“BETTER SAFE THAN SORRY”: SOCIAL MEDIA RESPONSES TO EMERGING COVID-19 RESEARCH IN THE NEWS

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ABSTRACT

In late 2019 and early 2020, the world faced the onset of a novel virus, SARS-CoV-2, also known as COVID-19 or Coronavirus, that would ultimately impact the lives of millions around the world. The COVID-19 Pandemic brought widespread attention to both the scientific process and communication of research from researchers through media outlets to the public. This study examines public responses to emerging and changing scientific research on surface transmission of COVID-19 as it was reported in *New York Times* articles during three different points in the pandemic. Three articles, published in March, May, and November of 2020, offer developing information about the surface transfer of COVID-19 as it became available. This study uses qualitative and quantitative analysis to analyze public Facebook comments on each *New York Times* article to document how public audiences understood and responded to changing COVID-19 research over time.

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DEDICATION

For my incredible parents Steven and Carol Wegner. Thank you for loving and supporting me always.

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CHAPTER I: INTRODUCTION

During the COVID-19 pandemic, much remained unknown about the virus that would soon affect millions around the world. Questions filled the minds of many: What is COVID-19? How does it differ from other viruses? How deadly is it? How can we remain safe? How does it spread? The COVID-19 pandemic, while a complicated, multifaceted, political, and social issue, collectively impacted the lives and work of individuals everywhere.

Looking at the United States alone, according to the Center for Disease Control and Prevention (CDC), between early January 2020 and June 2021, 595,387 COVID-19 deaths were reported ("National Center for Health Statistics"). Also, between these dates in the United States, the CDC reported 33,496,454 total positive COVID-19 cases ("National Center for Health Statistics"). Because of this significant impact, many individuals searched for more information about the virus. Public audiences around the world turned to doctors, scientists, political leaders, health organizations, and news outlets to learn more. Many people sought out scientific research in order to better understand the virus itself as well as how individuals should respond. Many questions about COVID-19 existed including topics such as mask wearing, mask material, mask efficacy, social distancing, lockdown, shelter-in place, and quarantining periods, virus symptoms, aerosol and surface transmission, virus impacts on preexisting conditions, essential workers, room ventilation, among others. However, all of these topics ultimately involved transmission of the COVID-19 virus and transmission prevention. In particular, the surface spread of COVID-19 became an important subject that was informed by differing scientific reports as time progressed and research became more available. Scientific research played an important role in informing the actions of individuals everywhere in order to slow the spread of the virus and help individuals remain healthy.

This study is an attempt to trace the thoughts and attitudes of the general public as they collectively experienced a volatile situation filled with anxiety and questions. Particularly, this study traces the ways in which individuals grappled with changing scientific information about the surface spread of the COVID-19 virus that would ultimately inform their thoughts and actions. This study analyzes and compares public Facebook comments posted in response to news articles published by *The New York Times* describing the surface spread of COVID-19 in March, May, and November of 2020. The latest research about the surface spread of COVID-19 evolved across these three articles. Within this study I qualitatively and quantitatively analyze Facebook comments posted in response to each article in order to understand public attitudes towards emerging and changing research throughout the COVID-19 pandemic.

New Relationships

The COVID-19 pandemic challenged and brought attention to typical methods of disseminating scientific research as well as the relationship between researchers, news media, and the general public. Because of the urgency of the situation, emerging, preliminary scientific research was reported by news outlets as it became available. However, individual studies published early in the pandemic did not yet reflect replication and widespread consensus in the scientific community. Dumas-Mallet et al. describe the nature of the scientific process saying "The production of scientific knowledge is an incremental process where early, promising but yet tentative findings are validated through replication. Thus, initial scientific results are uncertain per se" (125). Dumas-Mallet et al. give further details saying that the majority of scientific initial findings are later refuted, changed, or clarified (17). While the process of publishing initial findings, replication, changes in findings, and reaching consensus is not new, the urgency and public nature of the COVID-19 pandemic made this system more visible on a

public level. As time progressed throughout the pandemic, so did the number of studies regarding the spread of COVID-19. As expected, given the nature of the scientific process, later studies frequently debunked, clarified, or critiqued early findings published by researchers and shared via news media. Increased visibility of this process led to public debates about the accuracy and reliability of research on COVID-19 because ideas about surface spread changed throughout the pandemic. With a large social media audience, *The New York Times* worked to continually share emerging research, and later clarifications, with the public as it became available. This situation ultimately drew attention and public reactions to the scientific research process and the nature of scientific debate. These changes in research regarding COVID-19 were frequently met with questions and doubts of the validity of research and credibility of researchers by the public.

While the COVID-19 pandemic shed light on the scientific research process and nature of scientific debate, the pandemic occurred at a time where public audiences were already surrounded by suspicions of "fake news" and doubt regarding the credibility of news outlets and the authenticity of information. Shearer and Mitchell report that in a 2020 study, of users who receive news via social media, 59% indicated they expect news published to be "largely inaccurate". Lazer et al. define "fake news" as "fabricated information that mimics news media content in form but not in organizational process or intent" (1094). Concerns of public audiences about fake news are echoed by researchers. Vargo et al. state that political and ethical concerns are amplified given that "Fake news spreads on social media and is perhaps more popular than ever" (2042). This is particularly concerning given that news with no factual basis has influenced both public audiences as well as topics covered in mainstream media, particularly since the 2016 election (Vargo et al. 2031). Several researchers have identified a link between the presence of

fake news and social media. Lazer et al. state that social media is deeply entwined with fake news. By liking and sharing content, individuals can influence the algorithms used to share information to other social media users, therefore potentially amplifying the spread of misinformation or fake news (Lazer et al. 1095). During the COVID-19 pandemic, the public grappled with these concerns as they worked to discern what information should be used to guide virus prevention.

The Role of Digital and Social Media

Facebook

Despite skepticism surrounding the validity of information shared, digital media continues to play a key role in informing individuals. Research shows that social media remains a frequent and influential source of information for public audiences. Since social media posts can be distributed to more and more users through likes and shares, information can reach a wide audience. According to the Pew Research center, in 2020, 53% of Americans stated they "often" or "sometimes" used social media in order to obtain news; looking at individual social media websites, Facebook was the most frequently used social media website with 63% stating they used the site and 54% of those users saying they use the website to get news regularly (Shearer Mitchell). While social media generally is a key source of information, Facebook was chosen for this study because of these statistics about online information consumption. Additionally, Facebook was chosen because it offers more options for user responses and more individuals interacted with articles posted on Facebook than on *The New York Times* website itself.

While many individuals use social media to find information, social media also has the ability to influence individuals who may not be directly looking for news or research. Mueller-Herbst et al. identify this as "incidental exposure" which has the strong potential to increase

individuals' knowledge of current events. The authors state that there is evidence that information learned via incidental exposure on social media can play a strong role in influencing the future encounters with news on subjects (Mueller-Herbst et al. 4). After primary analysis Mueller-Herbst et al. also found that Facebook specifically played an important role in increasing public awareness of scientific issues (Mueller-Herbst et al. 9). From this research it is clear that social media, especially Facebook, is both a frequent and influential source of scientific information for public audiences. Facebook comments were chosen for analysis in this study because they serve as a window into perceptions of information for public audiences. Additionally, unlike other social media websites, Facebook allows users to interact with content in several ways. Within the comments section of *The New York Times* articles Facebook page, users respond, debate, question, and discuss the information presented by articles in one location, making it an excellent place for analysis to evaluate how audiences understood and responded to scientific information about COVID-19 at various points in the pandemic. Within this system of discourse over the course of the COVID-19 pandemic, Facebook comments revealed much information about the values, assumptions, and understandings of scientific information and those conveying it.

The New York Times

The New York Times also experienced increased attention through the COVID-19 pandemic. Throughout the course of the pandemic news outlets were tasked with the role of conveying to public audience's scientific research regarding the surface spread of COVID-19 in an accessible way. While many already relied on digital news media specifically as a main source of information before 2020, digital journalism reached new heights during the COVID-19 pandemic. *The New York Times* especially experienced this surge. The news outlet reported in

November of 2020 that the *Times* reached a record high number of subscribers, seven million, during the pandemic (Lee). This growth in online users was influenced by many factors including the COVID-19 pandemic and the political climate in the United States. Within just three months in 2020, *The New York Times* added 393,000 digital subscribers (Lee). This sharp increase in readers gave *The New York Times* an even larger platform and influence on public audiences. Lee writes that the surge in public attention to *The New York Times* was driven in part by the COVID-19 pandemic, the political climate surrounding the 2020 election, and pre-pandemic trends such as the Trump presidency which has caused a steady increase in readers since 2016 (Lee). As the pandemic progressed, more users looked to *The New York Times* for information regarding the virus. Additionally, *The New York Times* change to open-access articles available to anyone regardless of subscription status also contributed to the news organization's wider audience and influence. Over time, much scientific information was cited and summarized in news articles to inform users.

The New York Times was also chosen as a news outlet in this analysis for its long-standing history and reputation as a credible news source. During the pandemic, many looked to long-standing and familiar media outlets to learn more about the virus. Second, it was chosen because of its wide audience and far-reaching platform. *The New York Times* reaches over seventeen million Facebook followers, making it an influential source of information. Finally, *The New York Times*, unlike several local or regional media outlets, more frequently reported emerging scientific information.

Purpose and Summary of March, May, and November Articles

Three articles, published during three different points in the pandemic and shared via *The New York Times* Facebook page, give insight into the evolution of research about the surface

spread of COVID-19 as well as the scientific research process itself. While each article chosen for this study covers research regarding the transmission of COVID-19 in March, May, and November of 2020, each article includes different insights based on research available up to that point. The content of the three articles are summarized below. Also included are details about an influential study published in March of 2020 by *The New England Journal of Medicine* that is contextualized differently within all three articles.

Article one, published on March 17th, 2020, is titled, "How Long Will Coronavirus Live on Surfaces or in the Air Around You?" by Apoorva Mandavilli. In 2019, Mandavilli received the Victor Cohn Prize for Excellence in Medical Science Reporting. The article cites and directly links academic articles published in a variety of journals and quotes various doctors and researchers regarding the spread of COVID-19. This news article also draws attention to debates occurring between researchers by stating, "He [Dr. Munster] said the aerosols might stay aloft only for about 10 minutes, but Dr. Marr disagreed with that assessment, and said they could stay in the air for three times longer" (Mandavilli). I chose this article for this study because it was one of the earliest attempts by *The New York Times* to concisely publicize and inform readers about the surface spread of COVID-19 using research available in March of 2020.

Article two, published on May 22nd, 2020, is titled "Surfaces Are 'Not the Main Way' Coronavirus Spreads, C.D.C. Says" by Jacey Fortin. Fortin received an English degree from Northeastern University. This article is intended to clarify thoughts about COVID-19 transmission. The article makes visible studies that show surface transfer is not the main method of transmission of COVID-19. The article shows this by detailing changes to the language of the CDC website. The article cites research regarding the length of time COVID-19 can exist in the air and on surfaces while also stating much remains unknown. Fortin states, "Experts at the

C.D.C. and elsewhere are still learning about the new coronavirus". I selected this article because it offers a new perspective on the ways in which COVID-19 is spread that may have contradicted the public's previously held beliefs about transmission.

Article three, published on November 18th, 2020, is titled "The Coronavirus Is Airborne Indoors. Why Are We Still Scrubbing Surfaces?" by Mike Ives and Apoorva Mandavilli. This article gives insight into emerging research about the surface spread of COVID-19 while discussing the practices followed in Hong Kong as a case study. This article directly references research published earlier in the pandemic that had been recently disproved in November of 2020. This article was chosen because it specifically references changes in scientific consensus about the surface spread of COVID-19. It begins by stating "But scientists increasingly say that there is little to no evidence that contaminated surfaces can spread the virus" (Ives and Mandavilli). While evidence of new-found consensus is cited, the November article also directly mentions previously held ideas about the spread of COVID-19. Progress in available information and changes to scientific understanding is directly included in this article. Ives and Mandavilli directly link and reference the March and May 2020 articles to show this progression.

Changes in Research Findings Across March, May, and November Articles

While each article details what was known at various points in the pandemic about the aerosol and surface spread of COVID-19, each article also directly references an influential study published in March of 2020 by *The New England Journal of Medicine*. Although the March article states that "The coronavirus can live for three days on some surfaces, like plastic and steel, new research suggests" (Mandavilli), the May article also cites this same study saying,

> A lot of what we know about how long the virus lives on surfaces comes from a study published in *The New England Journal of Medicine* in March. The study found that the

virus can survive, under ideal conditions, up to three days on hard metal surfaces and plastic and up to 24 hours on cardboard (Fortin).

The second article recognizes that a widely held belief rests on one research study; however, it does not explicitly contradict the research published. Article two contextualizes this research and simply states that COVID-19 is more likely to spread through aerosol than through surfaces. However, the third article published in November of 2020, for the first time, contradicts information from the initial *The New England Journal of Medicine* study. The third news article states that while the journal article found "the virus seemed to survive on some surfaces, including plastic and steel, for up to three days" actually, "Studies later showed that much of this is likely to be dead fragments of the virus that are not infectious" (Ives and Mandavilli). While the third article does not completely reverse the initial article's claims, it makes a crucial clarification that substantially changes perceptions about the surface spread of COVID-19.

These three articles trace the progression of research and scientific discourse on the surface spread of COVID-19. Accordingly, Facebook comments posted in response to each article capture public reactions to new and changing research.

CHAPTER II: LITERATURE REVIEW

While the novel COVID-19 virus created a world of uncertainty, the situation brought attention to important concepts, research, and questions in Science Communication that scholars have considered for many years. The purpose of this literature review is to synthesize relevant literature in order to contextualize communication between scientists, news media, and the public. Scholarship included also will help guide the primary analysis conducted in this study. Many scholars in a variety of fields have studied the rhetoric of science, science communication, scientific literacy, and online media discourse in order to understand the best methods of disseminating and communicating scientific research for public audiences. All of these topics are grouped under the umbrella discipline of Science Communication. Science Communication examines and defines the ways various actors interact within the process of communicating science. This chapter defines Science Communication scholarship, describes the history of science and media as well as the role of relevant actors such as scientists, media organizations, and public audiences, and synthesizes recommendations from scholarship regarding best methods of communicating science.

Science Communication Discipline

Within this study I draw from scholars within the umbrella discipline of Science Communication. Science Communication is defined as "an empirical approach to defining and understanding audiences, designing messages, mapping communication landscapes, and—most important—evaluating the effectiveness of communication efforts" (Kahan et al. 1). This discipline is located at the intersection of several disciplines because it considers the relationship between various actors. Science Communication as a discipline involves analysis of writing and rhetorical practices, media systems and communications, and scientific inquiry and the rhetoric

of science. Scholars write that Science Communication is necessarily multidisciplinary because the process of conveying science is an issue that is not only involved in science and communication, but it is also deeply involved with social and political dynamics (Akin and Scheufele 25). Science Communication was chosen as the primary body of research literature in this study because it focuses on the interactions among actors such as scientists and researchers, media, and the public as well as methods of communication between these actors. Science Communication scholarship is an appropriate discipline of research in this study because, as Siegrist and Hartmann write, the goal of Science Communication as a discipline is to "inform people about risks, benefits, and other costs in order to help them make rational decisions" (446). This body of research is applicable to this study because emerging research published within *New York Times* articles was intended to help individuals understand the surface spread of COVID-19 as well as risk assessment in order to help guide their future actions during the pandemic.

Media Industry History and Analysis

While the COVID-19 pandemic was an unprecedented event, scholars have long considered how media institutions have evolved over time along with how these changes have impacted the relationship between science and media. Several scholars give insight into the history of the media industry as well as how scientific information is chosen, summarized, and contextualized for public audiences. Weingart, Kosterich, Yeo and Brossard, and other scholars offer descriptions of the relationship between scientists, journalists, and public audiences.

Several scholars have worked to define the evolving relationship between science and media. In a 1998 article, Peter Weingart traced significant systemic changes to this relationship by giving several instances of evidence that there was an increasingly close relationship between

science and media. Weingart describes the then current relationship between science and media as well as the dominant systems of communication at that time. Specifically, he describes "popularization" as the concept guiding communication of science at that time. He states that popularization of scientific research is guided by the "deficit" model of communication. He writes, "The traditional concept of popularization is one which typically implies a passive and generally un- specified public. The process of communication of scientific discoveries from science to the public is unidirectional. The public is perceived as purely receptive" (869). This "deficit" model of communication became a dominant theory that described the relationship between scientists, media, and public audiences. Essentially, the deficit model accounts for both the direction of communication, from scientists to media to public audiences, as well as the transformation of information for public audiences as simplification. Weingart writes that these views created a system of communication in which,

> Scientific truths are produced within the social system of science and then are transmitted in accessible form to the public. The control over the adequacy of this transmission lies with science. From the perspective of science, popularized knowledge is in the best case simplification, in the worst case pollution. (Weingart 869)

He also describes the direction of communication under the deficit model saying, "The conviction underlying this ideology was that if the public only understood science better it would also support it more readily. The media were given the role of the translator and propagandist" (Weingart 870).

Yeo and Brossard also synthesize research describing the relationship between scientists and media. They begin by describing the historical relationship between the two saying, "In the traditional model, lay audiences would turn to scientists as sources of information. Accordingly,

empirical communication scholarship on scientist-media interactions has typically focused on understanding this relationship with the assumption that it is linear" (Yeo Brossard 262). The authors argue that the use of search engines and social media has created a closer relationship between scientists and the general public. The deficit model guided many assumptions in scholarship. First, that ineffective communication of science was the result of uninformed audiences. Atkin and Scheufele note that scholars attributed lack of public support to simply a lack of public understanding (26). Because the "problem" with communication of science was public understanding, much scholarship was dedicated to improving the public's scientific knowledge.

The relationship between science and the media industry has continued to change since it was described by Weingart. In her 2019 article, Kosterich traces these changes to the news media industry, specifically in relation to scientific news. Kosterich argues that strategies and everyday practices of journalists are indicators of institutional change in the news media industry (57). Kosterich emphasizes the importance of legitimacy in the survival of news media (55). Heightened focus on legitimacy has also influenced the modern-day relationship between science and media. Kosterich found that the entrance of experts from outside fields lead to institutional change in the news industry (57). As Weingart observed in 1998, science and media have had an increasingly close relationship. While popularization drove this close relationship in 1998, Kosterich has determined that the role of experts from various fields outside of media into news production in order to increase legitimacy of news has contributed to an even closer and more complicated relationship between the two.

While institutional changes have contributed to changes in the process of communicating science, Science Communication scholarship itself has also shifted significantly over time. While

research was once guided by the deficit model, scholarship has now expanded to consider communication of science in more diverse ways. This development in research called Public Understanding of Science (PUS) and Public Engagement with Science (PES) challenges the deficit model that historically dominated communication scholarship. The shift from the deficit model to studies in Public Engagement with Science was met with some challenges. Giante writes, "Arguably, at least part of the reason for the rocky transition from the 'deficit' model to the Public Engagement model is that scientists are neither trained to be aware of the ways in which scientific culture operates nor prompted to take responsibility for communicating their research to non-expert publics" (77). Science Communication scholarship was challenged by this increasingly rhetoric-focused approach to communicating science which considered how scientists construct reports and how writing choices impact media reports as well as public understandings.

PUS is defined as "a type of research that considers the ways in which informal science education, formal science institutions and the scientific community, and civic institutions and public policy communicate in the form of public engagement with science" (McCallie et al. 26). Unlike scholarship guided by the deficit model, PUS studies consider the ways in which scientists inform public audiences, but also how public audiences can inform scientific research by sharing their understandings and values. This establishes that scientists have much to inform public audiences, but *public audiences also have much to inform scientis*ts. While research engaging in public understanding and engagement with science are significantly different than scholarship guided by the deficit model, the goal of this research is still "to make quality scientific knowledge accessible and engaging to everyone in order to help people learn science and enhance their lives" (McCallie et al. 21). Recently, researchers have worked to critically

examine how diverse public audiences understand science, not by observation, but through direct communication between scientists, communicators, and public audiences. McCallie et al. note that PUS and PES scholarship is characterized by mutual learning between those with a variety of backgrounds, scientific expertise, life experiences, ideas, and values (18). These studies work against the deficit model by recognizing that publics are not purely receptive. Huang et al. also state that Public Engagement with Science projects benefit both scientists and public audiences.

Defining Relevant Actors

The COVID-19 pandemic brought attention to the relationship between scientists, news media, and the general public on a global scale. While these three groups are relevant within the current study, each group can play unique roles depending upon the situation. Scholars have defined the scope and role of each actor in relationship to science communication as well as engagement between these groups.

Scientists, news media, and the public engage with one another in order to communicate scientific information. Engagement within Science Communication contexts is defined by McCallie et al. as, "behaviors that demonstrate interest in or interaction with a science-related activity or experience" (McCallie et al. 20). Complex systems of communication allow this interaction between various actors. Kahan, Scheufele, and Hall Jamieson describe the communication process saying that, in many situations, communication of science is not a linear process of information passing from scientists to media to the general public; rather, information can be spread in complex ways depending on context (6). Additionally, Science Communication as an area of study is complex given it involves attention to the "science" of science, the language of science, and the communication of science all as subdivisions of this research (Kahan, Scheufele, Hall Jamieson 8). While the role of and relationship between various actors

depend on specific situations, within Science Communication scholarship scientists, media organizations, and the public are three commonly studied actors.

Media

Several authors define the role of both media organizations as well as communication efforts. Schäfer notes that today science is sometimes considered "detached" from society. When it is needed, it is obtained by the public through media organizations, often via online media (Schäfer 51). Media organizations as well as individual journalists play an important role in both determining which topics should be conveyed to public audiences as well as how information should be presented. These roles emphasize the media's role as a mediator between scientists and public audiences. Kahan et al. recognize that the role of the media is twofold—their responsibility is not only communicating accurate information as an intermediary between scientists and publics, but their role is also countering inaccurate information (6). The authors also emphasize the necessity of both media organizations as well as the process of communication itself, "Communication is an inevitable part of the process of characterizing scientific findings, engagement among scientists about them, and the process of sharing them with policymakers and diverse publics" (Kahan, Scheufele, and Hall-Jamieson 2). The media often plays an important role in determining the relationship between science and the public. Schäfer emphasizes the role of media as determining the scope of public discourse, noting that the ways in which media shapes and presents science to public audiences plays an important role in the ways in which public audiences respond, specifically in regard to public audiences' decisions to support developments (51). Given that the media plays a key role in shaping information for public audiences, media organizations are frequently studied in science communication scholarship.

Reporters specifically play an important role in communicating events and the significance of events to the general public. Necessarily, the role of a reporter is to synthesize and convey the most important information to the general public. Within the case of the COVID-19 pandemic, reporters were tasked with identifying reports on the spread of COVID-19 as they became available and synthesizing this formation for readers. Individual journalists also play an important role in science communication within media systems. Mueller-Herbst et al. describe the interactions between journalists and media organizations and the general public in communicating science saying, "These mediated spaces facilitate filtering and interpretation of an enormous amount of information by presenting pre-selected news, either from traditional news organizations or from members of social media networks, and serve as an exchange platform for scientists, the media, and the public" (2). Selection and translation of information are both necessary and important given that, as Weingart observes, "Media cannot function as transmitters of representations of scientific discoveries or any other events 'true to reality.' They construct their own reality in the same way as science does" (Weingart 870). Even more boldly, Taylor writes, "The facts of science cannot speak for themselves; they must be spoken for" (76). From these perspectives it is clear scholars feel the role of individual reporters to act as interpreters of information. This role is not necessarily problematic, but rather, it is necessary in order to filter, translate, and disseminate information for public audiences. Reporters play an important role in communicating events and the significance of events to the public. Necessarily, the role of a reporter is to synthesize and convey the most important information. Within the case of the COVID-19 pandemic, reporters were tasked with identifying reports on the spread of COVID-19 as they became available and synthesizing this formation for readers.

Wald describes the importance of shaping science narratives especially within biological emergencies. Outbreak narratives, or the ways in which an outbreak is conveyed by the media, can have a serious impact on the ways in which people respond: "Outbreak narratives and the outbreak narrative have consequences. As they disseminate information, they affect survival rates and contagion routes. They promote or mitigate the stigmatizing of individuals, groups, populations, … behaviors, and lifestyles, and they change economies." Wald continues saying, *"They also influence how both scientists and lay public understand the nature and consequences of infection, how they imagine the threat, and why they react so fearfully to some disease outbreaks and not others at least as dangerous and pressing*" (Wald 3; emphasis added). From these statements it is clear that scientists have an important impact on public audiences, and public responses to these crises have an impact on scientists. However, media organizations and journalists play a key role in conveying these responses. It is also important to note the ways in which these communities overlap. While scientists are part of the scientific community and journalists are part of the media communications systems, these groups are also included in the general public.

The Public

Lastly, the public remains a crucial actor within Science Communication scholarship. The public is ultimately the focus of much scholarship given that the goal of the discipline is to increase clarity of science communication to public audiences. While "the public" is often referred to as a singular group, McCallie et al. recognize diversity of public audiences and define them as various communities and subcommunities differing in backgrounds, perspectives, expertise, values, and experiences who are willing to participate in the discussion (47). The public also includes those working in scientific and communications professions. While public

audiences differ greatly, Brewer and Leys describe the expectations of public audiences saying, "the generalized expectancy that a message received is true and reliable and that the communicator demonstrates competence and honesty by conveying accurate, objective, and complete information." (Brewer Ley 119). While deficit model-guided scholarship focused solely on improving public understandings, scholarship today is focused more on with improving the ease of access, quality, or the readability of scientific developments.

Proposed Solutions to Science Communication

Science Communication scholarship is committed to improving systems of communication. This necessarily involves proposed solutions or new methods of communicating science. Thus, the discipline is driven towards constant improvement within various contexts. In the overview to the *Oxford Handbook of The Science of Science Communication,* Akin and Scheufele recognize the complexity and importance of creating effective communication of science,

> Understanding the dynamics of science communication surrounding such wicked problems from an empirical perspective, at the individual, group, and societal levels, is not optional. It is instead a necessary condition for generating public debates that are based on the best available science. At the same time, we need to create communication structures that help us innovate in ways that acknowledge relevant political, ethical, and societal considerations surrounding emerging technologies (Akin and Scheufele 31).

Several scholars offer primary analysis of various contexts that give insight into better methods of improving communication about science. Scholars across a variety of disciplines offer different solutions or strategies in order to improve science communication. These proposed solutions target actors at various levels. Scholarship today has shifted to recognize the

importance of rhetorical components and audience awareness. Essentially, scholarship now considers not only audience-targeted solutions, but also solutions that target media and scientists themselves. This section synthesizes recent research and resulting recommendations scholars offer in order to improve science communication efforts.

Solutions Targeting Science and Media

Several scholars suggest altering the ways in which scientists report or represent scientific information, or the ways in which media organizations and reporters include scientific information in news articles. These are often writing and rhetoric-focused solutions.

Some scholars advocate for increased rhetorical education for future scientists. Giante uses the concept of "critical science literacy" in order to advocate for increased composition education for students entering scientific careers. Rhetoric and composition curriculum for scientists would address the "gap" between scientific writers and non-expert public audiences and create clearer communication (84). Giante claims that it is equally the role of both scientists to understand the implications of their communication and also of audiences to develop critical literacy of science in order to effectively communicate information (84).

Other scholars advocate for specific language-based rhetorical practices. Many researchers have emphasized the importance of adding contextual language in order to emphasize the preliminarily and changeable nature of initial findings in different ways (Dumas-Mallet 2016, Butterfuss 2020). Scholars calling for this change state that the purpose of this added context or hedged language is to make visible the scientific process and help set audience expectations. Emphasizing the preliminary nature of information by scientists, or adding this contextual information by news reporters, is intended to make visible the location of current research within the scientific process.

In 2018, Dumas-Mallet found that frequently news articles remove contextual information and literature from scientific reports that give readers a sense of arguments in the field as well as the limitations of scientific research. Dumas-Mallet draws attention to the communication of scientific information as a process marked by removal of information; more specifically, they found the removal of this information by newspapers sometimes affirms data in a way that may not be generally accepted by researchers (137). The scholars offer solutions to future communication efforts by saying, "Initial findings should always be described as tentative, uncertain and requiring replication when reported in the scientific literature, the academic press releases and the media" (Dumas-Mallet et al 18). Added contextual information is especially important given that Dumas-Mallet et al. state because the scientific process and the importance of replicating scientific findings are not frequently mentioned, the public often receives flawed information about biomedical developments (126). This is evident in their study that found that 13.2% of a database of biomedical discoveries were covered in the news initially while only 2.4% of subsequent studies were covered (127). Added contextual information would set audience expectations for future scientific developments.

This contextual language would differentiate between disinformation that is malevolently and purposefully spread, and misinformation, which is a product of the scientific process, errors, or developments. This contextual information would inform the public if reports are preliminary or they are the result of scientific consensus. It also sets audience expectations regarding future developments. Some writers have stated similar actions should have been taken during the COVID-19 pandemic. In an opinion piece published by *The New York Times*, Tufekci critically considers the history of research on the spread of COVID-19 and debates surrounding it. She critiques the methods used to disseminate emerging information, particularly referring to national

research organizations, to public audiences and evaluates public responses saying, “Righting this ship cannot be a quiet process — updating a web page here, saying the right thing there. The proclamations that we now know are wrong were so persistent and so loud for so long” (Tufekci). She continues saying clearer science communication is necessary in order to preserve the reputation of research organizations both now and in the future (Tufekci). Given the prevalence of responses rejecting emerging information because of the perceived lack of credibility of sources, these concerns are not unfounded. Tufekci advocates for a clearer communication style: “It needs to begin a campaign proportional to the importance of all this, announcing, ‘We’ve learned more, and here’s what’s changed, and here’s how we can make sure everyone understands how important this is.’ That’s what credible leadership looks like.” Butterfuss et al. also argue that the inclusion of contextual information in news articles could impact audience reactions to new information and changes to information, “Readers’ reaction to scientific information is influenced by their awareness of the tentativeness of scientific findings” (149).

Other scholars disagree that the emphasis on uncertainty, while a common practice and standard of credibility in scientific communities, could be detrimental to public understandings of credibility, “There are reasons to think that a long argumentative process between scientists might actually be a bad thing when public belief is on the line.” (Weatherall 1169). Butterfuss also acknowledges the potential of contextual information having a negative impact on public support of science saying, “the more accurately scientific claims reflect the tentative nature of science, the less some individuals may believe that information” (Butterfuss et al. 164). These are important factors in considering best practices for communicating new developments in science.

These questions have added yet another subdivision of Science Communication scholarship—how to effectively communicate changes in science. As established, science continually changes as a result of replication and debate in the scientific community. Because of this, many scholars have considered best practices for communicating these changes to science to public audiences. In their article, Chan, Jones and Albarracín trace the history of retractions and responses to retractions of scientific information and emphasize the importance of quickly changing misinformation as well as offering detailed reasoning behind changes in order to preserve integrity of the community (342). In a 2017 study Swire, Ecker, and Lewandowsky also considered the best ways in which to correct and communicate inaccurate information. The authors found if corrections to inaccurate information included many details explaining the correction, participants were more likely to change their previously held beliefs (30).

Solutions Targeting Public Audiences

Several scholars offer solutions that target public audiences. These solutions frequently included increased education about the scientific process or scientific literacy. Giante writes that increased education is especially important given that,

> One of the major assumptions that students make about science is that it is not open to dispute; the science professors explained that their students assume—and this is not a unique perspective—that everything is already known in science and that they could not possibly add to the body of knowledge. Of course, to the contrary, scientific knowledge is ever- changing, and articles are constantly published that posit new arguments to be disputed in the discourse community (Giante 80).

This increased education is intended to shape public expectations about shared scientific research. Giante advocates for increased scientific literacy, which is deeply connected to decision

making in relation to scientific issues. Giante states, “Critical science literacy, according to Priest, would enable citizens to discern between trustworthy and untrustworthy information so as to make informed decisions about scientific issues” (78).

Other scholars call for a closer relationship between scientists and public audiences. Scholarship targeting increased public scientific literacy often emphasizes creating resources that make science more accessible for public audiences. These scholars call for increased online communication tools that make scientific information more accessible for public audiences. Huang et al. consider how public audiences engage in scientific projects. The authors argue that an online software called “Mental Modeler” helps to create deeper learning about scientific issues. Through analysis of “Mental Modeler” a collaborative online scientific resource, the authors find that these resources led to shifts in participants understandings of problems (481). The authors state that Mental Modeler “which fulfills the function in bridging intersecting practices among citizen scientists, facilitators, and scientific communities” (481). Other scholars advocate for a similar type of health literacy, using technology as a means of collaboration between public audiences and physicians, strengthening the quality of information published online (Swire-Thompson Lazer 443).

In conclusion, for many years, Science Communication scholarship has examined the process of communicating science, and necessarily, how to improve communication of science at various levels. While early science communication scholarship was guided by the deficit model, scholarship now critically examines the role of scientists, media organizations and journalists, as well as the public. Further discussion of potential solutions to science communications efforts are included in relation to this study in chapter five.

CHAPTER III: RESEARCH QUESTIONS AND METHODOLOGY

This chapter includes discussion of research questions, primary texts analyzed, and mixed qualitative and quantitative research methodology used in this study to gauge public reasoning and responses to emerging scientific research. A mixed methods approach is appropriate for this study because it accounts for public responses to new information qualitatively, through analysis of commentary, and quantitatively, through the number and type of "reactions" listed for each post. Furthermore, several scholars have considered the ways that individuals understand and evaluate science by using coding as a qualitative method because it reveals themes in data (Eck et al. 2020, Huang et al. 2018, Nir 2011).

I formed two research questions in order to establish the purpose and goals of this study. Research question one is intended to understand and describe public attitudes towards emerging scientific research published in *New York Times* articles. Research question two is intended to compare responses at various points in the pandemic in order to understand the progression of public attitudes over time.

Research Questions

- RQ1: How did public audiences understand and respond to emerging scientific information about the surface spread of COVID-19?
- RQ2: In what ways did audience perceptions of the surface spread of COVID-19 within Facebook comments differ between March, May, and November of 2020?

Methodology

After *New York Times* articles have been posted to their website, links are posted by *The New York Times* Facebook page. The use of social media platforms allows media organizations to reach a wide audience. As established, Facebook particularly reaches a wide audience of

users. Facebook allows users to interact with information in various ways. Users can indicate their response to posted information, comment their perspectives directly, and interact with other users. Because of this system, a mixed qualitative and quantitative approach is appropriate to accurately capture public responses to news articles.

Quantitative Research

On each article post, users can react, comment, or share the content published. Quantitative data including the number of likes or "reactions" and comments were gathered for articles one, two, and three. Since 2016, Facebook has offered multiple "reactions" for users globally beyond the original "like" reaction. These reaction options allow users to choose their attitudes towards content from a list in order to more accurately respond to content. These reactions give much more accurate insight into the affective response individuals have to content posted on the social media platform. Other popular social media websites such as Instagram and Twitter, only allow users to "like" content shared. New reactions available on Facebook include the "love, care, haha, wow, sad, and angry" reactions. Reactions for each post were recorded because they give insight into the ways in which audiences responded to emerging information in a quantitative way.

Qualitative Research

I used a two-step coding process for qualitative analysis in this study in order to first sort and organize data and then account for responses within comments. First, I used initial coding in order to sort comments. Initial coding, also called open coding, is described by Saldaña as a coding process that "breaks down qualitative data into discrete parts, closely examines them and compares them for similarities and differences" (115). During this first cycle of coding, I took Facebook comments in response to articles one, two, and three and placed them into three

separate spreadsheets. Because all comments were read during this process, initial coding allowed for a deeper understanding of the data as well as developing a working set of codes for the second phase of coding that would accurately represent the data. After data was gathered, I uploaded all three comment spreadsheets to Dedoose, a qualitative data analysis software effective for coding.

Also, during this first cycle of initial coding, comments that did not give insight into audiences' perceptions of scientific information were removed. For example, comments "tagging" other individuals, a method of sharing information with other Facebook users, were removed from the dataset because these comments were intended to share the article with others rather than respond to it. Other comments removed included spam comments, advertisements, and any responses unrelated to the initial *New York Times* article and post. Additionally, many comments were not removed, but they were unavailable to be viewed. The first round of coding demonstrated that the number of comments automatically listed by Facebook does not necessarily reflect the number of comments available to be viewed for public audiences. Likely due to privacy settings of individual users, many comments were not able to be viewed. These comments, counted by Facebook but unavailable to be viewed by the public, were not included within this study. After a combination of initial coding, sorting, and reviewing available comments, article one, which lists Facebook lists as "88 comments" had fifty-one comments, article two, which lists "752 comments" had one hundred and sixty-seven comments, and article three, which lists "367 comments" had 59 comments. After this initial coding process, a total of two hundred and seventy-seven comments with responses were included in this study.

After completing the first cycle of coding and organizing the dataset, emotional coding and descriptive coding were used within the second cycle of coding in order to better understand

individual perceptions and responses to information presented in *New York Times* articles. Emotional coding is an affective method that identifies and labels emotions of participants (Saldaña 124). Saldaña states this coding method is appropriate for studies that "explore intrapersonal and interpersonal participant experiences and actions, especially in matters of social relationships, *reasoning, decision-making, judgement, and risk-taking*" (Emphasis added, 125). Emotional coding is appropriate for this study because within the comments sections of these *New York Times* articles participants often judged emerging research as well as how this indicated decision making processes regarding how article information would inform future actions and risk-taking in relationship to exposure to the COVID-19 virus. Saldaña also describes emotional coding saying, "Thus, careful scrutiny of a person's emotions reveals not just the inner workings of an individual, but possibly the underlying mood or tone of a society - its ethos" (125). Because credibility or trust in science, organizations, and media was often a central component of Facebook comment conversations, emotional coding was an appropriate coding method for the purpose and goals of this study.

Lastly, descriptive coding, also known as topic coding, was simultaneously used to describe common themes that fell outside of emotional-based coding. Descriptive coding "summarizes in a word or short phrase -most often a noun - the basic topic of a passage of qualitative data" (Saldaña 102). Within this study, descriptive topic coding often captured participants' reasoning behind their emotional response. Lastly, I completed a third and final cycle of coding in order to ensure codes were applied accurately and consistently. The combination of these coding cycles along with quantitative analysis account for the similarities and differences that exist between participant attitudes towards emerging scientific information at various points in the pandemic.

Codebook

A code is a descriptive word or phrase that describes data and is used to categorize themes in the dataset. A consistent set of codes, also known as a codebook, was used to code comments for all three articles. Using a consistent set of codes for all three article comments allowed for comparison of the similarities and differences in responses across all three articles. This also allowed for analysis of code co-occurrences, codes frequently applied together, for each article.

Emotional Code Applications

Emotional codes used in this study account for the immediate response individuals had to the information presented in each article. Emotional codes used include accepting and rejecting. Saldaña states that, while there are hundreds of words to describe emotion, most emotions can be categorized as positive or negative (126). Given the short nature of Facebook comments, responses were coded positively or negatively without subcategories. Responses coded as "accepting" responded positively and used language to express their approval, belief, or acceptance of the information included within the corresponding *New York Times* article. Oppositely, responses coded as "rejecting" expressed negative emotions towards information published and did not accept the information shared within the article with or without detailed reasoning behind the response. Lastly, the code "uncertain" captured responses that fell outside of the emotional codes used in this study. These responses did not explicitly accept or reject information cited in the article. Responses coded as "uncertain" were neither positive nor negative.

Table 1. Emotional Codes

Code	Description
Accepting	Expressed positive emotions and acceptance that information as sound and valid
Uncertain	Indicated individuals were unsure if this information was accurate or valid for a variety of reasons. These responses did not explicitly accept or reject information cited in the article.
Rejecting	Responded negatively and explicitly rejected the information shared within the article with or without detailed reasoning behind the response

Descriptive Code Applications

While emotional code applications capture immediate responses from individuals, descriptive code applications capture the reasoning behind individuals' emotional responses. Several descriptive codes were developed to account for trends. These include the codes: asking questions, future actions, better safe than sorry, lack of credibility, lack of value, language of belief, political and social responses to the pandemic, and scientific research.

Responses coded as "asking questions" seek clarifications about the content or application of article information. Responses coded as "better safe than sorry" used this language, similar language, or similar reasoning, in order to express an individual's choice to err on the side of caution. Given this situation, a "better safe than sorry" comment was frequently a way of dismissing research that proved COVID-19 cannot live as long as previously stated on surfaces. Responses coded under the "future actions" expressed that information published would impact users' future decision making, either by changing current practices or keeping current practices. Responses coded as "lack of credibility" rejected emerging information because of a perceived lack of credibility. Users sometimes identified the Centers for Disease Control, the World Health Organization, scientists, researchers, or the *New York Times* specifically. Responses coded as "lack of value" objected to the article because they felt it was

not valuable information. These responses often urged other users to use "common sense" rather than published information. Responses coded as "political and social responses to the pandemic" discuss responses to the pandemic. These comments frequently discuss and debate appropriate policies and responses to the pandemic itself. Responses coded under the "scientific research process" directly referenced the process of scientific discourse, evolving or changing research, and debate in the scientific community within their response.

Table 2. Descriptive Codes

Code	Description
Asking Questions	Ask questions or seek clarifications about the content or application of article information
Better Safe Than Sorry	Express an individual's choice to err on the side of caution
Future Actions	Express that information included in this article would impact future decision making, either positively or negatively.
Lack of Credibility	Reject emerging information and identify the specific reason as the CDC, WHO, scientists, researchers, or the NYT as uncredible.
Lack of Value	Indicate users felt information published was not valuable
Political and Social Responses	Discuss appropriate protocol in response to pandemic
Scientific Research Process	Reference the process of scientific discourse, evolving or changing research, and debate in the scientific community within their response.

After completing three cycles of coding for all comments posted across the three articles used in this study, code application and co-occurrence were analyzed to determine how individuals responded to scientific research in March, May, and November as well as how responses differed between these times.

CHAPTER IV: RESULTS

General Results

This chapter includes both qualitative and quantitative results from this study. In this chapter I list the most frequently applied codes along with examples of user responses for each article individually. While this chapter lists results from each article, chapter five compares results across articles and discusses trends. Out of the two hundred and seventy-seven comments included in this study across all three articles, the most applied codes included rejecting (102 comments), lack of credibility (82 comments), scientific research process (66 comments), and accepting (30 comments), and better safe than sorry (28). While these statistics are in response to information published across the entire pandemic, code applications and trends differed significantly based on each individual article.

Article One

Article one, published in March of 2020, was one of the first attempts by *The New York Times* to make public research regarding the ways in which COVID-19 is spread. It features statistics and commentary from various sources. In response to this article, the most applied codes within the 51 available comments included Political and Social Responses to the Pandemic (16 comments), Accepting (14), and Asking Questions (11).

Through data analysis, it became clear that the purpose of the comments section within article one, which was published in March of 2020 and is the earliest article published under analysis in this study, differed in purpose and content from the two later articles. In the comments section of article one, Facebook users used the comments section as a place to question the economic and personal impacts of the virus. In March of 2020, less research was available and therefore individuals were not yet subjected to changes or clarifications in

scientific findings. Because of this difference in situation, comments did not frequently reject the content of the article or the credibility of reporters and scientists. Rather, many Facebook users used the comments section as a place to debate the appropriate response to this information. The frequency of "Political and Social Responses to the Pandemic" code demonstrates users generally accepted information included in the article and used it to form arguments for various steps to be taken in response to the pandemic. While many responded explicitly accepting the information published with words or short phrases like "exactly," others used the information to form arguments about the virus and virus response. One user wrote:

> "Corona has only killed a one-percent of what the common influenza kills each year. It is criminal how The Establishment has turned it into a psychological weapon against the general population to cover up it's [sic] shortcomings and other crimes"

Another shared:

> "Everything is a risk. We could be super cautious at home then have to make a grocery run in a week and a half. Then come in contact with it on a box on the shelf. But isn't that life?... It happens. That's life."

These responses were coded as "Political and Social Responses to the Pandemic" While the code applications of "Political and Social Responses to the Pandemic" and "Accepting" demonstrate a largely positive affective response to information published explicitly or tacitly, the third most frequently applied code was "Asking Questions" This also demonstrates that while most responded positively and accepted the information published, a significant percentage of users were uncertain and seeking clarifications. The subject of these questions differed from topics like COVID-19 viability on surfaces not mentioned within the article, how this would impact work and social relationships, among many other topics.

Overwhelmingly, these responses accepted information published regarding the surface transfer of COVID-19 as reported in the article; however, debate in the comments section focused on social and political response to this information. Comments posted in response to this article include the greatest percentage of accepting comments as well as uncertain responses in relation to articles published at later points in the pandemic.

Article Two

Article two, published in May of 2020, was one of the first articles published by *The New York Times* to cover information that complicates previously held beliefs about transmission of COVID-19. Of the 167 comments available after the initial coding and sorting process, the most commonly occurring codes within article two comments were Lack of Credibility (75), Rejecting (68), Scientific Research Process (49), and Better Safe than Sorry (15). This article includes frequent emotional codes, rejecting information present in the article, while also including descriptions of the reason for this position.

As stated, the purpose of this article was to inform the public about changes in understanding of the ways COVID-19 is spread. The article details the change from surface to aerosol transmission and statement changes from the CDC. Given this situation, comments posted in response to this article give insight into public responses to changes in previously held ideas. Differing from the first March article, the comments posted in response to this article largely focused on users' beliefs about and direct responses to information published in the article. Comments on this article post tended to be largely affective while also drawing attention to the reasoning behind individual's positions towards this new information.

Lack of Credibility

Within article two, users most frequently discussed a lack of credibility in relationship to information included in the article. However, this perceived lack of credibility was sometimes general, and sometimes attributed to specific actors such as the CDC, political officials, COVID-19 researchers, or *The New York Times*. Within comments coded as "Lack of Credibility" users rejected published information because of a perceived lack of ethical integrity of the source of this clarification of the ways COVID-19 is spread. Many users indicated a lack of ethical intent causing them to reject information published. One user wrote: "They have not been saying that for 'months.' Liar." Another said, "Use your common sense they're all puppets." Looking at the CDC specifically, a user said, "Don't trust anyone, even CDC in such matters." Other comments coded as lack of credibility drew attention specifically to the ways in which research was communicated to the public, "The impression I've gotten is the authorities don't know much and are even worse at messaging what they do know." All these comments reject article contents because information was not from a credible source.

Scientific Research Process

The second most frequently applied code was "Scientific Research Process." Responses using this code frequently discussed changes in research regarding COVID-19. Users frequently rejected this change in research saying it contradicted previously held beliefs. Users frequently referenced changes in surface transmission saying, "They said the complete opposite a month ago." Another wrote, "Every week there's something new." Similarly, another user said, "It has been changing daily for months....".

Users also frequently anticipated that just as previously published information, current information would also be changed in the future. Users wrote, "Wonder what they'll discover

about transmission next." Another user, in response to the article title stating the CDC states COVID-19 is not primarily spread via surfaces, responded with, "Until it says that it does". These comments used changes in research as a reason to not accept new evidence. One user wrote, "The CDC could change this opinion back again in a month for all we know." Users also described changes in research within other subsections of COVID-19 discourse as evidence scientific information would change again, "We were told that we didn't have to wear masks. Why should we believe that we don't need to wipe surfaces?" While these comments differ in perspectives, all comments coded under the "Scientific Research Process" draw attention to changes in the past, present, or anticipated future of research. Users indicate this pattern of change is evidence that the public should reject current research.

Better Safe than Sorry

While article two shared that researchers now believe surface transmission is not the main way COVID-19 is spread, many users rejected this claim. As a way of rejecting this new information, many stated they would not change their actions or stop cleaning surfaces. While these responses are coded emotionally as rejecting the new information, many users gave descriptions of their reasoning behind their response.

Responses coded as "Better Safe than Sorry" indicate users' intent to reject latest transmission research and continue clearing surfaces to prevent transmission. One user wrote, "Better safe than sorry, makes me feel a little more in control. So, yesterday I should, today I don't. Right." Another user draws attention to risk saying, "I'm going to keep wiping everything down because I would rather be safe than sorry. Not worth risking it." In response to the article title "Surfaces Are 'Not the Main Way' Coronavirus Spreads, C.D.C. Says" one user wrote, "'Easily' does not say it cannot... like the old saying goes 'Better to be safe than sorry.'" While

many users used the saying “better safe than sorry” verbatim, other responses coded as “Better Safe than Sorry” did not use the exact language but expressed the same sentiment that acting in accordance with previous research would better avoid risk.

Article Three

Article three, published in November of 2020, offers a definitive statement about transmission of COVID-19. It also explicitly addresses the changes in research consensus about the spread of the virus over the course of the pandemic. Of the 59 comments used in this study, the most commonly occurring codes within this article included Rejecting (30), Research Process (15), and Better Safe than Sorry (12).

Rejecting

The most frequently applied code within article three was “Rejecting.” In their responses users indicated they believed information included in the article was false. Many indicated diverse approaches, reasoning, and examples to make the argument that information included in the article should be rejected. One user simply wrote, “What is up must come down. The droplets don’t just disappear. Keep scrubbing surfaces.” Another elaborated saying,

> This is completely wrong. Droplets can land on surfaces and people can get contaminated by touching these droplets on the surfaces and then touching their faces. Basic science here. Plus several scientific studies that explain this. Really irresponsible to make such statements and compromise everyone’s health and safety.

Several users described incidents where allegedly the origin of a COVID-19 outbreak was a surface, “And yet we DO hear reports of how long viruses can survive on some surfaces. And some mysteries as to how viruses got into some people at all who did all the right things. There is a lot we do not understand here. And that does not mean we should ignore such precautions.”

Similarly, another said, “In South Australia where there’s been no community spread for months, a new outbreak was sparked from a cleaner touching a surface in a hotel room where someone was quarantining.” While reasoning and evidence differed within all comments, these users argued that information published within the article should be rejected.

Scientific Research Process

Like in article two, in article three comments, several users indicated that changes in research would continue, and that research published in article three would soon be disproved. One user wrote, “depending on the wind direction they change opinion!” Sarcastically, one user wrote, “I love 21st century ‘science,’” drawing attention to changes in information and the process of reaching scientific consensus.

Also, like article two, many users drew attention to changes in practices of other issues saying, “Remember when western scientists also said masks were useless for people who aren’t showing symptoms (even though asymptomatic transfer was a thing)?” Another commented on changes to mask recommendations saying, “Just like you said there’s ‘no evidence’ that wearing masks could reduce the risks. People are dead and it’d be too late to wait for your evidence to come, stupid.” Again, these comments cite previous changes in research as reason to reject new information.

Better Safe Than Sorry

The comments coded as “Better Safe than Sorry” in article three reflect the general sentiment of those within article two. However, within article three many users referred specifically to a lack of harm in continuing to sanitize surfaces, while those in article two did not refer to harm as a possible result of continuing to sanitize surfaces. One user explained saying, “It makes us feel better to do SOMETHING. Although, it can’t hurt to have clean surfaces, so

why not…" Another said, "there is no downside to washing off surfaces and disinfecting them." Unlike those comments coded as "rejecting," these comments do not loudly reject information published in the article; however, these comments reject emerging scientific research in that they do not believe it can be used to inform actions and risk taking.

Overall Code Co-Occurrences

Code co-occurrences, or codes frequently applied together, also give insight into public responses to each article. The most common code co-occurrence was "Scientific Research Process" applied with "Lack of Credibility." Within responses, changes in research regarding the spread of COVID-19 was frequently understood as a lack of credibility or consistency by users. One wrote, "I'm not saying this info is incorrect but I think it's being charitable to say CDC has been 'consistent' about anything." Once user succinctly describes their perceived correlation between a lack of credibility and changes to policies based on emerging research saying, "CDC = Can't Decide Crap."

Quantitative Results

Like qualitative responses, quantitative data collected also gives insight into emotional responses as well as how public responses to emerging research differed throughout the pandemic.

Table 3. Article 1 Results

Reaction Type	Number of Reactions
Like	461- 79.8%
Love	6- 1%
Haha	2- .35%
Wow	88- 15.3%
Sad	16- 2.8%
Angry	4- .7%

In response to article one, the most frequent reaction was the “like” reaction. Looking at the more specific affective responses, the “wow” was the second most frequent reaction with 88 reactions followed by the “sad” with 16 reactions. Article one also lists 455 shares.

Table 4. Article 2 Results

Reaction Type	Number of Reactions
Like	2,300- 89.6%
Love	64- 2.5%
Care	4- .2%
Haha	126- 4.9%
Wow	44- 1.7%
Sad	7- .3%
Angry	22- .9%

In response to article two, the “like” remained the most frequent response with 2,300 reactions. Looking at the specific reactions, the “Haha” received 126 reactions followed by the “love” with 64 responses, the “wow” with 44 and the “angry” with 22 responses. Article two lists 958 shares.

Table 5. Article 3 Results

Reaction Type	Number of Reactions
Like	2,100- 83.3%
Love	22- .9%
Care	15- .6%
Haha	109- 4.3%
Wow	208- 8.3%
Sad	53- 2.1%
Angry	14- .6%

In response to article three, the “like” was the most frequently applied reaction with 2,100 responses, followed by the “wow” with 208 reactions and the “Haha” reaction with 109 reactions. Article three lists 915 shares.

Interpreting Quantitative Results

The original "like" remained the most frequent reaction applied to all *New York Times* article posts. This is likely because this is the original response to content posted. The "like" is given a stationary position on all posts, while more specific reactions require users to hover over the "like" response. The additional processes required may explain the frequency in the "like" response. Further research is needed in order to definitively document the meaning of the "like" button within this context. However, it is important to note within this study that users "liking" the article felt the content was important enough to interact with on Facebook. Similarly, the percentage of users who chose to "share" articles with other Facebook users may indicate how users responded to content. While we cannot determine users' motivations behind sharing content, from these results it is clear some felt others should be made aware of scientific developments. Looking at the specific reaction statistics, within article one the "wow" and "sad" were the most frequent reactions to news about the transmission of COVID-19. This differs from the later two articles that clarify information. Within the later two articles the frequency of the "Haha" and "angry" reaction increased. In a 2020 study Ethofer et al. write "it should be noticed that laughter is a multifaceted social signal, which goes beyond the social bonding, but can also serve as a social rejection cue" (353). Given the situation and serious nature of COVID-19, these reactions likely indicate that users applied the "haha" reaction in order to indicate their rejection to parts or all of information included in the later two articles.

CHAPTER V: DISCUSSION

The purpose of this study was to first identify public responses to emerging scientific research regarding the surface spread of COVID-19 and secondly to describe differences in audience responses to COVID-19 research at three different points in time. The following section discusses public responses to each individual article as well as compares trends in responses across the pandemic. Additionally, this section cites relevant scholarship describing factors that can impact reasoning and responses to new information. This scholarship helps to contextualize the results of this study.

Individuals Responded Generally Positively to Early Information (Article One), and Generally Negatively to Later Articles That Included More Accurate Information

As stated in the results, generally individuals were more likely to accept information published in article one than in later articles. Looking at the bigger picture in regard to accuracy of research published, article three holds the advantage because more time was allowed for researchers to replicate studies on the surface spread of the COVID-19 virus. While articles one and two offer preliminary, not yet accepted, research regarding the surface spread as well as debates between researchers, article three most accurately gives information. However, users in Facebook comments did not reject early information and accept later, more accurate information. Today, we have the advantage of greater time between the emergence of COVID-19 and now and more available research. Because of this perspective, we can more clearly evaluate the accuracy of information at various points in the pandemic. As of June 2021, the CDC website continues to state that COVID-19 is spread "when an infected person breathes out droplets and very small particles that contain the virus" ("How COVID-19 Spreads"). This information continues to align with research published in articles two and three in 2020. Given this historical

perspective, individuals responding to emerging research on COVID-19 were more likely to accept early research and reject later research that was actually more accurate.

As stated in the results, users frequently used information about the spread of COVID-19 to make arguments about future actions to be taken in response to the pandemic. Using preliminary information to make arguments could have played a role in shaping users' future interactions with changing research. Chan et al. state that, "Analysis suggests that individuals persist in their false beliefs because of mental models of misinformation, often strengthened by the process of generating arguments supporting it" (Chan, Jones and Albarracín 345-6). Johnson-Laird describes how individuals form mental models saying, "General knowledge and beliefs, along with descriptions of situations, lead to mental models that are used to assess probabilities" (206). The formation of mental models is especially important for future encounters with emerging information because when individuals "reach a credible (or desirable) conclusion, or succeed in constructing a model in which such a conclusion is true, they are likely to accept it, and to overlook models that are counterexamples" (Johnson-Laird 204). Connecting this mental model theory to the comments posted on articles within this study, individuals' likelihood to reject research as inaccurate was potentially strengthened by the fact that many used early, inaccurate information to make arguments. Mental model theory shows that the process of using information to make arguments reinforces it in an individual's mind, regardless of the validity of that information. Chan, Jones, and Albarracín describe this phenomenon saying, "The higher the likelihood of generating explanations for the misinformation, the greater the persistence of misinformation and the lesser the retraction effect. Moreover, correct information is not sufficient for a causal explanation to fill the discrepancy in the mental models" (345). In article one comments, users frequently used research to make arguments about COVID-19 policies. In

article three we can see users creating explanations that align with early research, “Or maybe, we are doing such a great job on surfaces that we eliminate them as a suspect. just thinking out loud…”

Several other scholars offer theories that potentially explain why individuals tend to accept and hold on to primary information. Theories of directional and accuracy motivated reasoning may give insight into why users majorly rejected changes that contradict their previously held beliefs. Directional motivated reasoning is explained by Bolsen and Druckman as the “tendency to view evidence as more effective when it is consistent with prior opinions (e.g., often dismissing information inconsistent with prior beliefs regardless of objective accuracy)” (748). Oppositely, accuracy-motivated reasoning is defined as “Tendency to evaluate information/evidence with the goal of forming an accurate (or “correct”) belief by attempting to engage in an “objective,” or evenhanded, assessment of new information” (Bolsen and Druckman 748). They continue describing accuracy driven reasoning “Instead of defending a prior belief, identity, or worldview, an accuracy motivation leads individuals to assess all available information objectively, even if it runs counter to one’s existing beliefs or identities” (Bolsen and Druckman 751). Nir also describes accuracy-oriented goals saying,

> An accuracy goal is defined as the need to maintain a correct belief about a given issue. When motivated by accuracy, people search for both confirming and dis- confirming information, attend to issue-relevant information more carefully, in- vest cognitive effort in reasoning, and process the information more deeply, using more complex rules (506).

Studies show that previously held beliefs and mental models also impact the extent that individuals question the credibility of sources. Lazer et al. describe the processes of individuals assessing new information stating, “Individuals tend not to question the credibility of

information unless it violates their preconceptions, or they are incentivized to do so. Otherwise, they may accept information uncritically. People also tend to align their beliefs with the values of their community" (Lazer et al. 1095). It is also important to note the role of social and political events in potentially prompting individuals to respond to content in a certain way.

While many have found that some individuals choose to seek out as much information as possible and others are more selective, in 2011, Nir found that an individual's type of motivation, goal directed or accuracy directed are key factors that can lead to different judgements (522). Further studies are needed in order to identify individuals' motivations that shape their interactions with information. Considering these theories is a crucial component for Science Communication scholarship and future practices for conveying science.

As stated, typical methods of sharing scientific research were challenged during the COVID-19 pandemic given the urgency of the situation and widespread attention to a subject not yet researched. Communication of early and then emerging scientific research regarding the surface spread was challenging especially given that results were not completely reversed or retracted; rather, many preliminary results were later clarified or contextualized by later studies. This made communication of research particularly difficult. Ambrose states that misconceptions can be difficult to correct, especially if they contain partially true components (25).

Changes in Research Findings Were Understood as a Lack of Credibility and a Reason to Reject New Information

Based on the content of user responses as well as the frequent co-occurrence of the codes Scientific Research Process, Lack of Credibility, and Rejecting, it is clear the users interpreted changes to information as a lack of credibility and a reason to reject new information.

Several authors have worked to trace how the public responds to retracted or changed information. Chan, Jones, and Albarracín state that trends towards public mistrust in science are not due to a rise in unethical conduct, but rather these trends are likely due to a greater awareness of the scientific process (341). As seen in this study, demonstrating the integrity and credibility of scientists is key in order to communicate emerging findings to public audiences because "Lack of Credibility" was cited as the main reason for rejecting emerging scientific information. Chan, Jones, and Albarracín state that distinguishing between "disinformation" and "misinformation" may show the ethical integrity of scientists (343). Misinformation is defined by Swire-Thomposon and Lazer. The authors write, "We define science and health misinformation as information that is contrary to the epistemic consensus of the scientific community regarding a phenomenon. By this definition*, what is considered true and false is constantly changing as new evidence comes to light and as techniques and methods are advanced"* (Emphasis added, Swire-Thompson Lazer 434). Misinformation is discrete from disinformation. Disinformation is defined as a *deliberate or planned* spread of false information in order to gain money, power, or reputation (Swire-Thompson Lazer 434). These definitions are particularly useful when considering individuals' responses to emerging research published by *The New York Times*.

Political contexts likely also influence users' interpretation of reports as disinformation. Individuals' perception of the *New York Times* is likely influenced by the long-standing debates between the publisher and Donald Trump. A CNN report cites several debates between from 2016 to 2018. These debates frequently involve the legitimacy of information shared by either party (Stelter). Xenos notes "Individuals' motivations and preferences loom large on the demand side, and those most commonly explored focus on the defense of existing political beliefs and

attitudes" (284). Within comments users frequently rejected information and defended their existing beliefs. These responses were likely impacted in part positively or negatively by the long-standing tension between the *New York Times* and Donald Trump. Responses may have reflected partisan affiliations.

Within the COVID-19 pandemic, information was reported as it became available. Because preliminary research studies were constrained by time, size, and scope, these early studies were frequently changed as time progressed and more research became available. Today, we can see that this preliminary research was debunked, and these early studies can be considered misinformation today. As seen within the definitions above, this misinformation was part of a typical progression of scientific research and process of reaching consensus. However, as seen in many responses in this study, users frequently used language characterizing this progression of scientific research and information as a spread of *disinformation,* as if changes in information were knowingly and intentionally wrong. Additionally, political and social contexts, such as the relationship between Donald Trump and the *New York Times*, may have impacted users' assessments of each article. Negative responses most frequently occurred when discussing the credibility of sources such as the CDC, researchers, or *The New York Times*.

Better Safe Than Sorry—Users Were Likely to Reject New Information and Cite Previous Research as "Safer" and More Accurate

A complex set of components and contextual factors ultimately contribute to individuals' understandings and responses to new information. These factors cannot be fully captured by the scope of this study. Understandings and responses are influenced by previously held beliefs as well as new information presented, credibility of sources, among other factors. Many researchers in a variety of disciplines have documented the ways in which individuals grapple with changing

information, particularly when it conflicts with preexisting ideas and beliefs. This scholarship comes from a variety of disciplines such as psychology and education. In chapter one of the influential book *How Learning Works*, Susan Ambrose considers how prior knowledge affects learning. While Ambrose considers these questions within classroom contexts, these principles of learning apply to the experiences of public audiences as well. Ambrose emphasizes the influential role of prior knowledge on individuals' perceptions of new information, "Student's prior knowledge can help or hinder learning" (13). The determining factor between prior knowledge helping or hindering learning is the accuracy and applicability of this information. The authors write that inaccurate prior knowledge has a strong potential to inhibit future learning, "Research indicates that inaccurate prior knowledge (in other words, flawed ideas, beliefs, models, or theories) can distort new knowledge by predisposing students to ignore, discount, or resist evidence that conflicts with what they believe to be true" (Ambrose 23-4). Researchers describe similar phenomena outside of the classroom. Chan, Jones and Albarracín share a research study that showed that "Despite then being informed that the study had been retracted, the participants subsequently reported higher belief in the hypothesis than did control participants" (Chan, Jones and Albarracín 345). Ultimately, stating that information was no longer accepted did not necessarily persuade readers.

In the body of article three, the authors of the article Ives and Mandavilli offer their perspective on public perceptions to changes in information by stating,

> By October, the Centers for Disease Control and Prevention, which had maintained since May that surfaces are "not the primary way the virus spreads," was saying that transmission of infectious respiratory droplets was the "principal mode" through which it does. But by then, paranoia about touching anything from handrails to grocery bags had

> taken off. And the instinct to scrub surfaces as a Covid precaution… was already deeply ingrained. (Ives Mandavilli)

In this paragraph Ives and Mandavilli concisely offer their perspective regarding how and why the public responded to research developments regarding the spread of COVID-19.

In summary, results published in this study reveal three overarching trends regarding the ways in which public audiences grappled and responded to emerging scientific data during the COVID-19 pandemic. First, users responded more positively to early, ultimately incorrect, information, and negatively to later, more accurate information. Second, the high co-occurrence of codes reveals changes in science were interpreted as a lack of credibility of scientists, the CDC, or the *New York Times*. Third, users indicated that information learned first was the "safer" option when new information emerged.

CHAPTER VI: LIMITATIONS AND CONCLUSION

Limitations

Several limitations should be recognized in relation to this study. Lazer et al. state that quantitative social media data, such as likes, comments, and shares, may not fully capture the influence of an article shared on social media. Speaking specifically about fake news or misinformation they state, "Knowing how many individuals encountered or shared a piece of fake news is not the same as knowing how many people read or were affected by it" (Lazer et al. 1095). This certainly applies to all information posted to social media. This observation should be considered as a limitation applicable to all social media analysis methodologies. Furthermore, this study does not necessarily account for which users choose to respond to content by commenting. Users disagreeing with content posted may or may not have been more likely to post responses beyond the quantitative reactions available. Further research of a controlled sample size is needed to make more definitive statements about public reactions. Furthermore, Yeo and Brossard also state the limitations and difficulties of research in Science Communication generally, saying that research findings and large-scale generalizations about the relationship between scientists, media organizations, and the public are difficult given that these relationships differ from situation to situation (266). Science Communication scholars face many challenges when describing the relationship between various actors as well as communication practices themselves.

Generalizations are difficult given that communicating science depends largely on context. How science is received by the public is also dependent upon the individual's interpretations; Akin and Scheufele write that the same data presented to various individuals can lead to widely different conclusions and assessments (29). This study does not consider the

extent to which social and political events shape public responses to scientific developments. These are considered limitations applicable to this study. User responses are certainly deeply intertwined with social and political contexts at any given time. Xenos describes patterns in the ways in which individuals interact with political content online saying the proliferation of technology and options in news media has led to individuals increasingly tailoring digital content towards their partisan preferences. Additionally, he states that this tailored content has likely contributed to extreme political polarization (283). Given these pre-pandemic trends, specific political contexts may have prompted users' responses positively or negatively. For example, responses to article two published in May of 2020 were likely influenced by the relationship between the CDC and the Trump administration. Article two traces language changes regarding the ways in which COVID-19 spreads. In May of 2020, CNBC reports public debate regarding the extent the Trump administration controlled the release of CDC publications. This strained relationship between government institutions and political officials may have prompted individuals to respond to content according to their political preferences.

Looking Forward

Further studies are necessary in order to make definitive statements regarding public responses to the scientific research process during the COVID-19 pandemic. However, this study remains valuable for a variety of reasons. This study offers some insight into public responses to the scientific research process and trust in media and scientific research institutions. While it is true that we cannot make major generalizations about the relationship between various actors from this study, we can see that within this specific time period, individuals reading emerging scientific information that may have conflicted with their previously held beliefs grappled with these changes and frequently rejected new information. While many gave more detailed

descriptions of the reasoning behind this response, it is clear many perceived these developments were the result of a lack of credibility of scientists or reporters. Additionally, many chose to continue accepting previous research as it was understood as the "safer" option.

Public responses to research are a crucial subject during crises. In their article documenting the importance of communicating uncertainties in science, Siegrist and Hartmann state "The decisions that people make under uncertain conditions have important consequences" (445). The authors give various historical examples in which individuals actually increased risk taking when they intended to decrease risk taking. For example, after the September 11, 2001 terrorist attacks, more individuals chose to travel by car rather than plane which resulted in a substantial rise in fatal car accidents (Siegrist and Hartmann 445). This instance demonstrates that sometimes the perceived "safer" option is not necessarily safer. We are still waiting to see the long-term consequences of both the COVID-19 virus and various responses to the pandemic.

As the world became aware of in 2020, the transmission of viruses, and ultimately the outcome of a global pandemic, is dependent upon the actions of every individual. Because of this, it is more important than ever to understand the values, assumptions, and emotions that inform the actions of individuals. This is incredibly important especially as it relates to how individuals perceive risk. From this study, we can see that many individuals were more likely to respond positively to preliminary studies with limited time and research and more likely to respond negatively to conflicting information shared later in the pandemic that was ultimately more accurate and widely accepted by researchers. While many, during the later points in the pandemic, cited "better safe than sorry" as their reason for rejecting scientific information published later, sometimes this is not the case.

Some claim this is true today regarding the responses to the COVID-19 pandemic. Tufekci writes, “so much of what we have done throughout the pandemic — the excessive hygiene theater and the failure to integrate ventilation and filters into our basic advice — has greatly hampered our response” (Tufekci). In both this situation and the future, holding initial claims as true regardless of evolving research and consensus could have serious negative implications. Working to create better systems of communication is essential to creating a well-informed public. According to the Center for Advancement of Informal Science Education, communication exchanges between various discourse communities such as scientist, leaders, and the public are essential in order to create “...well-informed, empowered publics who are better equipped to contribute to our understanding of the world and to responsible decision making” (McCallie et al. 11). More attention to public responses to scientific research, discourse, and communication of research is necessary in order to create a more well-prepared community so the world can be better equipped for whatever awaits us next.

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