographic can be the great trigger to human's brain to change human's behavior toward health care awareness" (2018, p. 66). Dudo et al. (2007) argued that quantitative data in journalistic coverage increases the possibility of informed decision-making for the audience compared to qualitative information. Infographics in media coverage attract attention of the audience and help readers make sense of complex information (Utt & Pasternak, 2000). However, certain studies found that infographics had particularly detrimental effects on risk recall, subjective risk comprehension, and information evaluations, especially among people with lower numeracy and health literacy (Damman et al., 2018). This finding suggests an influence of information overload on people who cannot digest numbers and understand quantitative information. This overload should not be a problem with media coverage since it is usually produced for a broader audience to understand and uses straightforward infographics representations.
Infographics accompanied by text can increase persuasion and audience engagement with the message. Through the Elaboration Likelihood Model and evaluation of pro-environmental messages, Lazard and Atkinson found that "individuals engage in greater levels of issue-relevant thinking when shown infographics than messages that rely just on text or just on illustration" (2015, p. 6). In their analysis of environmental health risks in the news, Miller and Barnett (2010) found that combining infographics and text is the most effective combination for people's perception. However, people who saw text-only information had a greater sense of control regarding the environmental risk. Stone, Yates, and Parker (1997) demonstrated through a series of experiments that infographics increased risk avoidance. According to Welhausen (2015), infographics about pandemics decrease risk perception among experts while increasing it for a non-expert audience. In the reality, it is possible to say that the journalistic coverage has to be clear for a broader audience, meaning that it is less likely most readers would be experts in epidemiology.

2.5 Message Credibility and Message Effectiveness

Recent research has conceptualized credibility through three main components: source credibility, message credibility, and media credibility (Appelman & Sundar, 2016; Metzger et al., 2016). Previously, credibility was mainly a result of a source attribute; however, scholars found the influence of other non-source characteristics such as the role of the channel or the structure of the message itself. For a long time, the last factor of message credibility was ignored; however, it will be an essential component to focus on in this study since there is a need to test the impact of the content elements such as infographics. Since today's informational environments of many people consist of a mix of sources and social media where multiple
messages from various sources repeat themselves, researchers talk about diminishing the role of
the source and the medium in credibility perceptions (Appelman & Sundar, 2016). Message
credibility assessment will help us investigate the message effects of various infographics and
text and information processing of health information in infographics. In this study, the
researcher will not implement source credibility since the primary purpose here is to see how the
content of the message affects people's political biases without additional information about the
source; however, it would be interesting to try it in future research.

Credibility is defined as "an audience member's perceptions of the communicator's
qualities" (Perloff, 2010, p. 166). Sundar argues that media credibility is "a global evaluation of
the objectivity of the story" (Sundar, 1999, p. 380). The main challenge of credibility assessment
lies in the method of measurement since it is not easy to find the right tool that would account for
many factors at play, such as trustworthiness and expertise (Appelman & Sundar, 2016; Chung et
al., 2012). However, there is a lack of studies investigating the message credibility apart from the
source. This concept is essential for journalists and is explicated in media-related research as
news perceptions related to quality, liking, and representativeness (Sundar, 1999). According to
Appelman & Sundar (2016), "people's perceptions of message credibility could, presumably,
affect the way they make subsequent judgments, but it would still be an effect in its own right"
(p. 63). Therefore, they have specified a definition of message credibility and argued that it
contains an "individual's judgment of the veracity of communication content" (p.63). In addition
to the definition, Appelman & Sundar invented a measurement scale specifically for message
credibility assessment that included questions about the extent to which the message is accurate,
authentic, and believable. This scale is implemented in this study to measure the credibility of
the messages with infographics and see whether the presence of data in the graph increases the perceived credibility of the news.

Today when people primarily consume information online and through social media, the questions of message credibility become more crucial than source and medium credibility since it becomes harder to figure out the source of the information and its medium. The issues of informational literacy, numeracy, graphicity, the ability to critically analyze and question information from various sources are critical in the current media environment. Message credibility is considered one of the fundamental indicators since it "examines how message characteristics impact perceptions of believability, either of the source or the source's message," and that is where the source's credibility and the message overlap (Metzger et al., 2016). According to the Elaboration Likelihood Model of persuasion, message factors play a significant role in coordination with high issue involvement, previous knowledge, and personal relevance (Metzger et al., 2016). Previous research investigated message comprehensibility, a number of arguments, incentives, fear appeals, repetition, and presentation style on recipients' attitude change (Slater & Rouner, 1997). Usually, unorganized messages are perceived as less credible than organized messages (Gass & Seiter, 1999). Using high-quality and relevant evidence increases the positive impact on the perceived credibility of the message (Hamilton, 1998). Rieh and Belkin (1998) found five dimensions that audiences use to judge information quality, such as accuracy, comprehensiveness, currency, reliability, and validity. Messages confirming our preexisting beliefs are perceived as unbiased and more credible (Bacon, 1979; Stamm and Dube, 1994). That could explain why people with particular political views will perceive partisan information as more credible because of the preexisting familiarity of that information. However,
it is important to consider the context of uncertainty in crisis situations such as pandemics when it should be hard for the audience to verify this information or connect it to the previous beliefs.

In addition to the perceived message credibility, previous research has identified the significance of message effectiveness and its impact on the audience's compliance with proposed measures from the message. For example, Davis et al. (2017) identified the direct causation between message effectiveness and desirable effect of smoking cessation: "Our PE [perceived effectiveness] scale at baseline was associated with prospective quit attempts at follow-up among a probability-based longitudinal online sample of adult cigarette smokers" (p. 936). Even though the effect was found in experiments with public service announcements, the findings illustrated an increase in perceived effectiveness in the messages with graphic and emotional content. However, there is not enough data about the data and infographics' influence on the message effectiveness of health news.

It is empirically identified that strong arguments are accepted with favoring thoughts and attitudes in line with the given message (Petty & Cacioppo, 1986). Argument strength is used interchangeably with message strength or message credibility and serves as a good indicator of persuasive impact. The findings from previous studies have demonstrated a more significant effect of a strong argument on attitude formation (Park et al., 2007; Shin et al., 2017) and attitude change (Johnson, 1994). Park et al. (2007) defined a strong argument as a message that consists of compelling logic, valid reasons, and objective data that provide support for an argument, while weak arguments formed statements without a strong logical basis. Overall, message strength is determined by examining whether the message presents objective and valid evidence for supporting an argument. The presence of data and infographics has the potential to increase the argument strength and credibility of the message.
Considering all the previous research analysis, it is necessary to test whether the message with infographics will influence participants’ attitudes and intentions as well as whether various thematic frames of infographics conditions will change the perception of news. As a result, specific hypotheses and research questions can be formulated:

**H1:** Message with infographics will be associated with higher measures of message acceptance (attitudes, intentions, self-efficacy intentions for a behavioral change) and lower measures of message rejection (defensive avoidance, reactance, anger) than text alone.

**H2:** Infographics will be related to higher message credibility and message effectiveness compared to text alone.

**RQ1:** What kind of infographics frame will result in the strongest message acceptance measures?

**RQ2:** What kind of infographics frame will be associated with the strongest message credibility and message effectiveness?

### 2.6 The Impact of Individual Differences: Graphicacy, Need for Cognition, and Political Partisanship

#### 2.6.1 Cognitive Psychology Perspective for Infographics Processing

Michal and Franconeri (2017) provided a basic explanation of how graph perception and interpretation work through the established visual routines that form an algorithm of what kind of relationships will be grasped and in what order. Those routines depend on graphical literacy, defined as "the ability to read, construct, and interpret visual displays of information" (Michal & Franconeri, 2017, p. 1). These routines have to direct our cognitive and visual capacity since human cognitive processing is limited, and the proper allocation of our resources is needed to
help digest information efficiently. According to the researchers, people most commonly pay attention to the bar on the left or the tallest bar. In this case, the visual routines may be needed because of "tight capacity limits on these types of visual relation extraction" (p. 2). Therefore, the graphic must be designed to tune our patterns precisely with separated anchor points – the target object and a referent object. Using this kind of design, it is possible to focus people's attention on a particular aspect of the graph and define the processing order. For example, Michal & Franconeri (2017) found that when judging the size, people usually attend the taller bar first, and while evaluating the color, the darker one is mainly preferred. Furthermore, participants usually attended the task-relevant dimension first in the experiment where the size and color were tested. However, the results showed that participants experienced interference from the task-irrelevant extent: "thus, the ability to extract relevant relations in graphs may require well-developed top-down control, particularly when graphs vary along multiple dimensions" (p. 8).

According to those results, visual routines are preinstalled within the attentional shifts that usually accompany eye movements and provide a serial mechanism for graph processing. However, other research showed that visual routines are not naturally inherent but formed through obtaining graphical literacy.

Halford et al. (2005) also investigated graph processing to determine how many variables a human can process. Similarly, their research was based on the assumption about the limited capacity for human processing and the findings of Miller (1956), who found that learning depends on the optimal amount of information that does not exceed the capacity. Miller stated that the limited span of immediate memory is a maximum of seven items in length that would be possible to reach by using various memorizing strategies such as chunking. Finally, Halford et al. (2005) tested the ability to process multiple interactions without using any method that would
help to memorize or process information. Their results demonstrated a significant decline in accuracy and speed of solution from three-way to four-way interactions. As a result, their findings concluded that "a structure defined on four variables is at the limit of human processing capacity" (p. 70).

Pinker (1990) was one of the researchers who systematized the principles of graph comprehension. According to his research, graphics help people digest information since they exploit general cognitive and perceptual mechanisms. He attempted to demonstrate how reading the graph is executed and what procedures and operations are implemented by human cognition. He specified four principles that constrain the form of visual descriptions in ways that are relevant to graph comprehensions, such as indispensability of space, gestalt laws of grouping, representation of magnitude, and coordinate systems. The indispensability of space is an object's spatial location consisting of two spatial dimensions (plus time) and indispensable attributes. These attributes include particular properties such as perceptual numerosity (variables and units), configural properties ("predicates corresponding to all perceptible physical dimensions" such as color, brightness, lightness-gradient, shape, and others that communicate particular patterns), discriminability and linearity, and selective attention ("mechanism that activates various encoding mechanisms to process a given spatial region of the visual array, to encode more predicates into the visual description or to verify whether a given predicate is true of the entity at that location" (p.83). Pinker also mentioned gestalt laws for graph comprehension that "dictate that distinct static perceptual elements will be seen as belonging to a single configuration if they are near one another ("proximity"), similar in terms of one or more visual dimensions ("similarity"), smooth continuations of one another ("good continuation"), or parallel ("common fate") in the 2D plane" (p.84). Another principle that constrains the form of visual descriptions
and affects graph comprehension is the representation of magnitude. Similar to Miller (1956) and Halford et al. (2005), Pinker (1990) emphasized the limitation of the number of values processed by a human. The fourth principle is defined as coordinate systems that are "appropriate to represent an object in a set varying along several dimensions" (p. 87).

According to Pinker, there are also additional processing constraints on visual descriptions such as processing capacity ("between four and nine nodes may be kept active at one time" (p.88) and default encoding likelihood and automaticity (the process when "the recognition of patterns becomes rapid, error-free, and relatively insensitive to other attentional demands as the patterns become increasingly well-practiced" (p. 89) that is affected by available processing capacity). Different types of graphs can convey various classes of information and dimensions; for example, a line graph is better for illustrating trends and interactions. Tables are helpful for absolute values, while bar charts serve to display differences between values.

2.6.2 The Role of Graphicacy

Shah & Freedman (2009) investigated how the format of the graph (line or bar chart), viewers' familiarity with the data, and graphicacy skills affected subjects' comprehension of the graphics. According to the authors' findings, the format of the graphs affected viewers' interpretations of data: "viewers were more likely to describe x–y interactions when viewing line graphs than when viewing bar graphs, and they were more likely to describe main effects and "z–y" (the variable in the legend) interactions when viewing bar graphs than when viewing line graphs" (p. 560) — the subjects' familiarity with the data and their graphicacy skills interacted with the influence of graph format. Participants, in most cases, could generate inferences only when they had high graphicacy skills and previous familiarity with the data. As the researchers
have stated, graphicacy or graph comprehension skills help people understand how to conduct various operations with visual data and mentally transform it to generate the proper inferences for particular graph formats. Content familiarity has also assisted participants in the process of mental computation and the generation of inferences. However, the effect of familiarity worked only for high-skilled graph viewers. The authors also found not only that participants who had higher graphicacy skills could generate more inferences from the data but also, they were more affected by the data format: "skill may sometimes correspond to greater differentiation between formats rather than less differentiation between formats" (p. 573). As a result, the best comprehension of the graphics works in interaction with the previous familiarity of the data and high graphicacy skills when the graph format provides the ground for those inferences. Low-skilled graph viewers' prior familiarity with the data does not help – they cannot generate the correct inferences.

Another study by Keller and Junghans (2017) emphasized the importance of graphicacy and numeracy skills in understanding quantitative graphs. According to their findings, individuals with high numeracy skills can better understand various complex charts, "such as survival curves or displays of trends in health-related quality of life after treatment, as well as risk comparisons" (p. 942). The authors combined the information-processing approach to numeracy with graph comprehension and information-reduction theories. They found that better graph comprehension by individuals with high numeracy skills was reached by their developed ability to pay attention to task-relevant graphical elements, which they used to extract numerical information for graph processing. As the authors stated, it is crucial to account for the information-processing approach to numeracy that "refers to knowing how much and what information to extract to perform mathematical operations" (p. 943). Numeracy was significantly
correlated with graph comprehension in the study and was associated "through visual attention to task-relevant numerical or graphical elements" (p. 944). They also found that intensive training may help people learn how to increase the ability to strengthen task-relevant visual attention skills similarly for people with high and low numeracy levels. However, it did not help to significantly improve graph comprehension for low-numerate individuals. Using appropriate instructions in the teaching strategy, such as guiding toward task-relevant information in the graph, may help people improve their graph processing skills. However, there is a need to work on numeracy levels to affect the graph comprehension skills. Another question of understanding probability in graph comprehension could be answered with the help of a study by Tversky and Kahneman (1975). They found that even people with a high level of expertise are often prone to biases when assessing probability, showing that people cannot naturally grasp this concept while making decisions under uncertainty.

2.6.3 Need for Cognition

Need for cognition is an individual characteristic that measures how a particular person is engaged in the cognitive thinking process. It was developed by Cacioppo and Petty (1982) who found that individuals with a high need for cognition put more effort into thinking about facts, arguments, and issues from the messages that are presented to them. The need for cognition is described as "a need to structure relevant situations in meaningful, integrated ways" (Cohen, Stotland, & Wolfe, 1955, p. 291) that helps to understand the information around us. People with a high need for cognition tend to engage in a more thorough analysis of facts and consider multiple factors and additional cues of the message, such as the sources and argument strength. Cacioppo, Petty, & Morris (1983) also identified that the need for cognition impacts message
evaluation, recall, and persuasion. They found that individuals with a higher need for cognition were significantly more influenced by the argument quality and source impressions and characterized by the stronger ability to recall message arguments and details.

Previous research found that people with high NFC experience higher motivation to think about a variety of issues and reflect on their thoughts: "This enhanced thinking often produces more consequential (e.g., enduring) judgments and can sometimes provide protection from common judgmental biases" (Petty et al., 2009, p. 318). Petty and Cacioppo (1982) conceptualized NFC as a component of dual-process theory that is called Elaboration Likelihood Model. It explains the efficiency of information processing through central and peripheral routes where the central route is characterized by higher motivation, involvement, and detailed analysis of information while the reliance on superficial cues would represent peripheral route. Need for cognition is used in this process to demonstrate the level of engagement with the message and the degree to which an individual prefers to actively process a message in order "to tap individual differences in intrinsic motivation to engage in effortful cognitive endeavors" (Hagtvedt & Petty, 1992, p. 309).

High need for cognition predicted the ability of individuals to consider the inconclusive nature of the issues with mixed evidence that demonstrates how people with high NFC tend to elaborate more extensively on the features of the argument (Kardash & Scholes, 1996). People with a lower need for cognition tend to rely on simple cues such as attractiveness, the credibility of the source, the appearance or frame of the message (Petty et al., 2009). However, that doesn't mean that people with high NFC do not use their feelings and perceptions in their decision-making process. They rely on them "only to the extent that they have confidence in them, so too do they rely on any salient mental contents primarily when perceived validity is high" (Petty et
al., 2009, p. 320). Previous research also found that individuals with lower NFC may scrutinize information and apply more detailed analysis in cases when the message is relevant to them (Axsom, Yates, & Chaiken, 1987) or when it overlaps with the recipient's self-concept (Evans & Petty, 2003).

Even though people with a lower need for cognition are prone to a more significant amount of bias produced by mental shortcuts, there is an evidence that people with high NFC tend to demonstrate bias. Still, this bias will emerge through effortful thoughts: "When a bias can come about through either route, individuals both low and high in NFC can show the effect, but it will be produced by different mechanisms" (Petty et al., 2009, p. 323). Previous research also found that it is harder for people with a higher need for cognition to change their preexisting beliefs obtained through more effortful cognitive processing (Haugtvedt & Petty, 1992).

2.6.4 Motivated Reasoning Theory and Political Partisanship

In addition to the need for cognition, our previous beliefs affect the cognitive processing of new information. Miller (2012) identified three types of persuasion: opinion formation, belief reinforcement, and belief change. The difference between them is placed on the time when the attitude was formed or changed. Opinion formation is the first phase when an individual tries to fill the knowledge gap and learn new information about an issue. Then an individual may encounter more information that confirms preexisting belief leading to reinforcement of that belief. A final type of persuasion is an opinion change that would mean new information attempts to change the behavior or previously formed attitude. As Miller stated, belief change is considered the most complicated goal to achieve compared to belief formation and reinforcement. Motivated reasoning theory explains how our preexisting attitudes affect the
processing of incoming information. Druckman & McGrath (2019) described the process of Bayesian updating that presents a primary mechanism for understanding how our reasoning is structured, with the prior beliefs serving as foundations for processing new information. The reasoning process can be directed by both accuracy goals and directional goals, where accuracy goals lead to seeking accurate information to update previous knowledge with precise facts, and directional goals lead to the selection of arguments that confirm previous attitudes and ignore information that contradicts prior knowledge.

Directional motivated reasoning is usually taking place in political communication when people's partisanship views interrupt with their reasoning and force them to follow their previous attitudes about partisan issues such as various scientific issues (global warming, vaccination, abortion, COVID-19), as well as socio-political issues (racial injustices, gun control) while ignoring unpleasant information about political candidates and resisting the rational arguments about the most important consequences of the political decisions that are at stake.

Lodge & Taber's John Q Public Model of motivated reasoning places the influence of emotion on our cognition as a central element of our processing (Lodge & Taber, 2013). The theory states that individuals form their attitudes and beliefs about political issues through emotional reactions that can hardly be modified. New information triggers the process of hot cognition when it is processed through the previously existing affect that leads to beliefs updating through the previous affective bias.

Directional motivated reasoning includes three types of processes: confirmation bias, prior attitude effect, and disconfirmation bias (Lodge & Taber, 2013). Confirmation bias demonstrates that people accept arguments that confirm their attitudes, while disconfirmation bias would do the opposite – people would disagree with the information that contradicts their
attitudes. The prior attitude effect would mean that the new data is assessed through the influence of the previously formed opinion.

Other theories that were mentioned by Druckman and McGrath (2019) include identity-protective cognition that reinforces previously existing partisan views, however, through a different cognitive mechanism. An individual would accept partisan opinions to avoid the perceived threat of incongruent information to their identity. In this theory, confirmation bias would work as a self-defense mechanism and help people feel secured through their in-group attachment. Druckman and McGrath also mentioned selective perception and a perceptual screen similar to selective exposure that allows to search for information that would confirm an individual's previous knowledge.

Much attention is paid to the strength of partisanship beliefs, political knowledge, and political sophistication in the previous research where researchers found that in most cases, people who know a lot about politics process political persuasion differently and express more affective polarization. Partisan attitudes become a part of the person's identity through higher political involvement and political sophistication. As it was already mentioned in connection to the need for cognition, the Elaboration Likelihood Model of persuasion presents evidence that people highly involved in a political discussion will process this information through the central route, paying more attention and spending more cognitive resources. In contrast, people who are not interested in the topic may take the peripheral route and form their opinion through peripheral cues. However, taking the central route of processing does not always mean that partisan readers will follow accuracy goals. Instead, they will highly likely spend more time and cognitive resources trying to debunk the contradicting facts using their previously accumulated knowledge (Druckman & Bolsen, 2011; Prior, 2013). People with higher political interests and
political knowledge have a stronger reaction to defending their previous beliefs, and for them, protecting social identity becomes the primary goal.

Nowadays, growing political polarization in the United States demonstrates that partisanship can often be predicted by demographic characteristics such as education, race, geography, and religion. The research identified that the U.S. population was significantly divided based on political preferences into more educated, urban, racially diverse, secular, liberal people and less educated, rural, mostly white, Christian conservative people (Cornelson & Miloucheva, 2020; Prior, 2013). This phenomenon reinforces social fragmentation and affective polarization. Also, partisans have a different perception of source credibility where liberals tend to trust science and media, and conservatives have more hostile attitudes towards those sources.

As a result, there are many different ways for acquiring a biased, false, or misleading belief about politics, science, and other controversial topics that are often being split based on political views and attachments. Our brain seeks necessary information to fill the gaps and resolve cognitive dissonances that increase proneness to accept disinformation and conspiracy theories (Carey et al., 2020).

Motivated reasoning could be measured through psychological reactance, a phenomenon conceptualized by Dillard & Shen through affect and cognition (Quick, Shen & Dillard, 2012). They proposed a system that would assess the degree of anger and counterarguing to measure reactance level. They have also formulated the theory that demonstrates that emotion is activated first before the cognition while cognition is connected later to the emotion and previous beliefs. Psychological reactance is particularly salient for strong partisans when political attachments are perceived as a part of an individual's identity.
As for limitations of the motivating theory reasoning, we need to emphasize a complicated process that is hard to simulate in the laboratory settings since the reality is much more complex, and our brain processes information from multiple sources and environments that would be hard to reconstruct in the form of the experiment. Even though motivated reasoning theory is very powerful and can explain a significant part of our real-life processing, previous research identified how to overcome motivated reasoning. Redlawsk et al. (2010) found the concept of 'tipping point' that illustrated how even extremely partisan voters might accept negative information about their preferred candidate when the right amount of negative information about the candidate is presented, and the tipping point is reached. The researchers suggested that there is a point when people become anxious after being exposed to a significant amount of negative information and, as a result, accept this information. According to the theory (Redlawsk et al., 2010), people with more neuroticism who can easily get anxiety are more deliberate thinkers. It could be the case that their sensitive neural system is easily stimulated by the negative information, and their immediate reactions become activated. At the same time, people with lower sensitivity may ignore negative information for certain amount of time. Another way to decrease the effect with motivated reasoning is to increase people's exposure to various sources and more diverse information. As mentioned in the study by Warner et al. (2020), debates can expose partisans to the opposite views and lead to a possibility that a candidate from the out-party group may gain a certain understanding of their position. Framing can play a role and increase the persuasion of scientific information. The study by Druckman & McGrath (2019) demonstrated that the patriotic frame successfully improved positive attitudes toward climate change and environmental issues among conservative voters.
There is a need to understand what kind of people usually tend to engage in motivated reasoning and how they react. In the current situation, when the COVID-19 pandemic became one of the controversial issues that divided people based on their political beliefs, it is necessary to investigate the role of need for cognition, graphicacy and political partisanship, as well as what kind of media messages could work for effective health communication after controlling for differences in those variables. Infographics could be another way to improve health communication (Lazard and Atkinson, 2015). Messages with infographics help better communicate environmental issues; however, there is a need to test its effects on accepting scientific knowledge about more controversial partisan topics such as the COVID-19 pandemic.

As a result, the following hypotheses are formulated:

**H3:** Message with infographics will be associated with higher message acceptance measures and lower message rejection measures as the value of the moderators such as need for cognition and graphicacy increases.

**H4:** The usage of infographics will be related to higher message acceptance/lower message rejection, higher message credibility, and message effectiveness for Democrats than for Republicans and independents.
2.7 Computational Textual Analysis

Now it is possible to observe how humanities are merging with so-called 'hard' sciences such as computer science, mathematics, and statistics to improve the analysis of unstructured data forms such as text and images. As a result, the new field of computational social sciences or digital humanities has evolved due to that merge. Now computational methods of analysis attract more researchers from various fields of humanities such as sociology, culturology, journalism, communication, literature, and other fields where the text is an essential component for analysis.

Computational text mining (or automated text mining) is a part of a wider field of natural language processing that has started its development in the 1960s. Since the 1990s, it has implemented the methods of machine learning and statistical tools. This field is growing every year with more tools, methods, and software applications being created and constantly improved. However, there is still certain skepticism about whether these methods can be used independently since there is still a need for qualitative analysis of the results obtained using computational methods for analysis. Some researchers claimed that computational methods would bring objectivity and rigor to the previously unstructured humanities. In contrast, another camp of researchers such as Manovich (2012) thinks that computational methods can only complement techniques that already exist.

Methods for computational textual analysis could be used for virtual/digital ethnography, political sentiment analysis, prediction of possible political uprisings, tracking the spread of the diseases, implicit framing analysis, and even political polls. Cui et al. (2008) used computational methods to identify how media coverage with reporting numbers of susceptible/infected/dead cases during the pandemic affects compliance with the prevention measures. O'Connor et al. (2010) have analyzed Twitter sentiments for a political campaign and found that it is correlated
with the sentiments expressed in political polls. Kosinski et al. (2013) revealed that data from social media can help predict personality traits of the person, including gender, sexuality, and political preferences. Wilson et al. (2009) analyzed textual data for Google searches and found that the trajectory was similar to the official tracking of the disease for the H1N1 pandemic in New Zealand. Gaby & Caren (2012) found particular features of the Facebook posts that helped recruit more followers for Occupy movement.

It is essential to say that there is no one universal solution of computational text mining implementation for every research idea. Every case is individual, and each researcher must consider all the advantages and disadvantages of the method to decide on the research design and type of data analysis needed. Most of those methods can be used for data mining, pattern recognition, data visualization, statistical analysis, prediction, and optimization of the research process and data analysis. Figure 1 demonstrates the main steps for implementation of computational textual analysis

**Figure 1. The Structure of the Process for Textual Data Analysis**

- **Data collection/extraction** (data access tools: API)
- **Data preparation** (tokenization, lemmatization, stemming, removing stop words, cleaning)
- **Data analysis** (dictionary-based, unsupervised, or supervised ML)
- **Data interpretation** (qualitative approach will be needed)

Computational textual analysis methods can be deductive (manual, semi-automated), inductive (fully automated), and abductive (moving around using both) approaches. Figure 2 illustrates how various methods for computational textual analysis are classified in the field:
For this research, unsupervised machine learning analysis will be used to identify topics in survey responses. Unsupervised methods are usually used when categories of the data are not identified. The algorithm processes all the textual data, searching for the patterns in the words and text structures figuring out by itself what are the overall topics or clusters. That is why these methods are used for identifying frames, topics, and discourses in the massive data with texts, news, and documents.

The main principle of unsupervised text classification is that it is based on the distribution of words in the scope of documents that could be defined as a frame or topic. The distribution of topics and words is analyzed from probability distribution based on the co-occurrence of words. For unsupervised methods, principal component analysis and cluster analysis are used for dimensionality reduction. Another method used for dimensionality reduction is tf-idf or term frequency-inverse document frequency (Arnold & Taylor, 2015). This method assigns a score
representing the weight of a particular word in the whole scope of text. If the word occurs many times in the data, it gets a lower score and smaller weight. These techniques replace each word in the text with a number (vector) and then use various metrics to calculate similarities and differences between textual units and documents. There are two significant types of analysis for unsupervised methods: clustering and topic modeling. Cluster analysis defines the number of possible clusters for the documents (k-means is a widely used statistical method). The K-means method sends each document to the closest cluster with the documents of similar characteristics identified by the algorithm.

Figure 3. K-means Clustering.

Topic modeling helps to identify topics in the documents using probabilistic models that evaluate the co-occurrence of words. LDA (Latent Dirichlet Allocation) is latent semantic indexing for text analysis and topic modeling (Arnold & Taylor, 2015). It assumes random allocation of words across a theme/topic and uses classification to analyze the probability of a document containing information about a topic by word distribution. Thus, it helps to find more meaningful relations and topic representations based on word distribution. However, there are limitations of the method that show the LDA algorithm doesn't take into account the order of words or the order of documents. Also, it does not recognize the relationship between topics, and it cannot identify slight changes in topics.
Guo et al. (2016) conducted a survey using LDA and dictionary-based methods for textual analysis. They found that LDA identified more topics comparing to the dictionary-based and manual coding, but at the same time, those topics were less structured. Moreover, shortly saying LDA yielded more false positives while dictionary-based produced more false negatives. However, there is a way to implement a supervised LDA where text is connected to a particular identifier (Blei & Lafferty, 2007) or add qualitative manual analysis to the unsupervised topic modeling. This study implements computational textual analysis to analyze the scope of open-ended question responses to identify overall topics and sentiments about COVID-19 coverage and see whether there are any differences between partisanship groups. As a result, a research question can be formulated:

\textbf{RQ3:} What differences can be found in reactions towards COVID-19 messages between Democrats, Republicans, and independents?
Chapter 3: Methodology

For this study, the experiment design is implemented to collect quantitative and qualitative data from the same sample of participants. This research aims to identify how different types of infographic messages about COVID-19 affect people's reactions through the influence of their political partisanship, need for cognition, and graphacy skills. The triangulation approach will be used to identify how people process infographic messages and whether a particular thematic frame of infographic improves the acceptance of the message and further intentions to follow the necessary measures. However, in addition to it, more qualitative data about people's reactions and thoughts about the media coverage of COVID-19 is collected and analyzed with computational methods.

As a result, a triangulation approach is used with the primary method of online survey experiment with multiple conditions of text vs. infographics with various thematic frames. Open-ended question for qualitative data collection is used to increase the reliability of research findings from online survey experiment. It is vital to collect all that data from the same set of participants since qualitative data must be analyzed in connection to the participant's survey responses, such as their party affiliation. The survey was executed online using Qualtrics as the primary survey platform. Amazon MTurk was used for survey distribution. Qualtrics has a particular function that allows keeping an equal number of participants in each condition while MTurk has an option to use random assignment for the population sample.

The triangulation research design for this study consists of two main parts such as survey experiment for analysis of infographics perception and computational qualitative analysis that would help the researcher to further investigate people's reactions, feelings, and thoughts to make conclusions about how various groups react to COVID-19 news depending on their partisanship.
For the second part, the researcher used recently invented methods for computational text mining, such as unsupervised learning algorithms, to implement topic modeling. Participants' qualitative responses about their reactions and emotional responses were collected and analyzed using the text mining approach for computational qualitative text analysis. LDA topic modeling is used to find the differences in reactions between Republicans, Democrats, and independents. The manual qualitative analysis was conducted to improve the precision of the results. With this data, the researcher could investigate what particular topics are seen in the responses from each partisan group.

Survey experiment is a widely used method in communication and media research. It helps to estimate whether direct causality exists between a particular format of the message (text and various frames of infographics) and dependent variables as well as whether the message is related to a higher level of acceptance or rejection after controlling for moderators. It also provides more possibilities for using multiple variables, statistical tools for analysis, and control for manipulation in the message. A survey experiment allowed the researcher to gather data from a prominent random representative and heterogeneous sample.

Certain limitations would need to be addressed. For example, there is a big problem with self-report measures, and people don't always answer questions with their honesty. Often, so-called prestige bias may take place, when people may answer by the socially accepted opinion or if they would like to feel better about their behavior (Wimmer & Dominick, 1997).

Among other limitations, it is necessary to mention that people could be overwhelmed with COVID-19 coverage, leading to the decreased strength of previously experienced effects. However, people may have different degrees of exposure to various messages, such as infographics. Also, several types of infographics were implemented to see the difference between
infographics and text conditions. The researcher used four conditions for study 1: a text condition as a control message and three infographic conditions. Among infographic conditions, the researcher created a basic infographic about 'flattening the curve' widely shared during the first stages of a pandemic. Two more infographics were added: an infographic with the bar chart showing the rising number of infected individuals and an infographic that contained a self-efficacy measure about wearing a mask with the line graphs showing different trajectories between countries that wear masks and those that don't. The purpose of various frames is to see whether there is a difference between them regarding message acceptance and message rejection measures. The self-efficacy frame was tested to identify whether it may better motivate people to implement desired measures through infographic conditions (Bandura et al., 1991). Infographic condition with a growing number of infected cases was implemented to test the theory that media coverage with numbers of infected people affects the development of pandemics through its persuasive effect on the people's processing of the news about risk (Mummert & Weiss, 2013).

There are certain advantages and disadvantages of the online survey experiment. It presents more opportunities for constructing a natural environment to consume media messages since most people now read news online. It also helps cover certain groups of participants that wouldn't be available otherwise (people who prefer the Internet or people who don't usually participate in in-person surveys but may do it online with the convenience and comfort of being at home). However, at the same time, it is hard to say that Internet users present a reliable sample of the population since they tend to be younger and possess specific demographic characteristics. However, recent studies showed that Internet samples, particularly MTurk samples, closely mirror the psychological traits of the mass public. MTurk provides even more diversity with its sample (Bartneck et al., 2015; Buhrmester et al., 2016; Clifford et al., 2015). As Clifford et al.
found, MTurk's results provide enough confidence with its validity. The samples reflect a similar demographic and psychological division of liberals and conservatives as the general U.S. population compared to the offline samples and student samples.

Qualtrics platform allows implementing and designing an advanced survey experiment since it has various types of questions and settings in its template. For example, it gives an ability to control the minimum time that the participant has to spend with the condition. Using that timer will help make sure that survey participants would read the message. It would be harder to do it with in-person survey.

Online survey experiments also help avoid direct contact of the researcher with the participants that helps to eliminate the experimenter's bias. It is also more convenient for both researcher and the participants since Internet surveys help cover a more diverse and broader sample. However, that could be the case that MTurk workers will less likely participate in surveys with lower compensation rates or will not pay enough attention to a particular human computation task that they are asked to do. This limitation may still take place in in-person surveys as well.

Also, the online survey demonstrates a higher rate of participants dropping out. In this study, to obtain qualitative data for textual analysis, the researcher has implemented open-ended questions and set up a required length for the textual response. The researcher has noticed that this type of questions led to a higher percentage of dropouts since people do not want to spend more time and cognitive effort on the qualitative questions that would require more elaboration. However, at the same time, it helps to filter participants who are not English speakers and who could violate MTurk rules trying to participate from another country. While it is more comfortable for people to take the survey at home, the possible limitation could be the lack of
control over the circumstances of the experiment and no possibility for interaction (in case the subject would have a question about the research procedure or technical issue). Technical problems may cause the inability of the subject to participate in the survey, and it could be another factor for a higher dropout rate. Also, for MTurk survey experiments, it is necessary to point out that subjects do not have to finish their survey right away; in many cases, they come back to it in several days, making it hard for the effect of the message to last. It is more difficult to assess the duration of the effect that makes it another point of criticism for the MTurk survey experiments. To eliminate this problem, the researcher set a timer of two hours for participants to finish the survey.

There are also other advantages of the MTurk and Qualtrics survey experimental method that are needed to be mentioned. It presents a tool for manipulation of the particular condition and observation of the effect. It establishes the cause and effect and control over the variables. It allows researchers to control subject assignment and exposure. For the Qualtrics survey experiment, it is possible to set a percentage of participants who could see a particular research condition that makes it very convenient for the assignment process. MTurk helps control the balance of political partisanship among participants to make it possible to have equal representation of people with various political preferences in each condition.

Among the disadvantages, there is a certain artificiality of the environment. Researchers' critique of the experiment usually emphasizes that the experiment does not replicate the complex reality where it is impossible to control variables and conditions. In addition, researchers claim that using a one-shot treatment does not produce a real-life effect. However, it is still possible to produce a similar reality projection and investigate a particular portion of it. The nature of the
method forces researchers to isolate specific variables for analysis to ensure that the effect comes from this particular interaction and exclude other possible explanations of the effect.

3.1 Online Experiment

The dissertation included two individual studies: Study 1 and Study 2. Both studies used the online experiments with a between-subject design and tested how various media formats such as textual and infographics affect people's intention to accept or reject the message about COVID-19. Also, these studies included individual differences in political partisanship, need for cognition, and graphica cy variables as moderators (entered as covariates in the models). Each participant saw one message (experimental stimulus) and provided the answers to the survey questions measuring a series of outcome variables about the message (experimental condition assigned to the participant). This was done for both Study 1 and Study 2: each participant saw one message condition out of four in Study 1 or one message condition out of ten in Study 2.

For study 1, there were a total of 202 participants who completed the study: 48 participants were exposed to text-only condition and 154 participants were exposed to one of the three infographic conditions (47-55 participants in each of the three infographic groups). For study 2, there were a total of 147 participants who completed the study: each participant saw one stimulus out of ten (five text-only conditions and five data visualization conditions), 76 participants were in text-only group (11-19 participants in each of the five textual condition groups) and 71 subjects in data visualization group (8-19 participants in each of the five infographic condition groups).

Figure 4 shows the model of the study exploring the cognitive and emotional mechanisms underlying the success or failure of coronavirus media messages. Format of the message is defined as independent variable (text-only and infographics groups); message acceptance
measures, message rejection measures, credibility and effectiveness of the message were selected as dependent variables with need for cognition, graphicacy, and political partisanship as moderators.

**Figure 4. The Map of Variables.**

For the independent variable, the format of the message about COVID-19 was used. In Study 1, the following conditions were used: text alone, an infographic 'flatten the curve', an infographic with the bar chart with the number of infected individuals, and a self-efficacy frame infographic about effectiveness of masks with the line graph about how masks help decrease the count of infected people in different countries. For the final survey, the study had ten conditions such as five text-only conditions with a random image of the virus and 5 data visualization conditions with various frames such as the control frame with the growing number of deaths bar chart, the line graph that shows the effectiveness of the vaccine (self-efficacy frame), the line graph that shows herd immunity concept, the bar chart with the racial divide frame and the line graph with an international frame featuring various countries' vaccination rates.
**Political Partisanship** was measured using seven categories ranging from 'strong Republican' (coded as '1') to 'strong Democrat' (coded as '7') with a median value of '4,' indicating 'Independent.' ‘Independent’ option was changed to ‘Moderate’ in Study 2.

**Need for cognition** was measured with a 6-item Need for Cognition Scale that was answered using a 7-point scale (a strong agreement, moderate agreement, slight agreement, neither agreement nor disagreement, slight disagreement, reasonable disagreement, strong disagreement) \( (\alpha = .76) \). For Study 2, this scale was shortened to the 4-item scale \( (\alpha = .94) \).

**Graphicacy** was measured with a 5-item Graphicacy Scale that was answered using a 5-point scale from "not good at all" to "extremely good" \( (\alpha = .89) \). The scale was also shortened to 3-item scale for Study 2 \( (\alpha = .95) \).

**Demographic variables.** Gender, age, race, education were collected. Gender was coded as female (1) and male (0), age was measured as a continuous variable, the race was a nominal variable with the following options: African American, Asian, Hispanic, Native American, Pacific Islander, Caucasian (White), Other. Education was ordinal variable: 0 - Less than high school degree, 1 - High school graduate (high school diploma or equivalent including GED), 2 - Some college but no degree, 3 - Associate degree in college (2-year), 4 - Bachelor's degree in college (4-year), 5 - Master's degree, 6 - Doctoral degree.

**Message credibility** was measured with responses for three questions: 'Do you think the message you viewed is: Accurate, Authentic, Believable’ on a scale from 1 ('strongly disagree') to 7 ('strongly agree') \( (\alpha = .86) \).

**Message effectiveness** was also measured after the participants’ exposure to a stimulus. Respondents were asked whether they agree or disagree with the following statements: (1) "this message was worth remembering," (2) "this message grabbed my attention," (3) "this message
was powerful," (4) "this message was informative," (5) "this message was meaningful," and (6) "this message was convincing." Each item was assessed on a scale from 1 ('strongly disagree') to 7 ('strongly agree') \( (\alpha = .91) \). This variable was eliminated in Study 2 survey due to the correlation with message credibility \( (r(206) = .83, p = .000) \).

**Message acceptance** is measured with several variables such as attitudes about the message, intentions to implement prevention measures, and self-efficacy intentions for behavior change.

**Attitudes** are measured with the questions: "Choose one answer from each pair. You think that measures that are being implemented to fight the spread of coronavirus are good/bad, desirable/undesirable, favorable/unfavorable, effective/not effective" \( (\alpha = .82) \). This scale is reduced to three-item scale for Study 2 \( (\alpha = .89) \).

**Intentions** were measured with several questions where subjects had to answer a 7-point Likert scale from 'no' to 'definitely yes. Respondents were asked about their intention to follow COVID-19 prevention measures such as 'Do you intend to practice measures such as self-isolation, washing hands, social distancing, and others?' \( (\alpha = .88) \).

The researcher also used a set of **self-efficacy** questions to check intentions for **behavioral change**. Participants were asked to answer a series of statements such as 'I'm able to practice measures to prevent COVID-19' using a 7-point Likert scale from 'Strongly disagree' to 'Strongly agree' \( (\alpha = .88) \). This scale was reduced to three items in Study 2 \( (\alpha = .93) \).

**Message rejection** was measured with several variables described below:

**Defensive avoidance** was measured with the set of questions about the extent to which they agree with the following statements after they have read the message about COVID-19 prevention on a 7-point Likert scale from 'strongly disagree' to 'strongly agree' \( (\alpha = .82) \).
Questions include statements as 'You wanted to think about coronavirus prevention,' 'You wanted to do something to keep yourself from getting COVID-19,' 'You wanted to protect yourself from COVID-19.'

**Negative attitudes about the COVID-19 message** were measured through the set of questions about the extent to which participants agree that the message they have read about coronavirus was distorted, overblown, exaggerated, boring, or overstated on the 7-point Likert scale from 'strongly disagree' to 'strongly agree' (α = .96). This scale was reduced to three items in Study 2 (α = .97).

**Reactance** was measured with a set of questions to identify whether participants felt they were manipulated or exploited by the messages they have seen (α = .95). Reactance Scale was reduced to three item scale in Study 2 (α = .95).

**Anger** was measured with questions such as whether a participant felt irritated, angry, annoyed, or aggravated after reading the message (α = .96). Anger Scale was reduced to three items (α = .96).

**The perceived threat** was measured with questions such as 'I feel frightened because of coronavirus,' 'It is possible for me to get infected with COVID-19 (coronavirus),' 'The threat of COVID-19 (coronavirus) will get worse,' and others (α = .91).

### 3.2 Computational Textual Analysis

For computational textual analysis, qualitative responses and reactions about COVID-19 were collected during the online survey. Participants were asked about their thoughts and reactions after they have seen a message with COVID-19 news. The primary purpose of this analysis is to identify common themes inside partisan groups and see whether the reactance takes
place. All the responses were gathered and then split between Republican, Democrat, and independent partisan groups. For textual analysis, LDA topic modeling as a statistical model for natural language processing was used. For LDA analysis, the researcher used NetMapper and ORA (Carley, 2014), two software applications created by the Institute for Software Research at the Carnegie Mellon University for executing computational textual analysis and graphical, statistical, and visual analytics to build networks inside the text.
Chapter 4: Results for Study 1

The sample consisted of 202 participants of age 19-78, however, the data was not clean and there were missing inputs identified for several variables. 69 participants were identified as male (32.7%) and 63 were identified as female (29.9%). The sample was predominantly white (N = 73; 34.6%), other groups were presented with African American (N = 33; 15.6%), Native American (N = 9; 4.3%), Asian (N = 7; 3.3%), Hispanic (N = 4; 1.9%). Responders have Bachelor’s degree (N = 76; 36%), Master’s degree (N = 35; 16.6%); Associate degree (N = 10; 4.7%), some college (N = 6; 2.8%), Doctoral degree (N = 3; 1.4%), high school diploma (N = 2; 0.9%). For political preferences, the sample consisted of Republicans (N = 65; 30.8%), Democrats (N = 49; 23.2%), and independents (N = 19; 9%). Each of the participants could see one condition out of four. 48 participants were exposed to text-only condition while 154 participants were exposed to one of the three infographic conditions (47-55 participants in each of the three infographic groups).

To test H1 and H2, One-way Multivariate Analysis of Variance (MANOVA) was conducted on a series of outcome variables. For Study 1, H1 and H2 predicted that infographics would result in higher message acceptance and lower message rejection, higher message credibility and message effectiveness. H1 and H2 were not supported as results of MANOVA model were not statistically significant for any of the measures that were included in the dependent variables such as credibility and effectiveness of the message, measures of acceptance (attitudes, intentions, and self-efficacy measures for behavior change), measures of rejection (defensive avoidance, negative attitudes about the message, reactance, anger, perceived threat), $F (10, 191) = .893, p = .54$; Wilk's $\Lambda = 0.955$, partial $\eta^2 = .045$. 
RQ1 and RQ2 asked which visualization frame would be associated with the higher message effectiveness, message credibility, higher message acceptance measures, and lower message rejection measures. Estimated marginal means are used to answer those questions (Figures 5 – 14).

**Figure 5.** Estimated Marginal Means for Positive Attitudes about the Message

![Figure 5](image)

Figure 5 shows that text has higher mean for positive attitudes about the message while infographic about the number of cases has the lowest. Among infographics conditions, data visualization stimulus about wearing masks has the highest mean for this variable that illustrates the effectiveness of self-efficacy component of data visualization.

**Figure 6.** Estimated Marginal Means for Intentions to Follow Prevention Measures

![Figure 6](image)
As shown in Figure 6, infographic about wearing masks has the highest mean for intentions to follow prevention measures while data visualization about flattening the curve illustrates the lowest mean.

Figure 7. Estimated Marginal Means for Self-Efficacy Intentions for Behavior Change

Figure 7 demonstrates the effectiveness of self-efficacy component in data visualization about wearing masks since it has the highest mean for self-efficacy intentions for behavior change while data visualization about flattening the curve presents the lowest mean.

Figure 8. Estimated Marginal Means for Defensive Avoidance
Figure 8 illustrates that data visualization about flattening the curve is associated with the highest mean for defensive avoidance compared to the rest of the conditions.

**Figure 9.** Estimated Marginal Means for Negative Attitudes about the Message

As shown in Figure 9, infographic about the number of infected cases has the highest negative attitudes about the message while infographic about wearing masks illustrates the lowest negative attitudes.

**Figure 10.** Estimated Marginal Means for Reactance
Figure 10 demonstrates the lowest reactance for infographic about wearing masks while infographic about the number of cases and flattening the curve shows significantly higher means for reactance.

**Figure 11. Estimated Marginal Means for Anger**

Figure 11 demonstrates significantly lower anger reaction for infographic about wearing masks while the highest mean is presented for infographic about the number of infected cases.

**Figure 12. Estimated Marginal Means for Perceived Threat**
Figure 12 shows that infographic about the number of cases is associated with higher perceived threat than the rest of the conditions.

**Figure 13. Estimated Marginal Means for Message Effectiveness**

Figure 13 shows higher message effectiveness for infographic about wearing masks and lower mean for ‘flatten the curve’ data visualization.

**Figure 14. Estimated Marginal Means for Message Credibility**

As illustrated in Figure 14, infographic about wearing masks demonstrates the highest message credibility than the rest of the conditions.
As a result, visualized estimated marginal means demonstrate that overall data visualization with self-efficacy component about wearing masks has the highest acceptance and lowest rejection, as well as better message credibility and message effectiveness. Also, infographic about flattening the curve and the number of infected cases had lower acceptance, however, data visualization about number of cases is more effective for perceived threat measure, has higher intentions to follow prevention measures and self-efficacy intentions for behavior change than ‘flatten the curve’ condition. It is less effective for negative attitudes about the message, reactance, and anger than ‘flattening the curve’ infographic. Text-only condition was associated with forming better attitudes toward the message than the rest of the conditions.

One-way Multivariate Analysis of Covariance (MANCOVA) test was conducted to compare message acceptance measures, message rejection measures, effectiveness, and credibility of text and infographics conditions using graphicacy and need for cognition as covariates. There was no significant difference in acceptance measures, rejection variables, and message effectiveness and credibility between text and infographic conditions after controlling for differences in graphicacy and need for cognition, $F (10, 187) = .862, p = .57, \text{Wilks' } \Lambda = .956, \text{partial } \eta^2 = .044$. However, the effects of covariates showed significant results, such as the need for cognition ($F (10, 187) = 2.692, p = .004, \text{Wilks' } \Lambda = .874, \text{partial } \eta^2 = .126$) and graphicacy ($F (10, 187) = 6.372, p = .000, \text{Wilks' } \Lambda = .746, \text{partial } \eta^2 = .254$). These findings illustrate that the level of need for cognition and graphicacy significantly affects the dependent variables irrespective of the format of the message.

The differences for need for cognition and graphicacy effects on the dependent variables are presented as regression plots (Figures 15 – 32).
Figure 15. Regression Plot for NFC and Intentions to Follow Prevention Measures

Figure 15 shows that higher need for cognition is associated with higher intentions to follow prevention measures.

Figure 16. Regression Plot for NFC and Self-efficacy Measures for Behavior Change

Figure 16 demonstrates that higher need for cognition is related to higher self-efficacy measures for behavior change.
As shown in Figure 17, higher need for cognition is associated with lower defensive avoidance.

Figure 18 illustrates that lower need for cognition is associated with higher negative attitudes about the message.
Figure 19. Regression Plot for NFC and Reactance

Figure 19 demonstrates that lower need for cognition is mostly related to higher reactance.

Figure 20. Regression Plot for NFC and Anger

Figure 20 shows that lower need for cognition is associated with higher anger.
Figure 21. Regression Plot for NFC and Perceived Threat

As illustrated in Figure 21, higher need for cognition is associated with higher level of perceived threat.

Figure 22. Regression Plot for NFC and Message Credibility

Figure 22 shows that higher need for cognition is also related to higher scores for message credibility.
Figure 23. Regression Plot for NFC and Message Effectiveness

Similar effect is shown in Figure 23 where higher need for cognition is associated with higher message effectiveness.

Figure 24. Regression Plot for Graphicacy and Intentions to Follow Prevention Measures

Figure 24 illustrates that higher graphicy is associated with higher intentions to follow prevention measures.
**Figure 25.** Regression Plot for Graphicacy and Self-efficacy Measures for Behavior Change

![Regression Plot for Graphicacy and Self-efficacy Measures for Behavior Change](image)

Figure 25 presents a strong association between higher graphicacy and higher self-efficacy measures for behavior change.

**Figure 26.** Regression Plot for Graphicacy and Defensive Avoidance

![Regression Plot for Graphicacy and Defensive Avoidance](image)

According to Figure 26, higher graphicacy is associated with lower defensive avoidance.
Figure 27. Regression Plot for Graphicacy and Negative Attitudes about the Message

Figure 27 shows mixed results but mostly higher graphicacy is associated with negative attitudes about the message. This effect is different from the need for cognition variable.

Figure 28. Regression Plot for Graphicacy and Reactance
Figure 28 shows that higher graphicacy levels are associated with higher reactance. This effect differs from need for cognition variable.

**Figure 29. Regression Plot for Graphicacy and Anger**

![Regression Plot for Graphicacy and Anger](image)

Figure 29 also shows a different result from need for cognition variable such as higher graphicacy is associated with higher anger, although the results are more mixed.

**Figure 30. Regression Plot for Graphicacy and Perceived Threat**

![Regression Plot for Graphicacy and Perceived Threat](image)
Figure 30 illustrates that higher graphicacy is related to higher level of perceived threat.

**Figure 31.** Regression Plot for Graphicacy and Message Credibility

As shown in Figures 31 and 32, higher graphicacy is strongly associated with higher message credibility and message effectiveness.
H4 predicted that the usage of infographics would be related to higher message acceptance, lower message rejection, higher message credibility, and message effectiveness for Democrats than Republicans and independents. MANCOVA model was conducted and shown that the model was not statistically significant ($F(10, 116) = .755, p = .67$, Wilks' $\Lambda = .939$, partial $\eta^2 = .061$). However, the effect of partisanship on dependent variables including message acceptance, message rejection, message credibility, and message effectiveness, was statistically significant ($F(10, 116) = 3.669, p = .000$, Wilks' $\Lambda = .76$, partial $\eta^2 = .24$). The estimated marginal means are visualized in Figures 33 – 42.

**Figure 33.** Estimated Marginal Means for Positive Attitudes about the Message

Figure 33 shows that Democrats have higher mean for positive attitudes about the message while independents have the lowest.
Figure 34. Estimated Marginal Means for Intentions to Follow Prevention Measures

Figure 34 demonstrates similar difference for intentions to follow prevention measures where Democrats have the highest mean and independents have the lowest mean.

Figure 35. Estimated Marginal Means for Self-Efficacy Intentions for Behavior Change

Same difference is illustrated in Figure 35 where Democrats have the highest mean and independents have the lowest mean for self-efficacy intentions for behavior change.
Figure 36. Estimated Marginal Means for Defensive Avoidance

Also, Figure 36 shows that Democrats have the lowest defensive avoidance while independents show the highest mean.

Figure 37. Estimated Marginal Means for Negative Attitudes about the Message

As shown in Figure 37, Democrats have significantly lower negative attitudes about the message while Republicans have the highest mean for this scale.
Figure 38. Estimated Marginal Means for Reactance

Figure 38 demonstrates the same difference for reactance where Democrats have significantly lower reactance while Republicans have the highest mean for this scale.

Figure 39. Estimated Marginal Means for Anger

Figure 39 illustrates similar difference for anger that shows Democrats having significantly lower anger and Republicans having the highest mean for this scale.
As demonstrated in Figure 40, Democrats have higher perceived threat compared to independents and Republicans. Independents have the lowest mean for this scale.

Figure 41. Estimated Marginal Means for Message Effectiveness
Figure 42. Estimated Marginal Means for Message Credibility

Figure 41 and 42 show the same difference for message credibility and message effectiveness where Democrats have higher means compared to independents and Republicans, and where independents present the lowest means for these scales.

Overall, Democrats demonstrate higher scores for message acceptance, lower scores for message rejection, lower scores for anger, higher score for perceived threat, effectiveness and credibility of the message than independents and Republicans. Therefore, H4 is partially supported.

Based on Study 1, Study 2 was designed with some modifications such that the number of variables and questions was reduced to improve the completion rate for the survey since participants tend to quit the survey before finishing due to the cognitive fatigue effect and time-consuming tasks. Specifically, since message effectiveness and message credibility were highly correlated \( r (206) = .83, p = .000 \), only message credibility variable is kept in Study 2. Perceived threat was previously considered to be a part of message rejection measures; however, the results have demonstrated that higher perceived threat is actually associated with higher acceptance of the message (e.g., Democrats in Study 1). As a result, perceived threat variable
was omitted in Study 2. Defensive avoidance was omitted in Study 2 survey since it had low correlation with the rest of the measures for message rejection. Further, Positive Attitudes about the Message Scale was reduced to three items (α = .89), and Self-Efficacy Intentions for Behavior Change Scale was reduced to three items (α = .93). Negative Attitudes about the Message Scale was reduced to three items (α = .97), Reactance Scale was reduced to three-item scale (α = .95), Anger Scale was reduced to three items (α = .96), Need for cognition was reduced to four-item scale (α = .94), and Graphicacy Scale was reduced to three-item scale (α = .95). Lastly, in Study 1, qualitative data to answer RQ3 was not adequately collected since the open-ended questions were placed in the second part of the survey, and majority of participants skipped or gave up before reaching the questions. Thus, for the Study 2, there was only one open-ended question for qualitative data, and the question was placed after a participant's exposure to the message before the rest of the survey questions. In addition, the researcher has noticed that in the partisanship variable, participants who selected 'Independent' option demonstrated more partisan conservative attitudes than participants who selected the 'Republican' option. As a result, the 'Independent' option was changed to 'Moderate' to avoid that effect. In the Study 2 survey, the conditions were changed and reframed since the phase of the pandemic has changed to the vaccination stage. Study 2 survey has ten conditions where five conditions have a data visualization component with various frames such as a graph with the number of COVID-19 deaths, a graph that shows the effectiveness of the vaccine, a graph that shows herd immunity threshold concept, a graph that illustrates racial divide for COVID-19 cases, and a graph that shows a difference in vaccine distribution between different countries. The other five conditions were text versions of conditions with data visuals (see the Appendices for more details on the surveys for Study 1 and Study 2).
Chapter 5: Results for Study 2

5.1 Online Experiment Results

For the study 2, 147 participants have taken a Qualtrics survey via MTurk. The sample consisted of 69 female (46.9%) and 78 male (53.1%) population 23-68 years old. The sample was predominantly white (N = 119; 81%), however other racial groups were also presented such as Asian (N = 13; 8.8%), African American (N = 7; 4.8%), Hispanic (N = 7; 4.8%), and Pacific Islander (N = 1; 0.7%). Participants have Bachelor’s degree (N = 68; 46.3%), others have Associate degree (N = 26; 17.7%), high school diploma (N = 21; 14.3%), some college (N = 16; 10.9%), Master's degree (N = 14; 9.5%), Doctoral degree (N = 2; 1.4%). Political affiliations are presented with three main groups of Democrats (N = 88; 9.9%), Republicans (N = 36; 24.5%), and independents (N = 23; 15.6%). Each participant saw one stimulus out of ten (five text-only conditions and five data visualization conditions), 76 participants were in text-only group (11-19 participants in each of the five textual condition groups) and 71 subjects in data visualization group (8-19 participants in each of the five infographic condition groups).

To test H1 and H2, One-way Multivariate Analysis of Variance (MANOVA) test was conducted on a series of outcome variables. For Study 2, H1 and H2 predicted that infographics would result in higher message acceptance, lower message rejection measures and higher message credibility. H1 and H2 were not supported as results of MANOVA model were not statistically significant for any of the measures that were included in the dependent variables such as message credibility, measures of acceptance (attitudes, intentions, and self-efficacy measures for behavior change), measures of rejection (negative attitudes about the message, reactance, anger), F (7, 139) = 1.255, p = .28; Wilk's Λ = 0.941, partial η² = .059.
RQ1 and RQ2 asked which visualization frame would be associated with the higher message credibility, higher message acceptance measures, and lower message rejection measures. Estimated marginal means are used to answer those questions (Figures 43 – 49).

**Figure 43.** Estimated Marginal Means for Positive Attitudes about the Message

![Estimated Marginal Means for Positive Attitudes about the Message](image)

Figure 43 shows that infographic #1 about the number of cases and data visual #4 about racial divide have higher positive attitudes about the message while infographic #2 about effectiveness of the vaccine has the lowest mean among infographics conditions. However, textual conditions #1 and #4 also show higher positive attitudes about the message.

**Figure 44.** Estimated Marginal Means for Intentions to Follow Prevention Measures

![Estimated Marginal Means for Intentions to Follow Prevention Measures](image)
Figure 44 shows that infographic #4 about racial divide is associated with higher intentions to follow prevention measures while infographic #3 about herd immunity threshold shows the lowest mean.

**Figure 45. Estimated Marginal Means for Self-Efficacy Intentions for Behavior Change**

![Estimated Marginal Means for Self-Efficacy Intentions for Behavior Change]

Figure 45 illustrates that infographic #1 is related to higher self-efficacy intentions for behavior change while infographics #3 about herd immunity threshold and infographic #5 with the global frame show the lowest means.

**Figure 46. Estimated Marginal Means for Negative Attitudes about the Message**

![Estimated Marginal Means for Negative Attitudes about the Message]
Figure 46 demonstrates that infographic #4 about racial divide and #5 with the global frame are associated with the lowest negative attitudes about the message while infographic #2 about the effectiveness of vaccination has the highest mean.

**Figure 47. Estimated Marginal Means for Reactance**

Figure 47 shows that infographics #1 and #4 are also associated with the lower reactance while infographic #2 about effectiveness of vaccination and data visualization condition #3 about herd immunity threshold present the highest reactance among infographic conditions.

**Figure 48. Estimated Marginal Means for Anger**
Figure 48 shows significantly higher anger for infographic condition #2 about the effectiveness of vaccination while infographic #1 is associated with the lowest anger.

**Figure 49.** Estimated Marginal Means for Message Credibility

![Estimated Marginal Means of Credibility](image)

Figure 49 shows that infographic conditions #2 about the effectiveness of vaccination and #3 about herd immunity threshold have the lowest means for message credibility compared to other data visualization conditions.

As a result, Study 2 conditions demonstrate more mixed results where it is hard to conclude that data visualization works better than text. However, some observations can be mentioned such as an infographic condition #3 about the herd immunity concept and #2 about the effectiveness of vaccination have lower acceptance, higher rejection and lower message credibility. Infographic condition #1 about the number of cases and #4 about racial divide frame have high acceptance and lower rejection as it is seen on the graphs. For self-efficacy measures for behavior change, infographic condition #1 showed the highest mean while infographics #5 showed the lowest mean. For rejection, overall infographic #2 about effectiveness of the vaccine
was associated with the highest anger compared to other conditions. Also, it has lower credibility score.

One-way Multivariate Analysis of Covariance (MANCOVA) test was conducted to compare message acceptance and message rejection measures as well as message credibility for text and infographics conditions using graphicy and need for cognition as covariates. There was no significant difference in acceptance measures, rejection variables, and message effectiveness and credibility between text and infographic conditions after controlling for differences in graphicy and need for cognition, $F (7, 137) = 1.125, p = .35$, Wilks' $\Lambda = .956$, partial $\eta^2 = .054$. In Study 2, neither graphicy nor NFC were significant covariates.

H4 predicted that the usage of infographics would be related to higher message acceptance, lower message rejection, and higher message credibility for Democrats than Republicans and independents. MANCOVA model was conducted and shown that the model was not statistically significant ($F (7, 138) = 1.24, p = .29$, Wilks' $\Lambda = .941$, partial $\eta^2 = .059$). However, as in Study 1, Study 2 results illustrate that the effect of partisanship on dependent variables including message acceptance, message rejection, and message credibility was statistically significant ($F (7, 138) = 14.089, p = .000$, Wilks' $\Lambda = .58$, partial $\eta^2 = .42$).

To further investigate the differences between groups, estimated marginal means are visualized in Figures 50 – 56.
Figure 50. Estimated Marginal Means for Positive Attitudes about the Message

Figure 50 shows that Democrats have higher positive attitudes about the message than independents and Republicans.

Figure 51. Estimated Marginal Means for Intentions to Follow Prevention Measures

Similar effect is shown in Figure 51 where Democrats also have higher intentions to follow prevention measures than independents and Republicans.
Figure 52. Estimated Marginal Means for Self-Efficacy Intentions for Behavior Change

Relatively similar result is presented in Figure 52 where Democrats also have higher self-efficacy intentions for behavior change than independents and Republicans.

Figure 53. Estimated Marginal Means for Negative Attitudes about the Message

According to Figure 53, Democrats have significantly lower negative attitudes about COVID-19 messages than independents and Republicans.
Figure 54. Estimated Marginal Means for Reactance

![Figure 54: Estimated Marginal Means for Reactance](image)

Same effect is seen in Figure 54 and 55 where Democrats have significantly lower reactance and anger than independents and Republicans.

Figure 55. Estimated Marginal Means for Anger

![Figure 55: Estimated Marginal Means for Anger](image)
Figure 56. Estimated Marginal Means for Message Credibility

Figure 56 shows that Democrats see messages about COVID-19 as more credible than independents and Republicans.

Overall, Democrats demonstrate higher scores for message acceptance, lower scores for message rejection, lower scores for anger, and higher score for credibility of the message than independents and Republicans. Therefore, H4 is partially supported since there is an effect of partisanship, however, this effect does not depend on the format of the message. This finding is consistent with Study 1 result.

5.2 Results of Computational Textual Analysis

For computational textual analysis, qualitative responses and reactions about COVID-19 were collected during the online survey. Participants were asked about their thoughts after they have seen a message about COVID-19 news. The primary purpose of this analysis is to identify common themes inside partisan groups and see whether the reactance takes place. All the responses were gathered and then split between Republican, Democrat, and independent partisan groups. For textual analysis, LDA topic modeling as a statistical model for natural language
processing was used. For LDA analysis, the researcher used NetMapper and ORA (Carley, 2014), two software tools created by the Institute for Software Research at the Carnegie Mellon University for computational textual analysis and graphical, statistical, and visual analytics to build networks inside texts.

**Table 1. LDA Topic Modeling for Democrats, Independents, and Republicans**

<table>
<thead>
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<th>Number of topics to find</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Iterations</td>
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<tr>
<td>Alpha</td>
<td>50</td>
</tr>
<tr>
<td>Beta</td>
<td>0.100</td>
</tr>
</tbody>
</table>

The input meta-networks are interpreted as a collection of documents (one document per meta-network). Each node is interpreted as a concept in the document. The frequency of each concept is the value of its frequency attribute. In the case a node has no frequency attribute, then its frequency is one. Only the top 10 ranked documents and topic members of each topic are reported.

The computational textual analysis needs to be carefully analyzed and interpreted. It is hard to connect the words in the topic, and as a result, there is a need for a more qualitative approach. Highly associated texts were read by the researcher and classified as a common theme or trend.

**5.2.1 Topic modeling for Democrats**

**Table 2. Ten Topics for Democrats**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
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<th>5</th>
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<td>Covid-19</td>
<td>.09</td>
<td>vaccine</td>
</tr>
<tr>
<td>Hope</td>
<td>.04</td>
<td>death</td>
<td>.06</td>
<td>disagreement</td>
</tr>
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<td>.04</td>
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<td>.03</td>
<td>dosage</td>
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<tr>
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<td>.03</td>
<td>lost</td>
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<td>worldwide</td>
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<td>.02</td>
<td>.03</td>
<td>.02</td>
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<td>wear, activity, selfish</td>
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<td>.02</td>
<td>.02</td>
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</table>

### Table

| feel, vaccination, country, feel, covid-19 | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  |
| worry, scare, pandemic, reach, Get vaccinated | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  |
| refuse, immunity, population, Much, vaccinate | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  |
| mask, virus, vaccine, shots, politics | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  |
| good news, take-it, concern, lot, serious | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  |
| handle, spread, decreasing, to-do, danger | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  |
| heard, progress, worse, never, lot | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  |
| body part, U.S., f***, progress, shooting | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  |
| majority, covid-19, global, Science, federal government | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  |
| safe, develop, reach, Threat, South | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  | .02  |
Figure 57. Textual Network Analysis for Democrats

Figure 57 demonstrates key nodes that represent connected concepts that form topic modeling for the Democrats.

The first topic and the overall central theme in the responses from participants identified as Democrats was the sense of hopefulness and relief after getting vaccinated. At the same time, people mention the conflict between the positive side of getting back to normal and a more negative side of vaccine hesitancy. Participants also criticize the previous administration and conservative politicians for undermining the virus mortality and ignoring prevention measures, misinformation, and news avoidance. Overall, the first pattern shows hope and an attempt to find the positive side of the situation. For the second topic, it is possible to see more positive thoughts
about the future, praising scientists and companies involved in vaccine production and COVID-19 mitigation, such as Dr. Fauci. People mention being thankful for their efforts and hope to better handle similar pandemics in the future. The third topic is focused on the frustration that so many people refuse to get vaccinated for political reasons. Respondents have criticized Trump supporters, their lack of responsibility, selfishness, and stubbornness of people who don't want to vaccinate. The fourth topic covers concern and worries about new variants and mutations that would be harder to fight. Responses have mentioned the lost faith in the nation, polarization of attitudes about the pandemic, and a shame about losing progress in the fight against COVID-19. The fifth topic sounds more optimistic, where participants emphasize the importance of working together to get back to normal sooner and combatting COVID-19 as a team effort. People share optimism about working as a nation to slow the spread and acquire herd immunity.

The sixth topic is dedicated to expressing doubts and light hesitancy and the lack of data about the long-term effects of vaccination. Participants say there are different opinions and facts, and it is hard to figure out what to believe. The seventh topic covers the global angle of the issue where participants express hopes about eliminating COVID not only in the U.S. but also in the whole world. People point out that it is necessary to reach herd immunity in the United States and globally and that vaccination should not be political, but vaccines should be distributed equally between countries. The eighth topic demonstrates some repetitiveness in mentioning politicizing the pandemic, Trump supporters who refuse to get vaccinated and criticizing conservative people, expressing concerns about uneven herd immunity in the country where more people are vaccinated in certain counties and in others not so many, that prevents eliminating the virus. Topics 9 and 10 mostly repeat the previous patterns about the need to get vaccinated as soon as possible, the lack of trust in vaccines, the anti-vaxxers movement, critique
about former president Trump and his misinformation about the disease. Topic #10 praised the current federal government for making the vaccine accessible and available for everyone. The following network visualizations represent connected concepts that are extracted from several responses for the Democrats (Figure 58).

**Figure 58. Examples of Text Networks for Democrats**
5.2.2 Topic Modeling for Independents

Table 3. Ten Topics for Independents

<table>
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Independent group expresses more mixed feelings such as positive emotions, hope that the numbers are going down and people are moving back to normal and at the same time saying that COVID-19 was 'overblown', and it is not real. Figure 59 demonstrates key nodes that represent connected concepts that form topic modeling for the independents. The first topic shows more optimism about lowering numbers and the importance of vaccination. Participants
pointed out that the disease should be taken seriously, and people should follow prevention measures.

The second topic is dedicated to more skepticism with underlining the mistakes in data, the lack of data on vaccines, and co-morbidities that add up more deaths to the statistics about COVID-19. People identified a lack of trust in politicians and transparency from the governments and health officials. Specific responses also emphasized the selfishness of people who do not want to get vaccinated and stop the spread of the virus. Subjects have expressed fear of new mutations, new vaccines, and the endless fight against viruses. The third topic presents responses about coronavirus being overblown all over the world. Some respondents demonstrated beliefs in conspiracy theories calling COVID-19 'a political tool used to divide the country, an invention of politicians that don't exist. Participants called the vaccine a 'kill shot' that is pushed by external actors.

Topic #4 is more a continuation of the third one, emphasizing how overhyped COVID-19 is by the media. It may demonstrate the information fatigue that people are experiencing after a long time of stressful information environment. People mention various kinds of exhaustion, such as with too much negative news and data and the exhaustion from constant fight with the disease. Topic #5 covered more negative sentiments about the U.S. as a country, calling it a 'failed state,' 'anti-common sense and anti-fact and anti-science country' and complaining about anti-vaxxers. Topic #6 shows more skepticism about the government, vaccines, exhaustion, and controversial media coverage.

Topic #7 demonstrates the desire of people to get back to normal as soon as possible, where participants emphasize a need to expedite the vaccination and stop the pandemic. Topic #8 illustrates more thoughts about the future of the country with some positive and negative
sentiments such as confidence after getting a vaccine, a need to work together on defeating the virus, and mentioning that politicians use COVID-19 to divide the country and worsen negative economic consequences. Topics #9 and #10 include a mix of sentiments from previous topics such as exhaustion, skepticism, a need for faster vaccination, and others. The following network visualizations represent connected concepts that are extracted from several responses for the independents (Figure 60).

**Figure 60.** Examples of Text Networks for Independents
### 5.2.3 Topic modeling for Republicans

<table>
<thead>
<tr>
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<th>2</th>
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<td></td>
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<td>.03</td>
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<td></td>
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<td>.06</td>
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<td>.04</td>
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<tr>
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<td></td>
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<td>.02</td>
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<td>scared</td>
<td>.03</td>
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<tr>
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<td>.02</td>
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<td>welfare</td>
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<td>Generalized</td>
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<td>.02</td>
<td>.02</td>
</tr>
<tr>
<td>incompetence</td>
<td>.02</td>
<td></td>
<td>get-to</td>
<td>.02</td>
<td>.02</td>
</tr>
</tbody>
</table>

Table 4. Ten Topics for Republicans
For Republicans, it was harder to draw separated groups from the LDA output since most of the themes and topics were mixed and related to each other. Figure 61 demonstrates key nodes that represent connected concepts that form topic modeling for the Republicans. The reason could be the low number of topics that are identified with the qualitative check. For the first topic, the responders expressed the fear of the virus and mutations; however, at the same time, they pointed out that the virus is dangerous only for people with certain conditions and not for the general population. Republicans, in general, emphasized that the attitude and the threat of the
virus were overblown. Most of the participants wrote about indifferent attitude and no intention to get a vaccine. People identified that the virus is dangerous only for 'old' and 'immunocompromised' people, and there is no need to vaccinate everybody. The second topic identified more anger and negative sentiments about the virus that was over-covered in the media. Participants generally mentioned the manipulative media that work by corrupted politicians to serve their interests. Lack of trust in the government, science, and the media and negative sentiments significantly stronger in this group, demonstrating higher reactance after the experiment. The third topic has also demonstrated the negative attitudes towards Democrats, who, according to the respondents, played an active role in politicizing the pandemic. Also, more sentiments about the overblown virus, and uncertainty about the vaccine were expressed by this group.

The fourth theme shows particular pro-vaccination sentiments and the need for herd immunity and that it would be necessary 'to restore people's freedoms.' Republican respondents expressed concern and fear; however, that fear was different from the one by Democrats. It was a fear of control from the government and media, incompetence of the experts who force people to get vaccinated, the fear of uncertainty. Topic #5 emphasized that the threat of the virus was exaggerated, and shutdowns were an overreaction. In topic #6, people expressed indifference towards vaccination, no trust in government or science, corrupted politicians, incompetent scientists, and 'fraudulent media playing politics.' Topic #7 was centered around the comparison of COVID-19 with flu, mentioning that the impact of COVID-19 was overstated, and the numbers of deaths and infected cases were inflated. Topic #8 covered the economic aspect of the pandemic. Republicans, more than other groups, identified the negative economic consequences, expressing anger because of the lockdowns which undermine the economy. The ninth topic
mentioned positive sentiments about vaccination; however, participants have expressed fear that it will not prevent the COVID-19 spread and the fear that there will be a constant need for vaccines with the new mutations. Topic #10 underlined the global perspective of the pandemic; however, people stated that 'it is not the end of the world' even though it was spread worldwide. According to the respondents, the damage to the economy was not justified. The following network visualizations represent connected concepts that are extracted from several responses for the Republicans (Figure 62).

**Figure 62. Examples of Text Networks for Republicans.**
Chapter 6. Conclusion and Discussion

Current research attempts to investigate how various formats of the news messages, such as textual and data visualization conditions affect people's perception of the message. Several dependent variables are used to measure message processing, such as measures of acceptance (positive attitudes about the message, intentions to follow prevention measures, and self-efficacy measures for behavior change) as well as rejection measures (defensive avoidance, negative attitudes about the message, reactance, anger) as well as the credibility of the message. Study 1 also used perceived threat and message effectiveness in the list of dependent variables. Political partisanship, need for cognition, and graphacy were used as moderators in this research. Results have demonstrated that the format of the message was not significant while moderators such as political partisanship, need for cognition, and graphacy were significant covariates for dependent variables. The computational textual analysis illustrated the differences in topics between partisan groups where Democrats expressed more hope, positive sentiment, and more trust in vaccination, government, media, and science than independents and Republicans who were more prone to conspiracy theory thinking. Republicans and independents were also more focused on the negative economic consequences of the pandemic. Network visualizations for textual analysis are created to demonstrate the increased fragmentation of topics for the group of independents while both Democrats and Republicans show denser networks of topics in their responses.

6.1 Findings

Previous research found that the presence of statistical or quantitative information influences people's judgment and risk perception as well as makes the message more informative.
(Steinhardt, 2019; Dudo et al., 2007; Roche & Muskavitch, 2003). As Siricharoen and Siricharoen emphasized, "infographic can be the great trigger to human's brain to change human's behavior toward health care awareness" (2018, p. 66). Dudo et al. (2007) argued that quantitative data in journalistic coverage increases the possibility of informed decision-making for the audience compared to qualitative information. However, the effect of quantitative information in data visualization was not supported in this study about COVID-19 news message processing, and the presence of data visualization did not have significant effect on the acceptance and rejection of the message.

H1 predicted that message with infographics will be associated with higher measures of message acceptance (attitudes, intentions, self-efficacy intentions for a behavioral change) and lower measures of message rejection (defensive avoidance, reactance, anger, perceived threat, negative attitudes about the message) compared to text alone. This hypothesis was not accepted in both Study 1 and Study 2. At the same time, similar results are identified for H2 for the credibility and effectiveness of the message. The reason that there was no significant difference between the formats of the message could be the information overload and information fatigue that people experience during this pandemic. As mentioned earlier, this pandemic is characterized by the enormous amount of data flooding around us. This environment could affect people's perception and make them less susceptible to the various formats of the messages. However, it makes it possible to investigate how data visualization messages are processed in the simulation that is closer to the real world of overwhelming information, and assume that in a situation like this pandemic, it is better to keep the message as simple as possible to increase the acceptance of the news. One more limitation could be the lack of statistical power that could prevent the effect from visible emergence in this study.
For conditions of our experiment, the researcher attempted to create news messages that would be close to the examples from the present news environment and would be similar to ones that participants would see in the major media outlets. However, for the experiment, it could be possible that the stimuli are not strong enough and there is a need to make the difference between conditions more salient. In addition, the phase of the pandemic and the saturation of informational environment could also play a role. A similar experiment could be conducted at the beginning of the pandemic to see whether there is any effect before the attitude formation has already taken place. However, for the purposes of this study the messages were also used to prime people’s existing beliefs and trigger emotional reactions. It was possible to see the differences in people’s perception of various stimuli.

To answer RQ1 and RQ2 about what kind of infographics frame would be associated with the strongest message acceptance and the strongest message credibility and message effectiveness, the estimated marginal means are visualized. Various thematic frames were used in surveys for Study 1 and Study 2, where the second survey had more frames and conditions. For Study 1, four conditions were used, such as text-only and infographics with three frames where one of them was with the data on COVID-19 number of infected cases, the second one was 'flatten the curve' infographic, and the third one was data visualization with self-efficacy frame about wearing masks. According to the results, the overall data visualization with self-efficacy component about wearing masks has the highest acceptance and lowest rejection, as well as better message credibility and message effectiveness.

Also, infographic about flattening the curve and the number of infected cases had lower acceptance, however, data visualization about number of cases was more effective for perceived threat measure, intentions to follow prevention measures and self-efficacy intentions for behavior
change than ‘flattening the curve’ stimulus. It is less effective for negative attitudes about the message, reactance, and anger than ‘flattening the curve’ infographic. Text-only condition was associated with forming better attitudes toward the message than the rest of the conditions. The results demonstrated that the third infographic with the self-efficacy element was the most accepted condition in Study 1, and 'flatten the curve' was the least accepted frame. Textual conditions worked better for persuasion purposes than 'flatten the curve' and infographic with the historical data on the number of cases.

For Study 2, the researcher needed to change the conditions since the phase of the pandemic has switched to vaccination stage. Ten conditions were used: five conditions were with text-only messages and the other five had data visualization element. Each pair has a theme where the first frame is a control one, the second one is about the effectiveness of the vaccine (self-efficacy), the third frame is about herd immunity threshold concept, the fourth one is about the racial divide in COVID-19 cases, and the last one is about the international angle and the difference in vaccination rates between various countries. Infographic with the third frame about herd immunity threshold and a message with data visualization about the effectiveness of vaccine were the least accepted and were associated with the lower intentions to follow prevention measures. There is a similarity between the findings from Study 1 and Study 2, wherein the infographic with the 'flatten the curve' concept was the least accepted. In Study 2, an infographic about herd immunity threshold is also the least accepted data visualization condition. It could be the case that people cannot effectively process statistical concepts in data visualizations, and there is a challenge in processing graphs without the actual data behind them.

Study 2 conditions demonstrate more mixed results where it is hard to conclude that data visualization works better than text. However, some observations can be mentioned such as an
infographic condition #3 about the herd immunity threshold concept and #2 about the effectiveness of vaccination are associated with the lower acceptance, higher rejection, and lower message credibility. Infographic condition #1 about the number of cases and #4 about racial divide frame have higher acceptance and lower rejection of the message. For self-efficacy measures for behavior change, infographic condition #1 showed the highest mean while infographics #5 showed the lowest mean. For rejection, overall infographic #2 about effectiveness of the vaccine was associated with the highest anger compared to other conditions. Also, it has lower credibility score.

The difference between two studies was that self-efficacy frame infographics was associated with completely opposite perception in two studies where self-efficacy frame with the effectiveness of vaccination in Study 2 was rejected compared to the condition about wearing masks in Study 1 that was highly accepted. It could be explained by the increased controversies and conspiracy theories about vaccination that were disseminated and could affect people's previous attitudes and beliefs. Another reason self-efficacy condition in Study 2 was not accepted could be that the influence of partisanship played stronger role during the vaccination stage. However, if self-efficacy frame would be highly implemented from the beginning of the pandemic, a certain promising potential of implementing self-efficacy narratives in data visualization examples could be explored by the media and journalists. Self-efficacy measures are positively associated with people's beliefs in their capabilities to manage the crisis situation, their functioning, and events that affect their lives (Bandura et al., 1991). Here, the approach of solution journalism could demonstrate positive results if journalists would provide more information about prevention measures that could easily be taken by their audience to take control over the crisis situation and uncertainty. This self-efficacy element can be effectively
implemented with data visualization formats. There is an assumption that the timing is important, and it is necessary to disseminate those messages early in the beginning of the crisis before the information gap is filled with disinformation and conspiracy theories.

H3 stated that messages with infographics would be associated with higher message acceptance measures, lower message rejection measures, and higher message credibility and effectiveness for people with a higher need for cognition and graphicacy levels than text alone. There was no significant difference in acceptance measures, rejection variables, and message effectiveness and credibility between text and infographic conditions after controlling for differences in graphicacy and need for cognition in both Study 1 and Study 2. However, the significant effect of covariates such as need for cognition and graphicacy was demonstrated in Study 1 but was not replicated in Study 2. The reason for that could be the phase of the pandemic and the higher controversy of vaccination as a topic. In the later stages of the pandemic, it is possible that both high-processors and low-processors have already formed their beliefs and cognitive shortcuts that were used for faster processing of news about COVID-19 and that could affect the results of Study 2. However, this finding also shows that it is necessary to find more effective ways to communicate the facts about the pandemic to low-processors (people with low need for cognition, low graphicacy) since they tend to have lower acceptance and higher rejection of the news about COVID-19.

H4 stated that the message with infographics would be related to higher message acceptance, lower message rejection, higher message credibility, and message effectiveness for Democrats than Republicans and independents. In both Study 1 and Study 2, MANCOVA model does not show a significant result for the message type after controlling for the partisanship variable. However, the partisanship itself demonstrates a significant effect on the dependent
variables independently from the message type and this effect was replicated in both studies. Partisanship as the main factor demonstrates significant results for intentions to follow prevention measures, self-efficacy intentions for behavioral change, defensive avoidance, negative attitudes about the message, reactance, anger, perceived threat, and credibility and effectiveness of the message. Overall, Democrats demonstrate higher scores for message acceptance, lower scores for message rejection, lower scores for anger, and higher score for credibility of the message than independents and Republicans in both studies. Interestingly, independents demonstrate higher degree of conservative partisan attitudes than Republicans in Study 1. This phenomenon could take place because of the phrasing of the response such as the wording ‘independent’ could have high correlation with conservative values. In Study 2, ‘Independent’ option was modified to ‘Moderate’, and it has changed the results. This phenomenon could demonstrate the level of polarization and the strength of those associations in the current political environment.

This study demonstrate that credibility works as "an audience member's perceptions" (Perloff, 2010, p. 166). Those perceptions and observations depend on previous beliefs and attitudes that make them susceptible to biases. This study findings confirm the previous understanding of the message credibility as an "individual's judgment of the veracity of communication content" (Appelman & Sundar, 2016, p.63). The definition itself illustrates that any message will be filtered through the personal judgement and therefore, will be selectively accepted or rejected depending on person’s existing values. Those values could be detected in qualitative responses that were collected and analyzed in this research.

Computational textual analysis was used to answer RQ3 about what differences can be detected in reactions towards COVID-19 messages between Democrats, Republicans, and
independents. For textual analysis, LDA topic modeling as a statistical model for natural language processing was used. In the process of analysis, it was clear that LDA textual analysis did not provide reliable results, and there would be a need for additional qualitative analysis to interpret the topics found in the LDA results. Here, the researcher will agree with Manovich (2012) that computational methods would better complement qualitative techniques and cannot be used independently without qualitative interpretation. It is hard to connect the words in the topic, and as a result, there is a need for a more qualitative approach. There are limitations of the method that show that the LDA algorithm doesn't consider the order of words or the order of documents. Also, it does not recognize the relationship between topics, and it cannot identify slight changes in topics. In this case, since the diversity of topics was pretty narrow, their differences were more blurred.

However, it was possible to see significant differences in topics and reactions between the three groups. Democrats expressed a sense of hopefulness and relief after getting vaccinated, more positive thoughts about the future, praising scientists and companies involved in vaccine production and COVID-19 mitigation. Democrats emphasize the importance of working together to get back to normal sooner and combatting COVID-19 as a team effort. Participants share optimism about working as a nation to slow the spread and acquire herd immunity.

Independents expressed more mixed feelings such as positive emotions, hope that the number of cases is going down, and at the same time, saying that COVID-19 was 'overblown', and it is not real. People identified a lack of trust in politicians and a lack of transparency from the governments and health officials. Independents demonstrated more skepticism about the government, vaccines, exhaustion, and controversial media coverage than Democrats.
Republicans expressed the fear of the virus and mutations; however, at the same time, they pointed out that the virus is dangerous only for people with certain conditions and not for the general population. Republicans, in general, emphasized that the attitudes about pandemic and the threat of the virus were overblown. Most of the participants wrote about indifference toward vaccination and no intention to get a vaccine. Participants generally mentioned the manipulative media that work by corrupted politicians to serve their interests. Lack of trust in the government, science, the media. Negative sentiments were significantly stronger in this group that demonstrates higher reactance after the experiment. Republican respondents expressed concern and fear; however, that fear was different from the one by Democrats. It was a fear of control from the government and media, incompetence of the experts who force people to get vaccinated. Republicans, more than other groups, identified the negative economic consequences, expressing anger because of the lockdowns that undermine the economy. Interestingly, this group demonstrated pro-vaccination attitudes in order ‘to restore people's freedoms.’ This narrative could be successfully used to improve acceptance of the COVID-19 prevention messages among more conservative population.

Computational textual analysis may serve as an additional tool to measure reactance. This study demonstrated that it allows us to see the range of topics in the set of texts in combination with qualitative textual analysis. The limitation of the method is that it is hard to see the differences between topics when they relate to each other. In this study, all the topics are related to the COVID-19 pandemic, and that was hard to see the clear lines between topics.

For the practical implications, it is possible to use these findings to improve the pandemic's health communication and media coverage. All the previous research demonstrates that to help people understand the information conveyed in journalistic data coverage with
graphics and data visualization, reporters need to use additional effort to explain how the analysis was made and what inferences are hidden in the graphs. As the research from cognitive psychology and the findings from the current research study have demonstrated, our ability to comprehend graphs and other formats of the message is governed by the individual graphicacy and need for cognition. There is a natural individual capacity limit for every person, making it essential for the journalists to account for those limits and constraints and avoid overwhelming variables and elements on the graph.

Previous research has also emphasized the importance of graphical literacy in the process of graph comprehension. Only people with high graphicacy levels can find the appropriate inferences in the graph. However, journalists need to think about the universal approaches for the broad audience and try to either adjust their data visuals for people with various numeracy levels (make the graph less complex) or provide multiple explanations and descriptions of inferences for low-numerate individuals to help them understand information from the graph. The cognitive psychology field has demonstrated that the concept of probability, in many cases, cannot be naturally processed by people. The results of the present study also find that it is more challenging for people to grasp statistical concepts such as ‘flattening the curve’ and herd immunity threshold. This finding may force journalists to think about additional tools and explanations of more abstract statistical concepts for their audiences.

6.2 Future Research

More frames and formats could be analyzed in relation to health news and communication for prevention measures in future research. It would be helpful to test more narratives that could be used for people in different political groups to help them better accept
information about COVID-19 prevention measures. More research could be conducted to test the perception of the messages during the different stages of the pandemic. It would be beneficial to see the trends developed over time and check whether there are any differences in the ways people process information about the pandemic depending on the stage. In this experiment, the previous knowledge, issue involvement, and personal relevance were not tested. Those gaps could be eliminated in future studies. Another critical issue in the coverage of the pandemics could be the issue of uncertainty. Many respondents identified this problem in their responses, and it could be an important topic to investigate in future studies.

In addition to the variables used in this study, future research may test the role of source credibility and whether it improves the acceptance of COVID-19 messages in partisan groups. Also, political communication variables such as political interests and political knowledge have enormous potential for explanations and adding more context about the perception of COVID-19 messages by the partisan groups. To eliminate the limitation of the current experiment, future research may elevate statistical power for the experiment and implement stronger experimental simuli to allow participants to be submerged in the news message.
References


Cornelson, K., & Miloucheva, B. (2020). Political polarization, social fragmentation, and cooperation during a pandemic. University of Toronto, Department of Economics.


doi:10.1017/CBO9781139032490


doi:10.1177/107769909907600213


Appendix A: Survey for Study 1

Did you see the graph or chart in the previous message?

○ Yes

○ No

Was it a line graph (red and blue areas intersect), a bar chart (red graph with the number of infected), or a line graph (red, blue, yellow lines about wearing masks)?

○ Line graph (red and blue)

○ Bar chart (red)

○ Line graph (red, blue, yellow lines about wearing masks)

Message Credibility Scale
Do you think the message you viewed is:

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
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<td>Accurate</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Authentic</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Believable</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
**Message Effectiveness Scale:**
To what extent you agree/disagree with the following statements about the message you've seen:

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<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>This message was worth remembering</td>
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<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>This message grabbed my attention</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>This message was powerful</td>
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<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>This message was informative</td>
<td>☐</td>
<td>☐</td>
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<td>☐</td>
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<tr>
<td>This message was meaningful</td>
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<td>☐</td>
</tr>
<tr>
<td>This message was convincing</td>
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</table>
**Perceived Threat Scale:**
To what extent you agree/disagree with the following statements after you've read the message:

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<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
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<tr>
<td>I feel nervous because of coronavirus</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I feel uncomfortable because of coronavirus</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>It is possible for me to get infected with COVID-19 (coronavirus).</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The threat of COVID-19 (coronavirus) will get worse.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Hospitals will be overwhelmed with more people.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
**Positive Attitudes about the Message Scale:**
Choose one answer from each pair. You think that measures for coronavirus prevention presented in the message are:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>good</td>
<td></td>
<td></td>
<td>bad</td>
</tr>
<tr>
<td>desirable</td>
<td></td>
<td></td>
<td>undesirable</td>
</tr>
<tr>
<td>favorable</td>
<td></td>
<td></td>
<td>unfavorable</td>
</tr>
<tr>
<td>effective</td>
<td></td>
<td></td>
<td>not effective</td>
</tr>
<tr>
<td>wise</td>
<td></td>
<td></td>
<td>foolish</td>
</tr>
<tr>
<td>positive</td>
<td></td>
<td></td>
<td>negative</td>
</tr>
<tr>
<td>necessary</td>
<td></td>
<td></td>
<td>unnecessary</td>
</tr>
</tbody>
</table>

**Intentions to Follow Prevention Measures Scale:**
Please answer the following questions

<table>
<thead>
<tr>
<th></th>
<th>Definitely no</th>
<th>No</th>
<th>Probably no</th>
<th>Not sure</th>
<th>Probably yes</th>
<th>Yes</th>
<th>Definitely yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you intend to practice self-isolation if it is needed to avoid COVID-19?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you intend to wear a mask to protect yourself from COVID-19?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you intend to practice social distancing measures for your protection during the pandemic?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you plan to reduce your activities and keep only those that are necessary such as grocery store visits, pharmacy/hospital visits, and others?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Self-Efficacy Intentions for Behavior Change Scale:**
Please select the extent to which you agree with the following statements:

<table>
<thead>
<tr>
<th>I'm able to practice measures to prevent COVID-19</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can handle this situation and change my life in order to better implement preventive measures against coronavirus.</td>
<td>○ ○ ○ ○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can manage to practice self-isolation and social distancing even if I need a long time to develop the necessary routines.</td>
<td>○ ○ ○ ○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can manage to practice self-isolation and social distancing even if I have to make a detailed plan.</td>
<td>○ ○ ○ ○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can manage to practice self-isolation and social distancing even if I have to rethink my entire way of life.</td>
<td>○ ○ ○ ○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Defensive Avoidance Scale:**  
Please select the extent to which you agree with the following statements. After you've read the message about COVID-19 prevention, your first instinct was:

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>You wanted to think about coronavirus prevention.</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
</tr>
<tr>
<td>You wanted to protect yourself from coronavirus</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
</tr>
<tr>
<td>You wanted to do something to avoid coronavirus</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
</tr>
</tbody>
</table>

**Negative Attitudes about the Message Scale**  
Please select the extent to which you agree that the message you've read about coronavirus was:

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>distorted</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
</tr>
<tr>
<td>overblown</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
</tr>
<tr>
<td>exaggerated</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
</tr>
<tr>
<td>boring</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
</tr>
<tr>
<td>overstated</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
<td>🟠</td>
</tr>
</tbody>
</table>
**Reactance Scale:**
To what extent you agree/disagree with the following statements about COVID-19 message you've seen:

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The message threatened my freedom to choose</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The message tried to make a decision for me</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The message tried to manipulate me</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The message tried to pressure me</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

**Anger Scale:**
After you've read the message about COVID-19, whether you felt...

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>irritated</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>angry</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>annoyed</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>aggravated</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
### Need for Cognition Scale:
Please select the extent to which you agree with the following statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I would prefer complex to simple problems.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I like to have the responsibility of handling a situation that requires a lot of thinking.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Thinking is not my idea of fun.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I would rather do something that requires little thought than something that is sure to challenge my thinking abilities.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I really enjoy a task that involves coming up with new solutions to problems.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
**Graphicacy Scale:**
Please select the extent to which you are good at the following tasks:

<table>
<thead>
<tr>
<th>Task</th>
<th>Not good at all</th>
<th>Slightly good</th>
<th>Moderately good</th>
<th>Very good</th>
<th>Extremely good</th>
</tr>
</thead>
<tbody>
<tr>
<td>How good are you at working with bar charts?</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>How good are you at working with line plots?</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>How good are you at working with pies?</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>How good are you at inferring the size of a bar in a bar chart?</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>How good are you at determining the difference between 2 bars in a bar chart?</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Appendix B: Survey for Study 2

Did you see data in the graph or chart in the previous message?

☐ Yes

☐ No

What feelings and thoughts do you have about COVID-19? Please, write 2-3 sentences describing the thoughts and feelings that you currently have about coronavirus pandemic and vaccination (minimum 100 characters required).

__________________________________________________________________________________________
__________________________________________________________________________________________

Message Credibility Scale:
Do you think the message you viewed is:

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accurate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authentic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Believable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Positive Attitudes about the Message Scale:**
Choose one answer from each pair. You think that measures for coronavirus prevention presented in the message are:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>good</td>
<td>o</td>
<td>o</td>
<td>bad</td>
</tr>
<tr>
<td>wise</td>
<td>o</td>
<td>o</td>
<td>foolish</td>
</tr>
<tr>
<td>necessary</td>
<td>o</td>
<td>o</td>
<td>unnecessary</td>
</tr>
</tbody>
</table>

**Intentions to Follow Prevention Measures Scale:**
Please answer the following questions.

<table>
<thead>
<tr>
<th></th>
<th>Definitely no</th>
<th>No</th>
<th>Probably no</th>
<th>Not sure</th>
<th>Probably yes</th>
<th>Yes</th>
<th>Definitely yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you intend to follow measures that were outlined in the message (COVID-19 prevention and vaccination)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you intend to wear a mask to protect yourself from COVID-19?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you intend to practice social distancing measures for your protection during the pandemic?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Self-Efficacy Intentions for Behavior Change Scale:
Please select the extent to which you agree with the following statements:

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I'm able to practice measures to prevent COVID-19 such as vaccination, wearing a mask, and others.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I can handle this situation and change my life in order to better implement preventive measures against coronavirus.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I can manage to practice COVID-19 prevention measures even if I need a long time to develop the necessary routines.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
**Negative Attitudes about the Message Scale:**
Please select the extent to which you agree that the message you've read about coronavirus was:

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>distorted</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>overblown</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>exaggerated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reactance Scale:**
To what extent you agree/disagree with the following statements about COVID-19 message you've seen:

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The message threatened my freedom to choose</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The message tried to make a decision for me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The message tried to manipulate me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Anger Scale:**
After you've read the message about COVID-19, whether you felt...

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>irritated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>angry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>annoyed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Need for Cognition Scale:**
Please select the extent to which you agree with the following statements:

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I would prefer complex to simple problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like to have the responsibility of handling a situation that requires a lot of thinking.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>I really enjoy a task that involves coming up with new solutions to problems.</td>
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<td>I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.</td>
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</tbody>
</table>
**Graphicacy Scale:**

Please select the extent to which you are good at the following tasks:

<table>
<thead>
<tr>
<th></th>
<th>Not good at all</th>
<th>Slightly good</th>
<th>Moderately good</th>
<th>Very good</th>
<th>Extremely good</th>
</tr>
</thead>
<tbody>
<tr>
<td>How good are you at working with bar charts?</td>
<td>○</td>
<td>○</td>
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<tr>
<td>How good are you at working with line plots?</td>
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<tr>
<td>How good are you at inferring the size of a bar in a bar chart?</td>
<td>○</td>
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</tbody>
</table>
Iuliia Alieva is a Postdoctoral Research Associate at the Carnegie Mellon University, where she works at the Center for Informed Democracy & Social - cybersecurity (IDeaS). She received her bachelor’s degree at the Pyatigorsk State Linguistic University in Russia and her master’s degree at the MU School of Journalism with a concentration on data journalism and international reporting. During her Ph.D. program, Iuliia’s research interests focused on media effects, data journalism, political communication, and computational social science.