EVOLUTION OF INFORMATION AND DECISION-MAKING THEORY USING HEURISTICS AND BIASES TO ANALYZE PILOTS' DECISION NOT TO VACCINATE AGAINST COVID-19

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Abstract: Using airline 25 pilots due to their uniformity in education, political views, personality traits, and dimensions, an informed grounded theory (GT) studied how the subjects in an information overload environment selected sources and consumed information to create mental models on COVID-19 and make a protective action decision to vaccinate or not. A semi-structured interview guide was used for the Zoom interviews. The developed substantive theory revealed that people's response to an informational overload environment is to limit the amount and type of information vying for their attention. Individuals prefer to accept like-minded information, so most people will limit sources to a similar type of information in what is termed narrowcasting. An individual's mental model of a novel threat or hazard will be formed and anchored by this information flow and previous personal experience. The formed mental model is influenced by the bias and veracity of their information sources. The attention of competing information sources is either accepted or rejected based on the congruence of the new information source with the established mental model and the person's trust in the source of information. More exposure to extreme information and the lack of moderating sources will push and harden the anchor point of a person's mental model to a more extreme position. Most people lack the expertise to identify and process factual information from misinformation to make appropriate risk analysis and protective action decisions. The least skilled in this area tend to be the most confident in their information validation and newly formed mental models. Individuals use impressions and feelings of the information (System 1) to form these mental models instead of analyzing a series of facts (System 2). People make logical action decisions and judgments based on their mental model no matter how extreme or moderate the position is. Appendices contain a comprehensive alphabetical listing of common heuristics and biases and misinformation definitions.

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CHAPTER I

INTRODUCTION

As SARS-CoV-2 is a novel virus that just recently appeared on the world scene, countries across the globe have instituted pandemic restrictions that the world population has not seen in over 100 years since the Spanish flu pandemic. In the United States, before the vaccines were available, coronavirus disease 2019 (COVID-19) killed an estimated 1 of every 500 people infected (Ioannidis, 2021). In the fall of 2020, it became the third leading cause of death in America for those over age 45 (Woolf et al., 2021, p. 123). By December 2020, vaccines against COVID-19 started to be fielded. Three vaccines (by Pfizer, Moderna, and Johnson & Johnson) proved to be highly effective in preventing COVID-19 disease and death with a very low risk of complications and virtually no chance of dying. Current warning information (Mileti & Sorenson, 1990) and protective action decision models (Lindell, 2018) suggest that the rational protective action judgment for COVID-19 is to get vaccinated. However, nearly one-third of all America adults are not vaccinated (Jones, 2021). Popular judgment models used in emergency management and disaster science fields fail to explain why almost one-third of Americans would make a seemingly illogical and nonrational decision to forego a COVID-19 vaccination. Moreover, the amount of information that people are exposed to

has radically expanded since these models were introduced. The work of Amos Tversky and Dan Kahneman in behavioral economics and cognitive psychology describe how heuristics and biases can affect a person's decision-making process to where logical persons can make irrational judgments. Recognizing this impact and focusing on the COVID-19 vaccination decision, 25 airline pilots were selected and interviewed for an informed, constructivist grounded theory (GT) investigation with interpretivist and subjectivist assumptions. Using heuristics and biases, a substantive theory was created to explain how an information overload environment affects an individual's information consumption and mental model construction. Those pilots, with very similar personality traits and dimensions, made different rational decisions to vaccinate or not from a diverse set of mental models. The information sources selected by the pilots seem to have a major impact on their mental models and subsequent vaccination decision. However, the interviewed subjects lacked effective information validation skills and used impressions and feelings of the gathered information (System 1) to form their mental models instead of analyzing a series of facts (System 2).

Chapter Summaries

Due to the amount of information contained in the project, the chapter summaries were separated from the main body of the introduction for ease of reading and reference.

Chapter Two: Review of Literature

COVID-19. With information current as of the fall of 2022, the new SARS-CoV-2 Omicron variants were estimated to be nearly as contagious measles and among man's most highly infectious pathogens. This virus will be endemic in the world's population. Fortunately, the vast majority of COVID-19 cases have mild or no symptoms with an

estimated average global infection fatality rate of 0.23 percent (Ioannidis, 2021). The risk of death and serious illness increases with age and COVID-19 became the third leading cause of death in the United States. The newly developed COVID-19 mRNA vaccines are extremely effective in preventing serious injury and death. These vaccines help reduce the transmission of COVID-19 and are the single best mitigation action to protect against COVID-19 disease.

Dual Process Model of Thinking. The review continues with a foundational concept of dual process of thinking with System 1 and System 2. System 1 uses the automatic and mostly unconscious associative memory to generate impressions, intuitions, and responses quickly. The slower and more aware System 2 devotes attention to effortful mental activities, including complex computations and is associated with agency, choice, and concentration. The human mind through System 1 will believe almost anything. System 1 is gullible and geared to believe. System 2 is in charge of doubting and unbelieving, but System 2 limited capacity. This system demands much more energy because of its greater cognitive effort.

Heuristics and Biases. Heuristics are simple procedure or rule of thumb used to find adequate, though often imperfect, answers to difficult questions. These System 1 operations provide a speedy and efficient result as a goal. However, they can be the source of predictable errors. Biases are a fundamentally flawed reasoning process that often leads to a thinking error that are systematic deviations from normative reasoning.

Information/Warning Theory. Information and warning theory has evolution since McGuire's information-processing model proposed that the persuasive impact of messages was a product of six information-processing steps. Mileti and Sorenson's (1990) Warning Response Model describes a similar set of six related sequential factors that were tailored to

the threat-warning environment. Unlike McGuire's model, the sequence of these steps may not be the same for every person warned and the accomplishment of every part is not necessary for a response to occur. For Mileti's model, the personalizing of a warning is a key step that facilitates responding to the warning message. The Protective Action Decision Model (PADM) (Lindell & Perry, 2012) predicts changes in receivers' beliefs and behaviors through a multi-stage process starting with a person receiving warning messages. The next step contains the attention, exposure, and comprehension of the information and is influenced by personal perceptions. This part leads to a protective decision resulting in a behavioral response. Multiple-Motive Model of Heuristic-Systematic Processing assumes individuals are cognitive misers and prefer less effortful heuristic processing to systematic processing.

Mental Models. Humans can quickly organize information and "fill in the blanks" about the external world using mental models built from their past experiences to form a relatively quick, efficient, top-down method of understanding the world (Chaiken & Ledgerwood, 2012, p. 252). These mental models can be described as deeply ingrained assumptions and generalizations that influence how people understand the world and take action, often without conscious knowledge of the effect of the mental model. However, these models are simpler than the reality they represent and therefore are incomplete.

Attention Capacity. Since the 1990s with the Internet, personal computer, and cell phone, members of modern society have been overloaded with information. Humans have a biologically limited capacity for attention and excess information consumes that capacity. Humans always face the fundamental tradeoff between processing more information to improve decisions or less and saving on the limited mental effort of doing so. Several models describe ways that the human mind reduces the amount of information inputs to a

manageable level. As a result, from an external viewpoint, a person's attempt to lessen the overwhelming amount of information may produce a seeming illogical or error-prone choice.

Misinformation. A message intends to influence the recipient's behavior. The internet and social media are perfect platforms for the proliferation of misinformation as online news stories and blogs are subject to very few quality controls. Anyone with an inexpensive digital device can manipulate data and produce visualizations with the appearance of scientific authority that appeals to an individual's skeptical nature (Lee et al., 2021). The existing information ecosystem and economy have strong financial incentives to produce and spread distorted stories, rumors, and fake news that generate clicks. Due to automation, clicks make money for content providers with little regard for truthfulness (Hendricks & Vestergaard, 2019). The behavioral impact of disinformation is more identifiable in health crises since disinformation is easier to link to concrete behaviors, such as the decision to vaccinate for COVID-19 or take ivermectin (Colley et al., 2020).

Individualism versus Collectivism. Individualism promotes a person's self-interest while collectivism prioritizes the common good of society as a whole. Individualism surpassed citizenship as the key social construct of American society with rights more important than responsibilities (Kamens, 2019). An individualistic society sees an increase in the fear of the state as an enemy of personal freedom and a decrease in expertise and knowledge's role in public affairs. Individuals are unconsciously motivated to persist in their beliefs, selectively focus on evidence and arguments that reinforce their beliefs and dismiss any opposition as noncredible ((Kahan, 2012). Just countering misinformation by bombarding people with factual information will fail to change a person's mental models.

Chapter Three: Methodology

Research Aim and Question. The question that started this inquiry was "Given the lifesaving capabilities of the current COVID-19 vaccines and the risk of injury and death from COVID-19, why would one out of three Americans have yet to be vaccinated and about one in five say they will not get the vaccine?" Current information/warning theory failed to give a satisfactory explanation to that question. The research aim was to formulate a substantive theory of how individuals use heuristics and biases to create mental models and make protective action decisions and judgments under uncertainty.

Research Paradigm. This study takes a constructivist paradigm. People construct the realities in which they participate. So multiple individuals can create and experience many different realities (Denzin & Lincoln, 2018). A human's knowledge and perception of the external word is never direct but mediated by their concepts (Erickson, 2018). Researchers try to view realities from the minds of the individuals and to gain multiple perspectives of the researched phenomenon (Bryant & Charmaz, 2019). An inductive-abductive research approach was used to create theory. In the inductive process, concepts emerge from data in a the bottom-up fashion to form more abstract units of information into a final theory. Abduction logic confirms, dismisses or modifies the new concepts with collected data.

Grounded Theory. To study this type of decision-making, researchers need to allow the participants to reveal their multiple perspectives of reality used to make their choices (Chowdhury, 2014). A constructivist grounded theory approach allows for the generation of descriptive-rich information from the individual's perspective. Twenty-five domestic U.S. airline pilots were used because they are a very homogenous group with personality traits and

dimensions consistent across backgrounds and circumstances. Minorities, females, and foreign-born individuals were oversampled to explore any possible differences that these demographics might have on COVID-19 vaccination willingness, information consumption, and individualism. An attempt was to balance each five-year age category from 35-60 years old to see if age was a factor in vaccination willingness and information consumption. Semi-structured interviews were conducted by Zoom and transcribed via *Otter.ai software Pro.* Case-based memos captured each interview's data. After each block of six interviews, conceptual memos described the researcher's thoughts on codes, categories and emerging concepts. Interview number 25 reached theoretical saturation. The created set of interrelated concepts was expressed as a substantive theory. The research was conducted per Oklahoma State University research guidelines (Institutional Review Board application IRB-22-41).

Transparency and Potential Bias. All research is interpretive and guided by the researcher's set of beliefs. The grounded theory method is a deeply personal research method where theory is constructed by the researcher who views the world through their particular lens (Chun Tie et al., 2019). In this case, the researcher is a senior airline captain and Air Force pilot with a degree in biology. This background created a connection and fostered trust with the targeted pilot group, aided in subject recruitment, and candidness in interview responses. Transparency and adherence to methodology promote a reader's confidence and trustworthiness in qualitative research studies. Presenting quotes allows readers to see and evaluate data for themselves and lends authenticity to this study (Levitt et al., 2018). The triangulated use of two independent media rating organizations with the author's assessment imparts credibility to the information source evaluations (Creswell & Creswell, 2019).

Chapter Four: Findings

Mental Models. The pilots naturally separated into five different groups based on their protective action decisions on the COVID-19 vaccine. The Vaxxed-Boosted group willing took the COVID-19 vaccine and the booster. They thought vaccines are lifesaving and safe and COVID-19 is much worse than the flu. The Vaxxed-Only people willingly got vaccinated but will not get the booster. They believe their personal situation has changed and getting the booster no longer makes sense. They see COVID-19 just like the flu. The Weak Anchor Point individuals changed their stance because of the side effects of the COVID-19 vaccine or disease and think COVID-19 was slightly less impactful than the flu. The Mandate trio deemed receiving the vaccine was better than the consequences of not getting the government or spouse mandated shot. They believed COVID-19 was pretty much like the flu and not enough risk to them to get vaccinated. Vaccines were not unsafe but unproven. The Anti-Vax individuals refuse to get vaccinated no matter what the consequences were. The group consensus was that COVID-19 is milder than the flu and COVID-19 vaccines are unproven experimental treatments that could even be deadly. Pilots made logical decisions to vaccinate or not that were consistent with their mental models of COVID-19 and vaccines.

Information Overload. Roughly half of the pilots experienced general information overload, and 83 percent stated they faced a substantial COVID-19 information overload. Most of overload mitigation efforts were ineffective and limited consumption of certain types of information (*Narrowcasting*). The ubiquitous nature of the cell phone means individuals are constantly tied to their primary portal of information and its demand for attention.

Information Validation. Subjects seem unable to systematically determine mis/disinformation from accurate and generally correct information that would be indicative of System 2 processing. Pilots used feelings and gut impressions to determine information and source validity consistent with System 1 processing. They are more accepting of information sources similar to their beliefs (*Fluency*). Pilots exhibit *confirmation bias* and *belief perseveration* to alleviate *cognitive dissonance* when faced with evidence countering their mental model. They also seem to look for and select the information that completes their story (*Associative Coherence*). Most individuals are overly confident in their ability to determine truthful information (*Dunning–Kruger effect*).

Information Sources. People's information consumption has shifted from broadcast television and print material to digital and online media. Social media was not popular with the pilots as only four actively used Twitter. All subjects thought COVID-19 information was manipulated and weaponized for political and financial gains. All pilots lacked an accurate understanding of COVID-19 and the efficacy of COVID-19 vaccines; they just had vague ideas and inaccurate conceptions. Pro-vaccine people trusted the CDC and their private doctor's guidance without much questioning. However, the anti-vaccine group rejected governmental and CDC information and believed much more in alternative information sources. Overall, most pilots thought they were much healthier than the average American (*Overconfidence Effect*), and COVID-19 posed a much lower risk to the general population than other causes (*Probability Neglect*). They had a hard time comprehending that a very low disease death rate can greatly impact society. Pilots mostly use digital media resources for their information. Answers to COVID-19 and vaccine questions lacked detail and were represented more by feelings and impressions which may indicate *digital amnesia* and the

Google effect. None of the pilots could recall any COVID-19 information coming from state or local emergency management officials, but the majority believed COVID restrictions created a distrust of governmental agencies and their information.

Assessing Information Sources. In response to information overload, the pilots in the different vaccination groups focused their attention on information sources with similar political bias and factual characteristics (*Narrowcasting*). The vaccinated group commonly seeks information from more politically neutral and more factually reliable sources. Whereas the anti-COVID-19 vaccine group tended to pursue more politically right and less factually reliable information providers. The choice of information sources affects pilots' mental model on COVID-19 and their commitment to getting COVID-19 vaccines.

Mandates. The vast majority of pilots were strongly against all forms of mandates. Many viewed masks, shutdowns, and vaccines as ineffective in preventing or reducing COVID-19 transmission. Individuals perceived agencies attempting to impose such restrictions and requirements as an abuse of governmental powers (*Loss Aversion*). The vaccine mandate had the most negative reaction, with 23 of 25 subjects interviewed rejecting it. However, the failure to explain breakthrough cases led to the erroneous belief that vaccines did not reduce the transmission of COVID-19. The study group displayed a great deal of promotion of their desires above the welfare of the greater society (*Individualism*).

Proposed Theoretical Model. Individuals limit sources to a similar type of information. A mental model of a new threat will be formed and anchored by this information flow and previous experience. New information is either accepted or rejected based on the congruence with the established mental model and trust in the source of

information. People lack the expertise to identify factual information from misinformation to make appropriate risk analysis and decisions. Individuals use impressions and feelings of the information (System 1) to form these mental models instead of analyzing a series of facts (System 2). People make logical action decisions based on their mental model.

Chapter Five: Discussion

Theory/Model Comparison. The Warning Response (Mileti & Sorenson) and Protective Action Decision (Lindell & Perry) Models address individuals' responses to warnings of immediate threats. Neither address the effect of misinformation on decision-making nor the existing information overload environment. Conversely, the proposed model describes how people select and use information sources to build mental models over a longer period to make decisions on threats and protective actions. The new model claims most people lack the skills to validate the integrity of their information sources and conduct an appropriate risk analysis. PDAM is characteristic of System 2 processing with detailed analysis and complex questions requiring cognitive effort. The proposed new theory postulates that people use System 1 cognitive processes to form a single, unified mental model to explain the situation and simplify protective decisions to "Is the vaccine safe?".

Misinformation in the Public Sphere. An estimated 80 percent of Internet users search for health information online (Kata, 2012, p. 3779). High quality COVID-19 and vaccine information competes with equally available misinformation that is often difficult to identify (Betsch & Sachse, 2012). This coexistence tends to give misinformation some sense of legitimacy, and the more something appears, the more willing our minds are to accept that piece of information (*Fluency, Illusory Truth Effect*). The majority of people lack the skills

needed to determine misinformation from legitimate content on subjects that they have little expertise. According to the proposed theory, an effective method for reducing misinformation's influence on people's mental models would be to limit or eliminate its availability to people. Congress could amend Section 230 of Communications Decency Act of 1996 to remove the exemption for Internet social media and networking services from liability under laws that normally apply to other types publishing platforms.

Implications for Emergency Management. Many people use non-traditional means of information sources thus warning communications most likely will not capture the attention of individuals in today's information-overloaded society. Third-party news sources may filter and distort the message thus not having the desired effect on the targeted population. Officials need to frame discussions as enhancing protection for society. If not, people will view such measures as a loss of personal freedom and destruction of their livelihood (*Loss Aversion*) rather than temporary measures to reduce the loss of life. Pre-crises education of the public is an effective way to influence mental models on vaccines and health interventions. The emergency management community must reexamine and define its role in epidemics, disease prevention, and mitigation at both the practitioner and academic levels. Emergency management programs need to add classes in epidemic response.

Chapter Six: Conclusion

The chapter provides a summary of research methods, findings, and proposed theory.

Appendices

The appendices offer a comprehensive listing of heuristics and biases and misinformation definitions and concepts used in this project.

CHAPTER II

REVIEW OF LITERATURE

COVID-19

Since the report of the first cases of atypical pneumonia in Wuhan, China, in December 2019, COVID-19 has become a worldwide catastrophe and has overwhelmed healthcare systems all over the globe. While about half of the cases of COVID-19 are asymptomatic, symptomatic cases can range from mild cough and headaches to severe complicated pneumonia with acute respiratory distress syndrome (ARDS) and multiple organ failure leading to death. Loss of taste and smell became a telltale hallmark of COVID-19 infection. Early case fatality rates were estimated at 1.4 percent. The older population was at a greater risk of injury and death, with the over-age 60 groups having greater than five times the death rate as the age 30-59 group. The World Health Organization (WHO) declared COVID-19 a global pandemic on March 11, 2020 (Al-Iede et al., 2021).

SARS-CoV-2

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that causes COVID-19 belongs to the Coronaviridae family of RNA virus, which includes the SARS-CoV-1 responsible for the 2003 outbreak in China and the MERS-CoV 2012 occurrence

Saudi Arabia. SARS-CoV-2 shares 70 percent of viral structure and genetic sequence with SARS-CoV and 40 percent with MERS-CoV. Four other coronaviruses have been linked to the common cold since 1960 and cause only mild respiratory infections (Al-Iede et al., 2021; Khan et al., 2021). Like SARS-CoV-1, SARS-CoV-2 is also thought to have originated from bats, which have served as established reservoirs for various pathogenic coronaviruses (Khan et al., 2021). The RNA viruses like coronaviruses have significate error-inducing replication processes with high mutation rates, and they tend to combine with other similar sections of other RNAs during replication. This recombination in a very large global population has resulted in the emergence of viral variants with improved replication and transmission and increased immunological escape. These viral variants include variants of concern B.1.1.7 (20I/501Y.V1 or Alpha), B.1.351 (20H/501Y.V2 or Beta), P.1 (Gamma), and B.1.617.2 (Delta) and variants of interest B.1.526 (Iota) and B.1.429 (Epsilon) (Pegu et al., 2021). As of the winter of 2021-2022, the Omicron variant (B.1.1.529) and its several sub-variants, first detected in South Africa, have replaced the Delta (B.1.617.2) variant globally as the predominant SARS-CoV-2 variant of concern (Ng et al., 2022).

Coronaviruses are characterized by the presence of club-shaped spike projections on the virus's surface that appear similar to a solar corona. They are heat and ultraviolet ray-sensitive at 130 F (56 C) degrees for 30 minutes, causing inactivation. Also, chlorine-containing disinfectants, peracetic acid, and 75 percent ethanol deactivates coronaviruses. As a zoonotic virus, coronavirus can be transmitted from animals to humans and among humans through airborne aerosols with many different types of animals identified as

reservoirs to include camels, pigs, turkey, mice, dogs, bats, birds, and cats. The bat as the most widely known carrier for human infections (Khan et al., 2021).

Transmission

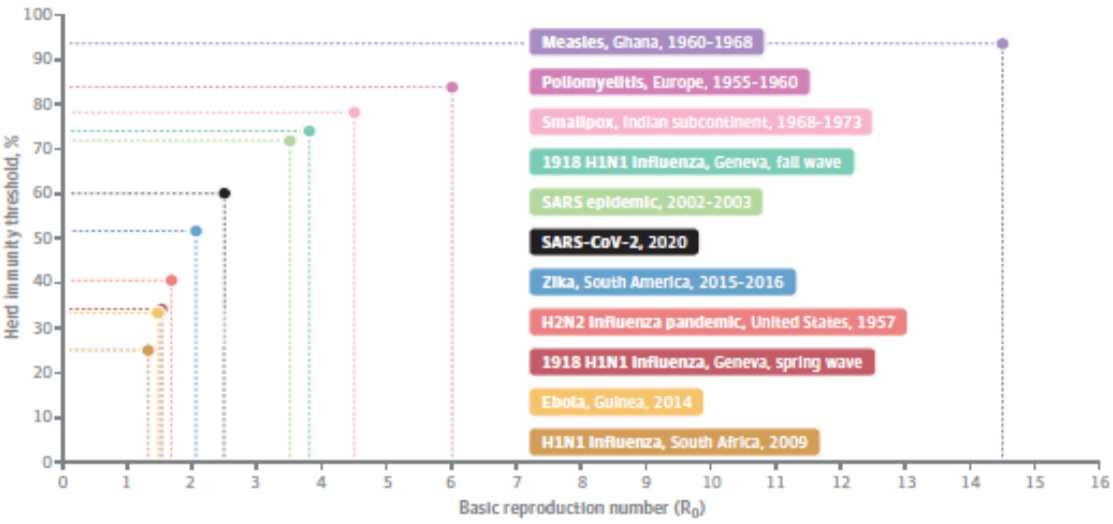
Exposure and infection occur mainly in three ways. Most cases happen through the inhalation of very fine respiratory droplets and aerosol particles, with the greatest risk of transmission being within three to six feet of an infectious source. Two other less prominent ways are the direct deposition of respiratory droplets and particles on exposed mucous membranes by splashes and sprays and touching mucous membranes with virus-soiled hands (CDC, 2021). The viral load (quantity of virus particles) that a person is exposed to and the general state of the effectiveness of a person's immune system at the time of exposure is believed to determine whether or not a person develops COVID-19 and the severity of their case. While not perfect, the use of cloth face and surgical masks works by reducing the viral load exhaled and inhaled and containing expelled fine respiratory particles close to an infected person, which moderates the procession of COVID-19 through a population. Forceful speaking, such as yelling or singing, found at bars, churches, and sporting events expel high viral loads and leads to higher infection rates (Gandhi et al., 2020). The ancestral WA-1 wild-type (WT) of SARS-CoV-2 has an estimated R0 of 2.5 to 3, while the Delta variant has an R0 between 5 to 8 (del Rio et al., 2021). The latest Omicron variant has an R0 estimated at ten and groups it among man's most highly infectious pathogens (Burki, 2022). The basic reproduction number (R0) estimates the contagiousness of a disease as it progresses through a completely susceptible population with no interventions and is a function of human behavior and

biological characteristics of pathogens. The R0 number refers to the average number of secondary cases that arise from an infected person (Delamater et al., 2019).

Herd immunity is when a sufficiently large proportion of immune individuals exist in a population to prevent the propagation of an epidemic outbreak due to the lack of contact with sufficient numbers of susceptible people. Such personal immunity may be gained through natural infection or vaccination. The herd immunity threshold is the proportion of the population who, having acquired immunity, can no longer participate in the chain of transmission, and the outbreak will extinguish. The percentage is based on a pathogen's (SARS-CoV-2) basic reproduction number (R0) (Omer et al., 2020). For the ancestral WA-1 wild-type (WT), the herd immunity threshold was about 75 percent; for the Delta variant, that number increased to 85-90 percent. The current Omicron variant is about as infectious as measles and needs an approximate herd immunity of 95 percent (see Figure 1). With protective immunity from COVID-19 infection lasting on average about six months from the ancestral WA-1 wild-type SARS-CoV-2, less than six months from infection with Delta (Stephens & McElrath, 2020) and significantly less than Delta period protection offered by Omicron infection (Servellita et al., 2022), achieving the needed 95 percent herd immunity threshold seems impossible. The SARS-CoV-2 will become endemic in the world's population.

Figure 1

Herd Immunity Thresholds by Disease (Omer et al., 2020)



Infection

For COVID-19, the latency period (time from expose to infectiousness) can be as short as slightly less than three days, while some incubation periods are over 21 days (Cheng et al., 2021). However, the typical incubation period of COVID-19 infection has been estimated to be a median of 5.1 days and a mean of 6.0 days (Cheng et al., 2021; Thevarajan et al., 2020). People can be highly infectious for several days before showing infection. Additionally, more than ten percent of cases acquired COVID-19 more than 14 days after infection, and only about 70 percent of people developed COVID-19 within a 10-day window (Cheng et al., 2021, p. 8). That means the current CDC 10-day quarantine window could miss 3 of every ten infected people. Since about half of SARS-CoV-2 is asymptomatic and contagious, contact tracing as a method of epidemic and transmission control is impossible due to too many dead ends and the massive number of individuals to be tracked.

COVID-19 Disease Progression

Fortunately, about 80 percent of COVID-19 symptomatic (the other half of total infections) cases are mild respiratory illnesses that can be managed outside the hospital. The next 15 percent typically need hospital care (usually for moderate to severe pneumonia), and the last five percent have a critical illness requiring more intensive support. Approximately a quarter of hospitalized patients may need transfer to the intensive care unit (ICU) to manage major complications (Thevarajan et al., 2020). The estimated average global infection fatality rate (IFR) for COVID-19 is 0.23 percent (Ioannidis, 2021). Common COVID-19 symptoms are cough, shortness of breath, fatigue, lack of appetite, loss of smell and taste, muscle pain and weakness, and confusion or brain fog. Less frequently, people experience diarrhea, sore throat, runny nose, headache, chest pain, dizziness, abdominal pain, and nausea (Thevarajan et al., 2020). In more critical cases, viral pneumonia from COVID-19, in combination with a dysregulated inflammatory response, produces severe lung injury with extensive vascular and alveolar damage due to microthrombi (small blood clots) leading to acute respiratory distress syndrome (ARDS) and multiple organ (heart, lungs, liver, kidneys, gastrointestinal and central nervous system) dysfunction, damage and failure resulting in death. This systemic inflammatory response is commonly referred to as a cytokine storm and can gravely affect otherwise very healthy individuals. Over 70 percent of hospitalized COVID-19 cases have low lymphocytes (white blood cells) (Al-lede et al., 2020; Sinha et al., 2020; Thevarajan et al., 2020). One-third of COVID-19 intensive care unit (ICU) patients have blood clot-related issues such as venous thromboembolism and arterial thrombotic complications, which can damage major organs, including the brain (Klok et al., 2020).

Increased age and comorbidities are associated with more severe disease and poorer outcomes. Early treatment for COVID-19 was predominantly supportive care with a focus on the management of respiratory dysfunction and thromboprophylaxis with antivirals (Remdesivir), monoclonal antibody, and anti-inflammatory corticosteroids (dexamethasone) (Klok et al., 2020; Thevarajan et al., 2020). In December 2021, the Food and Drug Administration (FDA) authorized the newly developed Pfizer COVID-19 anti-viral treatment, Paxlovid. When used in the first five days of infection, Paxlovid is highly effective against all current variants of SARS-CoV-2 and associated with a significantly reduced risk of progression to severe COVID-19 or mortality, regardless of COVID-19 vaccination status (Najjar-Debbiny et al., 2022). Multiple studies fail to show any benefit of treating COVID-19 patients with hydroxychloroquine and ivermectin (López-Medina et al., 2021; Reis et al., 2021).

COVID long-haulers have symptoms well past their recovery from COVID-19. At the six-month recovery point, 68 percent of patients reported at least one sequelae or long-term symptom which dropped to 49 percent at the 12-month point. Fatigue, muscle weakness, and loss of sense of smell or taste were the most commonly reported symptoms (Huang et al., 2021; Logue et al., 2021). For up to 12 months, lung diffusion (O2 and CO2 exchange efficiency) impairment was observed in about 20 to 30 percent of moderately ill patients and as high as 54 percent in critically ill patients. One year after infection, COVID-19 survivors still had a lower quality of health than non-COVID-19 individuals (Huang et al., 2021).

Risk of COVID-19

By October 2020, COVID-19 had become a major cause of death in the United States. For ages 45 to 84, it was the third leading cause of death, and for those 85 and older, the second leading cause (see Table 1). Unvaccinated adults 45 years or older were more likely to die from COVID-19 during those months than chronic lower respiratory disease, transportation accidents, drug overdoses, suicide, or homicide (Woolf et al., 2021). One would expect the same relative risk would apply today to an unvaccinated American adult of that age group.

Table 1

Age-Specific Mortality Rates (per Million) for COVID-19 (March-October 2020) and Other Leading Causes of Death (March-October 2018) (Woolf et al., 2021, p. 123).

	Causes of death[b]										
					Unintentional injuries		Intentional injuries		Leading causes of infant deaths		
Age, y	COVID-19	Heart disease	Malignant neoplasms	Chronic lower respiratory disease	Transport accidents	Accidental drug overdoses	Suicide	Homicide	Birth defects	Short gestation	SUID
<1	7.4	51.6	8.6	2.9	15.5	1.6	0.0	46.7	773.7	682.2	603.4
1-4	1.0	4.8	13.1	2.0	17.5	0.3	0.0	15.6	15.9		
5-14	1.0	2.7	13.5	2.0	14.6	0.4	9.4	4.7	6.4		
15-24	9.9	13.8	20.9	2.8	108.3	66.1	97.0	72.1	5.5		
25-34	38.6	52.1	53.7	4.2	113.2	220.7	120.9	78.8	6.4		
35-44	109.9	169.1	172.0	10.1	93.8	234.0	128.1	54.7	7.2		
45-54	294.8	509.7	597.5	56.1	100.7	208.2	140.3	33.9	11.2		
55-64	683.3	1239.8	1802.4	285.8	105.0	161.2	139.8	23.7	17.8		
65-74	1574.6	2516.9	3702.0	809.9	99.2	50.8	114.1	15.7	13.4		
75-84	3832.4	6478.5	6845.7	2117.3	129.9	16.0	129.6	13.2	14.9		
≥85	10 699.7	24 530.2	10 442.4	4278.4	139.1	14.7	133.4	13.3	31.2		
Total	698.8	1287.7	1219.8	307.5	89.2	122.3	102.3	39.0	19.4		

Abbreviations: COVID-19, coronavirus disease 2019; SUID, sudden unexpected infant death (including sudden infant death syndrome).

[a] Table presents 8-month aggregate COVID-19 mortality rates during the period of March through October 2020[5] and mortality rates for other causes during the period of March through October 2018,[4] the most recent year for which detailed cause-of-death data are available.

[b] Causes of death are defined by *International Statistical Classification of Diseases and Related Health Problems* codes for heart disease (I00-I09, I11, I13, I20-I51), malignant neoplasms (C00-C9), chronic lower respiratory disease (J40-J47), transport accidents (injuries) (V01-V99, Y85), accidental drug overdoses (X40-X44), suicide (*U03, X60-X84, Y87.0), homicide (*U01-*U02, X85-Y09, Y87.1), birth defects (Q00-Q99), short gestation (P05-P08), and sudden unexpected infant death (R95, R99, W75).

The summer of 2021 had a large shift to the vast majority of US cases due to the Delta variant. The risk of hospital admission and emergency care attendance is much greater for the Delta variant of COVID-19 than the ancestral WA-1 wild-type (WT) for the total population of vaccinated, recovered, and unvaccinated people (Twohig et al., 2021). Data collected in July of 2021 for 13 American states demonstrated that unvaccinated people have more than a ten times greater risk of both hospitalization and death from COVID-19 and more than five times greater risk of infection. For both vaccinated and unvaccinated groups, older Americans had higher hospitalization and death rates, resulting in a larger impact of age-standardization on overall outcomes; however unvaccinated younger people (under age 50) had the greatest number of COVID-19 cases and hospitalizations. Reported events per 100,000 persons (age-standardized and weekly averaged for the June 20–July 17 period) were for unvaccinated 19.4 infections, 7.0 hospitalizations, and 1.1 deaths compared to 19.4 infection cases, 0.7 hospitalizations, and 0.1 deaths for fully vaccinated people (Scobie et al., 2021).

By the winter of 2021-2022, the Omicron variant became the dominate strain worldwide. While Omicron's greatly increased infectious nature caused a rapid spike in cases and excess deaths, this variant is generally associated with a milder disease progression and a reduced risk of hospitalization and death compared to prior lineages of SARS-CoV-2 (Servellita et al., 2022, p. 1545). Due to the milder disease process, Omicron infections generate lower levels of neutralizing antibodies than earlier SARS-CoV-2 varieties. Protective immunity may be less durable than other past COVID-19 infections, such as Delta, in preventing infection from another, more pathogenic variant (p. 1546).

Vaccines

In response to the COVID-19 pandemic, three vaccines received emergency use authorization (EUA) from the US Food and Drug Administration (FDA) in an extraordinarily short time. The Pfizer-BioNTech (BNT162b2) mRNA vaccine reported an overall efficacy of 94.6 percent with 88.9 percent prevention of severe COVID-19 after two doses. The Moderna (mRNA-1273) mRNA vaccine had an overall efficacy of 94.1 percent with 100 percent prevention of severe COVID-19 after two doses in trials. Johnson & Johnson produces a more tradition adenovirus-based vaccine that only requires one shot and has a 72 percent overall efficacy and 85 percent prevention of severe COVID-19 (Creech et al., 2021). In real-world results from March 2021, the Israel Ministry of Health reported that the Pfizer-BioNTech (BNT162b2) mRNA vaccine effectiveness was at least 97 percent in preventing symptomatic, severe/critical disease and death (Pfizer-BioNTech, 2021). With the much greater prevalence of the Delta variant, counties have seen an increased number of breakthrough cases of COVID-19 among vaccinated people. While still highly protective, the Mayo Clinic system informed for July 2021, that vaccine effectiveness against hospitalization remained high (Moderna mRNA-1273 was 81 percent; Pfizer BNT162b2 was 75 percent) but effectiveness against infection was lower for both vaccines (Moderna mRNA-1273 at 76 percent; Pfizer BNT162b2 at 42 percent) (Puranik et al., 2021). Similar findings have been reported for the Johnson & Johnson vaccine, but this data has not yet been published (del Rio et al., 2021). Protection against severe COVID-19 starts to wane after five months with the 2-dose mRNA vaccinations. Adding a booster mRNA vaccination markedly increased protection against severe COVID-19 and lowered the odds of SARS-CoV-2 infection.

That viral armor remained durable over at least six months (Patalon et al., 2021). However, both 2-dose and 3-dose mRNA vaccination protection against Omicron infection waned rapidly, and a fourth mRNA vaccine dose may help increase protection against confirmed infection (Ng et al., 2022, p. 12).

In the United States, the vaccination program substantially reduced the burden of disease by preventing serious illness in fully vaccinated people and interrupting chains of transmission. While vaccinated people can still become infected and potentially spread the virus to others, they have much lower rates and risks of transmission than unvaccinated people. Vaccinated people who get COVID-19 have reduced levels of viral mRNA and culturable virus (viral load) and are infectious for shorter periods than unvaccinated people infected with COVID-19. The viral load has been identified as a key driver of transmission. Studies from multiple countries found a significantly reduced likelihood of transmission to household contacts from people infected with SARS-CoV-2 who were previously vaccinated for COVID-19 (National Center for Immunization and Respiratory Diseases, 2021; Shah et al., 2021; de Gier et al., 2021; Harris et al., 2021).

The new mRNA vaccines work by injecting a lipid-encased nanoparticle holding the manufactured messenger RNA strands into a person's body. The nanoparticle enables the mRNA to cross through a cell's membrane undamaged. Vaccine mRNA strands are coded to reproduce a particular area of a virus particle that would elicit a protective immunological response by the human body. For COVID-19, this area codes for the full-length spike protein on the SARS-CoV-2 virus (Abbasi, 2020; Creech et al., 2021). Once safely in the cell, the created mRNA uses the same system as a body's mRNA to deliver instructions from the DNA to the cell's protein-making structures (ribosomes) to produce

spike proteins. Spike protein production peaks in about 24 to 48 hours. The created mRNA is broken down by enzymes and is eliminated within approximately one day. The artificial spike proteins are gone within about three days (Mishra, 2020). After about three days, all that is left from the vaccine is the body's protective immunological memory. These mRNA vaccines are very clean.

As of September 20, 2021, about 182 million Americans were fully vaccinated, with 99 million people receiving the two doses of the Pfizer, 68 million getting two Moderna shots, and just less than 15 million opting for the Johnson & Johnson vaccine (CDC, n.d.). No obvious complications or hazards seem to be appearing with all three vaccines. A records review of 6.2 million mRNA-vaccinated people in eight major health plans found that event rates for 23 serious health outcomes were not significantly higher for individuals 1 to 21 days after vaccination compared with similar individuals at 22 to 42 days after vaccination. Those items tracked for a risk interval were acute disseminated encephalomyelitis, encephalitis/myelitis, Guillain-Barré syndrome, immune thrombocytopenia, Kawasaki disease, seizures, transverse myelitis, appendicitis, Bell palsy, acute myocardial infarction, disseminated intravascular coagulation, myocarditis/pericarditis, pulmonary embolism, stroke [hemorrhagic and ischemic], thrombotic thrombocytopenic purpura, cerebral venous sinus thrombosis, thrombosis with thrombocytopenia syndrome and venous thromboembolism, acute respiratory distress syndrome and multisystem inflammatory syndrome in children/adults with narcolepsy/cataplexy were observed for 84 days. Anaphylaxis was only looked at on the day of inoculation (Klein et al., 2021). Anaphylaxis was identified in 52 females and three males for a total of 55 people, corresponding to an incidence of 4.8 cases per

million doses for Pfizer-BioNTech and 5.1 cases per million doses for Moderna (Blumenthal et al., 2021; Klein et al., 2021). Several studies indicate an increased risk of myocarditis/pericarditis among those aged 12 to 39 years, with an estimated additional 6.3 cases per million doses in days 0 through 7 after vaccination, while an Israeli Pfizer study of individuals aged 16 years and older identified a risk of myocarditis of an additional 1 to 5 events/100000 persons (Blumenthal et al., 2021). However, the risk of myocarditis with COVID-19 is much greater, with nearly 1 out of 100 highly fit athletes with mild COVID-19 infection having evidence of myocarditis (Montgomery et al., 2021). Currently, no evidence supports that mRNA vaccination has contributed to any patient deaths (Warren et al., 2021). However, after 8 million doses of the Johnson & Johnson vaccine, 15 women developed clots located in the cerebral venous sinuses leading to three deaths (MacNeil et al., 2021). A logical comparison of the risk of death from the vaccine to the risk of death due to COVID-19: 3 deaths in 182 million vaccinated people compared to 1 death out of every 500 people infected with COVID-19. The obvious rational choice and single greatest protective action for COVID-19 a person can make is to get initial and booster shots.

Rational Theory

The traditional economic decision-making models assume rationality and utility. In this context, rationality means that people take all available information and make consistent and informed decisions in their best interest (Dean et al., 2016, p. 238). These best interests are measured by the increase in utility or satisfaction, usefulness, and value one obtains from the decision (p. 37). The economic premise is based on people will seek the highest level of utility or satisfaction. However, individuals can be the only judge of

their own utility (p. 213). The roots of utility can be seen in early Greek Hedonism theory by Epicurus' proposal that the logical purpose of all human action is to attain physical and mental happiness by maximizing pleasure and minimizing pain (Souryal, 2011, p. 131).

In everyday life, a rational person computes the value of all the options faced and then follows the best possible path of action (Ariely, 2009, p. xx). The assumption that individuals are rational does not presume that they have every piece of information available to them that might be relevant to a specific decision or choice. However, rational individuals need to act on the available information in a manner consistent with obtaining a given objective that maximizes their utility (Curtis & Irvine, 2021, p. 131).

In the latter part of the twentieth century, social science accepted that people are generally rational and that their thinking is normally sound. Any departure from this rationality was mostly due to emotions such as fear, affection, and hatred (Kahneman, 2011, p. 8). Kahneman and Tversky (1984) detailed several qualitative principles, or axioms, that should govern the preferences of a rational decision-maker. These axioms included transitivity (if A is preferred to B and B is preferred to C, then A is preferred to C), and substitution (if A is preferred to B, then an even chance to get A or C is preferred to an even chance to get B or C). However, strong evidence suggests that people do not always follow the substitution axiom. In addition, a rational choice has two principles: dominance and invariance. Dominance requires if prospect A is at least as good as prospect B in every respect and better than B in at least one respect, then A should be preferred to B. Invariance stresses that the preference order of the items should not depend on the manner in which they are presented (p. 343).

Dual Process Model of Thinking

In our daily lives, conventional economics assumes that people act rationally by computing the value of all the options faced and then follow the best possible course of action (Ariely, 2009, p. xx). However, in the real world, people sometimes make the right decision, and sometimes they error with a wrong decision. Research in the last 50 years describes how different people make the same cognitive judgment errors in some circumstances while consistently choosing the correct solution in other situations. Researchers documented these systematic thought errors and traced these mistakes back to the design of the machinery of cognition rather than the corruption of thought by emotion. The obvious solution to this dilemma is that people must have two ways of thinking. This dual-process model is commonly and generically referred to as System 1 and System 2. This model can explain why individuals make rational, analytical decisions in some circumstances but fail to use that same quality of logical reasoning in other situations (Reisberg, 2013, pp. 412-413; Ariely, 2009; Kahneman, 2011; Stanovich & West, 2000; Wood & Bechara, 2014).

Using a computer analogy, System 1 and System 2 are compared to operating system (OS) software. The two systems share the same computing hardware and data and can operate in a parallel fashion in which mental tasks migrate between them. System 1 uses the automatic and mostly unconscious associative memory to generate impressions, intuitions, and response tendencies. However, the slower and more aware System 2 monitors System 1 and sometimes rejects, modifies, or clarifies its operations (Morewedge & Kahneman, 2010, p. 439). In this dual-system model, errors of judgment are due to a combination of two factors: the automatic operations of System 1 generate a

faulty intuition, and the controlled operations of System 2 fail to detect and correct that erroneous perception (see Table 2) (p. 435).

System 1 can generate complex representations but cannot accomplish rule-governed computations or the processing of explicit repudiations. System 1 tasks the effortful System 2 when it runs into difficulties. However, an important feature of System 1 is that it rarely fails to generate an answer. This system automatically, quickly, and effortlessly creates a skilled response to the task. If one is unavailable, another solution will be produced, sometimes by answering an easier question or somewhat related to the one that was asked (Morewedge & Kahneman, 2010, p. 439). The part of the brain that corresponds to System 1 is the amygdala–striatum. This area responds quickly and automatically based on conditioned (learned) and unconditioned (innately motivational) stimuli and associations. These associations are relatively inflexible in that the motivational value is difficult to change once a stimulus value is learned. The amygdala–striatal system is responsible for expressing motivated responses (like fear and reward) and transferring controlled behaviors and preferences into habits (Wood & Bechara, 2014, pp. 182-183).

System 2 devotes attention to effortful mental activities, including complex computations. Only it can follow rules, compare objects on several attributes, and make deliberate choices between options. System 2 is associated with agency, choice, and concentration (Kahneman, 2011, pp. 20-21). System 2 functions that include reflection and valuation seem to be located in the ventromedial prefrontal cortex (vmPFC). This cortex area modifies decision-making through mechanisms of impulse control that modulate amygdala activity (System 1) (Wood & Bechara, 2014, p. 193). Statistical

thinking derives conclusions about individual situations from properties of categories and groups. Only System 2 can perform this type of reasoning if properly trained (Kahneman, 2011, p. 77). In addition, System 2 behaves more rationally than System 1 and will seek to fulfill the person's goals in those cases where the goals conflict with System 1 responses (Stanovich & West, 2000, p. 661).

Although delivering superior cognitive analysis, System 2 requires great mental effort and demands more energy. Applying cognitive and physical exertion, the general law of least effort asserts that if multiple paths to a goal exist, systems will pursue the least demanding course of action. Evolutionary biology proposes that organisms seek and adapt to more energy-efficient ways to accomplish a task. "In the economy of action, effort is a cost, and the acquisition of skill is driven by the balance of benefits and costs. Laziness is built deep into our nature" (Kahneman, 2011, p. 35). Because of the great cognitive demand, System 2 can be easily overloaded. The system's response is selective and precise by protecting the designated most important activity then releasing any spare capacity to other tasks. In perceived emergencies, System 1 takes over and assigns total priority to self-protective actions (p. 35).

Table 2

Properties of Dual-Process Theory of Reasoning

	System 1	System 2
Properties	associative	rule-based
	holistic	analytic
	automatic	controlled
	relatively undemanding of cognitive capacity	demanding of cognitive capacity
	relatively fast	relatively slow
	acquisition by biology, exposure, and personal experience	acquisition by cultural and formal tuition
	unconscious	self-aware
	skilled	rule-following
	biased to believe	doubting
Task Construal	highly contextualized	decontextualized
	personalized	depersonalized
	conversational and socialized	asocial
Personal Perception	gut reaction	conscious thought

(Stanovich & West, 2000, p. 659; Thaler & Sunstein, 2009, p. 20)

The big lesson for errors in rational decision-making is when System 2 is not engaged, the human mind will believe almost anything. System 1 is gullible and geared to believe. System 2 is in charge of doubting and unbelieving, but System 2 can be busy and often lazy (Kahneman, 2011, p. 81). Only System 2 is capable of skepticism of information and its sources.

Heuristics and Biases

In making judgments when the outcome is uncertain, people rely on a number of heuristic processes, which reduce the complex tasks of assessing probabilities and predicting values to much simpler cognitive operations. These heuristics can be quite useful, but sometimes they lead to severe and systematic errors (Tversky & Kahneman,

1974, p. 1124). The errors induced affect the thinking of both experts and novices alike. Working definitions of heuristics and biases and associated concepts in alphabetical order are listed in Appendix A.

Heuristic

A simple procedure or rule of thumb used to find adequate, though often imperfect, answers to difficult questions. The solutions, judgments, or decisions obtained through this process lack an application of an algorithm or an exhaustive comparison of all available options. A speedy result is a goal, not a selection of the most correct or optimal result. The mind widely uses heuristics as an efficient way of cognitively processing problems. While they can lead to sensible conclusions, heuristics can be the source of predictable errors (Colman, 2015; Kahneman, 2011; Reisberg, 2013).

Bias

A fundamentally flawed reasoning process that often leads to a thinking error. These errors are systematic deviations from normative reasoning and do not refer to transitory processing errors such as one-time or random mistakes. The human mind's reliance on heuristics and its automatic contextualization of problems and information produces predictable errors in judgment (Kahneman, 2011; Stanovich, 2021; Stanovich & West, 2000).

Information/ Warning Theory

The last half century has witnessed an evolution of information/warning theory that increased our understanding of how people process and comprehend information and

warning communications to take protective actions. Four models deemed influential to this study are summarized below.

McGuire's Information-Processing Model

Early theories explained persuasive communications in three phases: attention to the message, comprehension of its content, and acceptance of its conclusions (Eagly & Chaiken, 1984, p. 271). By the late 1960s, McGuire proposed that the persuasive impact of messages was a product of six information-processing steps: initial message presentation, attention/awareness, comprehension, yielding/acceptance, retention of the new belief, and action (Eagly & Chaiken, 1984, p. 271; Flay et al., 1980, p. 130). Failure of these six steps breaks the sequence of processes causing the subsequent steps not to transpire. For experimental measurement reasons, attention and comprehension are commonly combined into a single step of reception of the message. The focus on reception constitutes the distinctive contribution of McGuire's theory and that independent variables such as intense distractions, recipients' verbal intelligence, and communication modality can have a strong influence on attitude change through their effect on the reception of message content (Eagly & Chaiken, 1984, p. 272; p. 277). Lower comprehension reduced acceptance of the recommended action by lessening the number of message-supportive thoughts held by the recipient (p. 275). With difficult messages, influence is greater when the message is written compared to video or audio. However, with easily understood messages, like many warnings, persuasion is greatest when the message is video, moderate when audio, and least when written (p. 276).

However, McGuire's theory assumes that the message recipients follow the rational and systematic mathematical laws of probability in combining information, and

people take the available items of information into account in forming an overall evaluation or impression. In addition to his probabilogical model, McGuire logically postulated "hedonic consistency" in most of his works which recognize that rational thinking and sometimes wishful thinking affect belief formation and change (Eagly & Chaiken, 1984, p. 332).

Warning Response Model (Mileti & Sorenson, 1990)

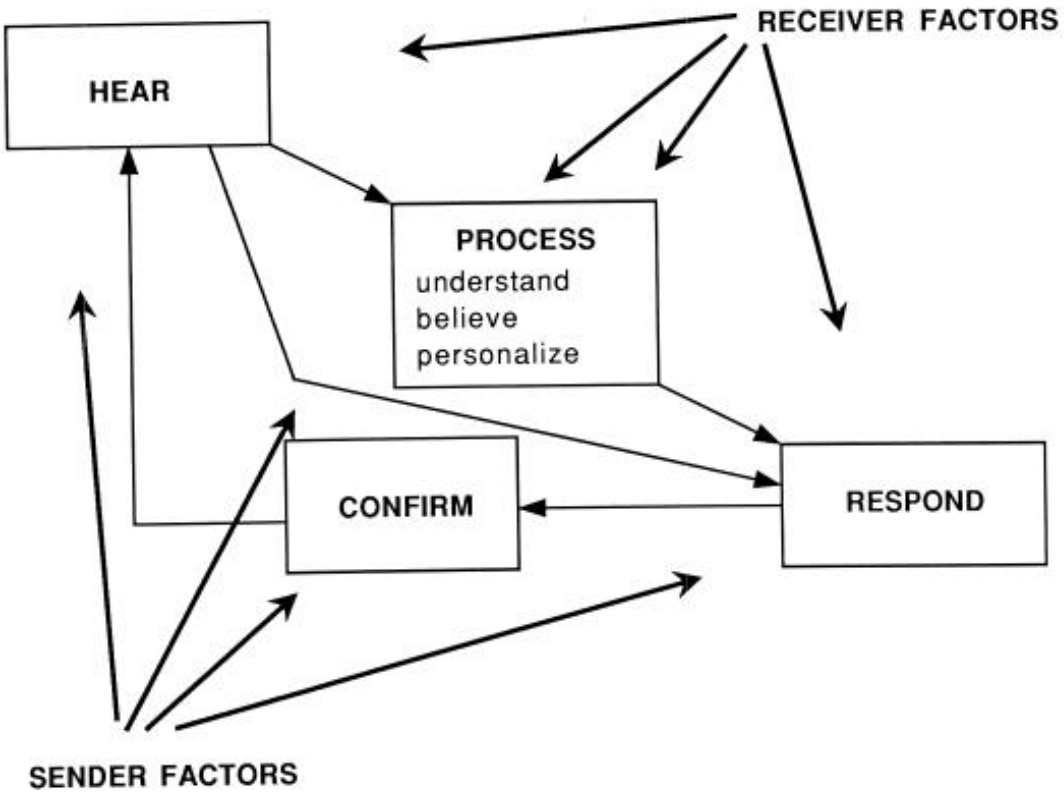
Responses to public warnings are a series of related sequential factors (see Figure 2) that are described as: the actual reception of warnings [aural, visual, text or written], believing the warning, confirming the threat, personalizing the communication, determining if protective action is needed and feasible, and finally deciding on and engaging in the response behavior (Mileti & Sorensen,1990, p. 5-10; Mileti, 1999, p. 191). Human decision-making about warnings mirrors a series of related sequential steps in a decision process. But unlike McGuire's Information-Processing Model, the sequence of these steps may not be the same for every person warned and the accomplishment of every part is not necessary for a response to occur. This process is shaped by both sender and receiver factors (Mileti & Sorensen,1990, p. 5-1). People think of warnings in personal terms, which translates to what is the risk of the hazard to themselves, their families, and their group. If a person does not believe an event they have been warned about could or will happen, they may ignore the warning message. This personalizing of a warning is an important step that facilitates responding to the warning message (p. 5-1).

People vary in their capacity to process information contained in warning messages and cues. This variability exists because people have differences in education, cognitive abilities, hazard knowledge and experience, and their particular life views.

Also, the circumstances of each event can differ and affect the receiver in unique ways. All this can lead to variation in warning responses (p. 5-11). Furthermore, special needs populations such as the elderly can exist in noninstitutionalized settings scattered around the community. They may demand a greater effort to convince them to take necessary protective actions such as evacuation and need specialized warnings tailored to their unique situations (p. 5-15).

Figure 2

Warning Response Model (Mileti & Sorenson, 1990, p. 5-14)



In describing this model, the authors state people typically act rationally from their standpoint even thought their behavior may be deemed irrational by an expert observing them (p. 5-2). Some people process warning information well while others do not. Those people will seek additional information to be convinced to engage in

protective actions (p. 5-9). The public will perceive warning messages to be convincing and reasonable if they are specific, consistent, accurate, certain, and clear as to the location of the area of risk, guidance about what the public should do, the character of the hazard, and the amount of time until its impact (p. 5-10). However, response anomalies are explained by human variation in the ability to process risk information. Some people are a hearty lot and not easily convinced. Other individuals readily accept information from trusted sources. And a few just refuse to heed the advice in warnings regardless of their character (pp. 5-11-15). Later, Mileti (1999) modified his position by saying that individuals do not process information about hazards in perfectly rational ways and often assess situations imperfectly. Furthermore, they use flawed cognitive heuristics to reach decisions on protective actions (p. 137).

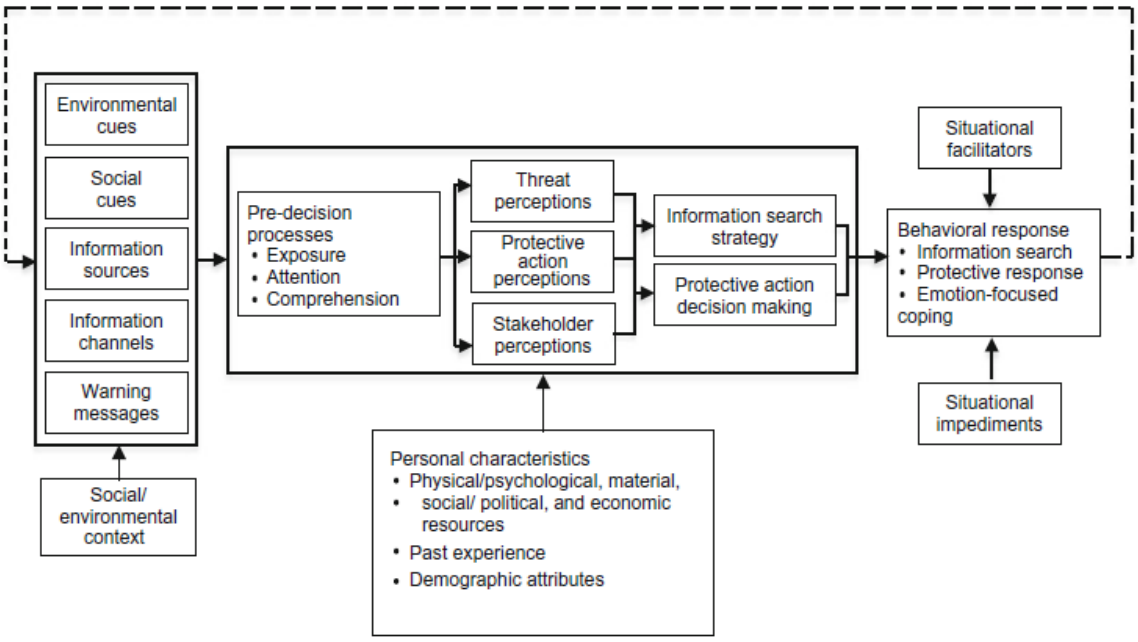
Protective Action Decision Model (Lindell and Perry, 2012)

The Protective Action Decision Model (PADM) predicts changes in receivers' beliefs and behaviors through a multi-stage process (see Figure 3), starting with a person receiving warning messages and cues (Lindell & Perry, 2012). The next PADM step contains the attention, exposure, and comprehension of the information and is influenced by personal perceptions. This part leads to protective decision-making, which results in behavioral responses (Lindell, 2018, pp. 451-452). The final stage is a feedback loop in which people seek to confirm or contradict any received warnings, usually via another information source or method (Lindell & Perry, 2012, p. 624). Generally, the resulting response through the stages can be characterized as an information search, a protective response (problem-focused coping), or an emotion-focused coping method (p. 617). If an individual cannot answer the question posed at any one of the decision stages, then the

implementation of a protective action will probably be terminated. If the question is about risk identification, then the person will most likely return to normal activities. If the risk assessment is inconclusive, people will continue monitoring the situation. If an individual determines protections are neither acceptable nor available, the decision maker is prone to enter a state of either denial or panic (Lindell & Perry, 2004, pp. 63-64).

Figure 3

Information flow in the PADM (Lindell, 2018, p. 452)



A person's perceptions can be shaped by their unique physical and psychological characteristics (Lindell, 2018, p. 452). These attributes, such as age, gender, ethnicity, and socioeconomic status, affect an individual's preexisting views about the gravity of the hazard and the credibility of the warning message. Through these perception filters, a person must cognitively process that warning information and recommended protective actions to avoid injury or death before they ultimately decide to comply with or ignore the message. The stages of PADM are heavily reliant on the information-processing

capabilities of the message recipient (Mayhorn, 2005, p. 165). Older adults may have several perceptual and cognitive issues that can negatively affect how they process the information contained in emergency warnings and impact the progression through each stage. Perceptual problems such as age-related auditory loss and visual changes can interfere with an elderly person's ability to notice a warning during the pre-decision stage. Degraded cognitive abilities such as text comprehension and memory can inhibit proper understanding of the emergency message information during both the pre-decision and decision stages (p. 169). The real driving forces behind these models are a person's cognitive processes and abilities (Lindell, 2014b).

However, the Protective Action Decision Model is quantitively driven with its emphasis on colorations between values and constructs like risk perception and hazard intrusiveness to be measured through surveys than on how the mind produces mental models (schemas or stories) on current hazardous situations through cognitive processes like anchoring, substitution, availability, framing, and representation. PADM's decision-making process forces people to process multiple pieces of information, interpret those data inputs in relation to some goal, then select the best course of action from available alternatives to achieve that goal in a very rational, linear process (Mayhorn, 2005, p. 168). While Lindell and Perry (2004) do recognize that preexisting schemas affect the interpretation of new information, they fail to include in their model how such schemas (mental models) shape information gathering and processing (p. 85) nor do they support their suggestion that inappropriate disaster responses are more frequently due to inadequate information than to defective cognitive processing (Lindell & Perry, 2012, p. 619). Additionally, the authors appear not to embrace the Prospect Theory (Lindell &

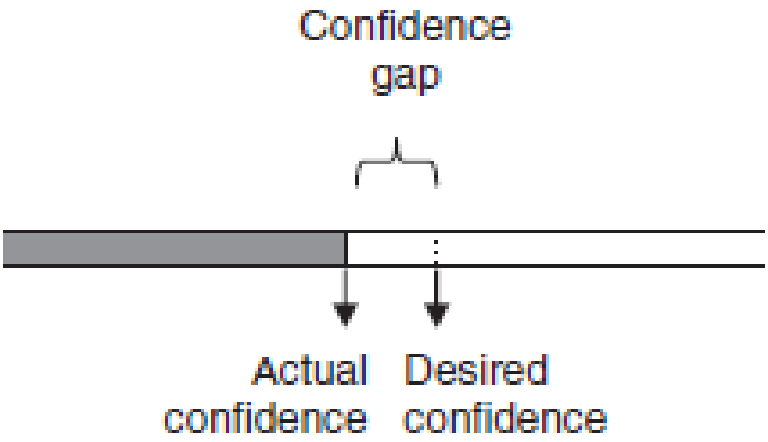
Perry, 2004, pp. 34-35), dual process models of cognition (like System 1 and System 2), nor the concepts of heuristics and biases proposed by Tversky and Kahneman (Lindell, 2014a, p. 19). Curiously, Lindell and Perry (2012) attempt to explain some mediation issues in PADM (like the inability of risk perception or hazard intrusiveness to completely mediate the relationship between perceived stakeholder characteristics and hazard adjustment adoption) by using Chaiken's Heuristic-Systematic Processing Model (p. 629).

Multiple-Motive Model of Heuristic-Systematic Processing (HSM) (Chen & Chaiken, 1999)

This model assumes that people attempt to make decisions efficiently as possible, '*cognitive miser*.' Individuals prefer the less effortful mode of heuristic processing to the more time and cognitive resources consuming systematic processing. However, the sufficiency principle asserts that humans are sometimes motivated to exert additional cognitive effort to reach a higher, defined level of judgmental confidence. A sufficiency threshold is established by the chosen level of confidence in the decision, which is consistent with achieving a person's cognitive processing goals. The mind sees a gap between a person's actual confidence and its desired sufficiency threshold (see Figure 4). Humans, as lazy organisms, will first attempt to close this gap in confidence via the easier heuristic processing method. Only when this strategy fails to generate the desired judgmental confidence will people, if able to exert the additional cognitive effort required by systematic processing (Chaiken & Ledgerwood, 2012; Kim & Paek, 2009).

Figure 4

Heuristic-Systematic Processing Confidence Gap (Chaiken & Ledgerwood, 2012, p. 248).



Later, HSM was broadened to include two motivations, defense and impression, that can result in selective and bias information processing geared toward arriving at a particular attitudinal viewpoint rather than an open-minded position. This process can be either heuristic, systematic, or a combination. Defense motivation reflects the impact of such self-focused variables as ego-involvement and personal commitment and seems similar to *conformational bias*. People defend their position by confirming the validity of preferred (pre-existing) attitude positions and challenging the legitimacy of nonpreferred positions. Impression motivation is the desire to express socially acceptable attitudes by following what a majority regard as socially appropriate (Chaiken & Ledgerwood, 2012; Kim & Paek, 2009).

Mental Models

Humans can quickly organize information and "fill in the blanks" about the external world using generalized mental structures built from their past experiences to form a relatively quick, efficient, top-down method of mental understanding of the world

(Chaiken & Ledgerwood, 2012, p. 252). These generalized mental understandings have been labeled by many different terms: schemas (Chaiken & Ledgerwood, 2012), stories (Kahneman, 2011), and mental models (van Ments & Treur, 2021). The definition of these understandings has varied greatly, partly due to humans having messy, sloppy, incomplete, and indistinct structures of mental understanding instead of neat, elegant models of explanations (Doyle et al., 2008, p. 269). The term mental model is widely used in aviation and athletics and will be the preferred term in this research. Doyle and Ford (1999) define a mental model (of a dynamic system) as "a relatively enduring and accessible, but limited, internal conceptual representation of an external system (historical, existing or projected) whose structure is analogous to the perceived structure of that system (p. 414)." Mental models can be further described as deeply ingrained assumptions and generalizations that influence how people understand the world and take action, often without conscious knowledge of the effect of the mental models. They frame the decision situation, including the variables, alternatives, decision premises, and biases (Chermack, 2003, pp. 409-410). These models are used in simulations to link and relate facts about external and internal processes and take many forms, such as prediction, visualization in sports, dreaming, and reasoning (van Ments & Treur, 2021, p. 6). Decision-making mental models are highly variable depending on task characteristics, goals, response modes, and framing (Doyle et al., 2008, p. 274). The knowledge and beliefs forming mental models are organized in a person's memory in narrative or story-like structures that are variously termed narrative models, scripts, schemas, or stories. This narrative is spontaneously constructed and guides decision-making when judgments are based on large amounts of interrelated information or experience (p. 276). New

events and information do not replace existing data in a mental model, but a person's mind evaluates and integrates the new material with the current representation (p. 285).

If a human is presented with a new object or concept, their mind attempts to categorize it according to its perceived characteristics. Each cognitive category is represented by a prototype or anchor whose characters are thought to be most representative or typical of that category (Reisberg, 2013, p. 289). An example would be a robin would be prototypical of a bird, while a penguin would not (p. 291). Categories also have exemplars, examples of the group that comes easiest or most available for recall from the mind (p. 294). For a person who loves hummingbirds, they might be first imaged and associated with the word 'bird.' The human mind then compares the new item or concept on how well it resembles the known prototypes and exemplars and assigns a category to the new concept (p. 302). Once the new item is categorized, the mind assumes it has the same characteristics as other group members and assigns those features to the new concept (p. 308). Other associations are drawn from the memory to form a complete story or mental model (Kahneman, 2011). Humans attempt to understand concepts in the world by constructing mental models through categorization and association. But, these models are simpler than the reality they represent and therefore are incomplete. However, these constructed mental models allow people to function in situations where they lack complete comprehension (Chermack, 2003, p. 409).

Attention Capacity

In 1971, Herbert A. Simon astutely commented:

> [I]n an information-rich world, the wealth of information means a dearth of something else: a scarcity of whatever it is that information consumes. What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention and a need to allocate that attention efficiently among the overabundance of information sources that might consume it. (pp. 40-41)

As Dr. Simon observed, the overabundance of information sources depletes the attention of an individual and hence exhausts the energy level of the person (Bruya & Tang, 2018, p.5). Per *cognitive miserliness*, a human being will attempt to decrease energy demands by reducing the amount of information sources that consumes their attention. However, Kahneman (1973) warns when a person appears to control the choice of stimuli or information, that selection will be allowed, in turn, to control their behavior (pp. 3-4). The following information and attention concepts were integral to this study.

Information Overload

Since the 1990s, with the commercialization of the World Wide Web and the development of the personal computer, society, and its members have been awash in mounds of data. The old slow and labor-intensive methods of finding answers to questions, such as going to the library or consulting encyclopedias, would yield only one to a handful of possible answers. Now, hundreds of possible solutions are less than seconds away from being revealed by a Google search or asking Alexa. The problem

shifts from actively trying to find the required information to sifting through the mounds of data provided by automated search engines. Add that most people carry portable digital devices such as smartphones 24 hours/7 days a week, twenty-first-century humans face an informational tsunami every waking minute through social media feeds, YouTube channels, email newsletters, and other electronic media delivery methods. Official protective action messages and information competes for the attention of individuals in such an environment. The average global smartphone user exceeds 10GB of data per month. In just five years, that number will triple to an estimated 35GB by the end of 2026 (Jonsson et al., 2021, p. 15). At the end of 2020, the world had six billion smartphone subscriptions, and within another five years, that number is forecasted to reach almost eight billion (p. 5). This global information overload problem affects the vast majority of people with decision agency worldwide.

Capacity Model of Attention

Living organisms have a limited capacity to absorb and process informational inputs. In these situations, the organism appears to control the choice of stimuli that will be allowed, in turn, to control its behavior. Whether a conscious act or not, that control selects some stimuli, or aspects of stimulation, in preference to others (Kahneman, 1973, pp. 3-4). That selected and sustained concentration on a specific stimulus or sensation (attention) enables a person to use their information-processing systems with limited capacity to handle vast amounts of information available from the sense organs and memory stores for the mind to consciously register the input (perception) (Colman, 2015). In this model, attention controls perception (Kahneman, 1973, p. 6). However, humans have a limited amount of this attention capacity. This limit sets an upper bound

for how much each of us may pay attention to, and therefore how much information we can take in and process during a time period (Hendricks & Vestergaard, 2019, p. 23). Kahneman's (1973) capacity model of attention assumes that this limited capacity can be allocated with considerable freedom among concurrent activities so that attention is a shared resource (p. 8). In this model, "pay attention" is equated with "exert effort," and as such, the attention-effort requires metabolic expenditures that occur inside the brain's nerve cells (Kahneman, 1973; Bruya & Tang, 2018, p. 4). Physiological factors like fatigue and lower blood glucose levels affect attention and can diminish a person's capacity for attention. Additionally, the act of attention expenses bodily energy (glucose) and further reduces one's ability to focus attention (Gailliot et al., 2007). Novel and surprising stimuli that spontaneously attract attention require a greater effort of processing than more familiar stimuli and cause a surge of mental effort (Kahneman, 1973, p. 4; Bruya & Tang, 2018, p. 4). The highly diverse operations of System 2, which include critical analysis of new information needing careful and effortful assessment, require attention. These processes are disrupted when attention is drawn away and trigger the emotional reactions of System 1, which are more likely to be determined by a single evaluation (Kahneman, 2011, p. 22; p. 355).

Selective Attention

The information overload resembles the classic cocktail-party problem/effect: a guest at a cocktail party engages in a conversation and ignores all others. Our guest is aware of other people in the room talking but cannot decern what they are saying. However, when someone has a conversation close to them mentions a close friend's name, they find themselves listening to that discussion and momentarily ignoring their

ongoing chat (Reisberg, 2013, p. 121). Perception entails two types of priming (preparation for the upcoming input or cue): stimulus or expectation based. Stimulus-based results from recent or frequent past inputs, such as hearing one's name, draw their attention. The latter priming involves the prediction or expectation of an event and readying their senses to capture that information (pp. 130-133). A person's perception is distinctly impaired if their mind commits no resources to the incoming stimulus information (p. 157).

Inattentional blindness can result from misallocating attention resources and cause perceivers to literally not see stimuli right in front of their eyes (p. A9). The classic Chabris and Simons's "Invisible Gorilla" study demonstrates this blindness. Subjects are shown a short film of two teams passing basketballs, with one team wearing white shirts and the other wearing black. The viewers were instructed to count the number of passes made only by the white-shirted team while ignoring the black-shirted players. This task was made difficult and completely absorbing. Halfway through the video, a woman wearing a gorilla suit appears, crosses the court, thumps her chest, and moves on for nine seconds. Thousands of people have seen the video, and about half do not notice anything unusual. The gorilla study illustrates two important facts about our perception: we can be blind to the obvious, and we can also be blind to our blindness (Kahneman, 2011, pp. 23-24). Possible impairment of perception makes selecting information and allocating attention of crucial importance. (Hendricks & Vestergaard, 2019, p. 23).

Theory of Rational Inattention

Every decision situation that a person has to make comes with a choice of attention. Humans always face the fundamental tradeoff between processing more

information to improve decisions or less and saving on the mental effort of doing so. Economists developed the theory of rational inattention to describe how people in an environment with large quantities of information select, condense, summarize, and digest the abundant available information to meet a person's limited ability to process that information (Maćkowiak et al., 2021, p. 4). The individual is flexible in what kind and how much information to absorb and then acts based on that selected information (p. 2). The decision maker may proceed with incomplete information rather than incur additional mental and physical costs to become more perfectly informed (Sallee, 2013, p.1). In a rational inattention decision, a person's choice may seem illogical or error-prone from an external viewpoint. Still, the subject makes those mistakes in actions in their attempt to deal with the perceived overwhelming amount of information. The result reflects the person's choice of what to think about, what to pay attention to, and what level of detail (Maćkowiak et al., 2021, p. 5). This process resembles satisficing.

Misinformation

Data in its raw form is neutral, devoid of emotion, opinion, bias, and judgment. However, a message is formed once that information is collected, interpreted, packaged, and distributed. A message intends to influence the recipient's behavior. These messages can take the form of newspaper articles, broadcast shows, YouTube videos, social media feeds, and even peer-review academic journal papers. To complete their designed tasks, messages have to reach their intended audiences; they have to compete for and capture the attention of the targeted population. Memes, bots, sock puppets, trolls, websites, and filtering algorithms found on the internet dramatically increase the quantity, reach, and speed of information (Colley et al., 2020, p. 91). Facebook found engagement was an

effective way to capture and maintain people's attention and used strong emotions such as hate and anger to increase engagement. The social media giant's data scientists found that angry reactions were much more frequent on problematic posts such as low-quality news, political misinformation, civic toxicity, health misinformation, and health antivax content and those strong emotions were being weaponized by political figures and so-called intellectuals (Merrill & Oremus, 2021).

Modern intellectuals (pundits, reporters, activists, bloggers, etc.) judge new ideas not by their specific merits but by the readiness with which these notions fit into their general conceptions of good and evil and the vision of a modern, equitable, and socially advanced world. These intellectuals are uninterested in technical details, practical difficulties or troubling facts that disrupt their neat and coherent picture of the world. They champion scientific specialists for reasons that have little to do with scientific eminence or prowess and everything to do with their acceptance of the intellectuals' viewpoint. The heralded specialists achieved public fame and wide influence not by gaining the recognition of their peers but by promoting modern intellectuals. Often these men and women of science and medicine whom the other experts regard as cranks, amateurs, or even frauds will become, in the eyes of the general and naive public, the best-known exponents of their subject (Hayek, 1949).

The internet and social media are perfect platforms for the proliferation of misinformation. Online news stories and blogs are subject to very few quality controls. Even if those stories are fact-checked, the corrected information rarely gets to those exposed to the misinformation, especially in homogeneous environments or echo chambers. Even when corrected information gets to them, people exposed to

misinformation may continue to rely on the debunked facts in a phenomenon known as the continued influence effect (Roozenbeek & van der Linden, 2021, p. 5). Additionally, social media can add credibility to such material through the effect of friends and family sharing implies they endorse the content (Ali & Zain-ul-abdin, 2021; Hendricks & Vestergaard, 2019). The digitalization of information and media content makes creating high-quality videos and eye-catching graphic misinformation and propaganda easy and cheap. Anyone with an inexpensive personal computer, I-pad or I-phone can manipulate data sets and produce stunning, professional visualizations with the appearance of scientific authority that appeals to an individual's skeptical nature and counter-argument mind set (Lee et al., 2021). The Internet created a market for media products that are highly favorable for the propaganda opportunities of vested political and economic interests. The existing information ecosystem and economy have strong financial incentives to produce and spread distorted stories, rumors, and fake news, which are highly contagious, seize attention, and generate clicks. Due to automated advertising systems, clicks make money for the content provider with little regard for the truthfulness of the stories generating the clicks (Hendricks & Vestergaard, 2019). A click is a click, and money is king. In 2020, approximately 356 billion USD was spent globally on digital advertising, with social media ad revenues raking in an estimated 41.5 billion USD or about 30 percent of total internet ad revenue (Couric et al., 2021, p. 21). Even the American main stream media looks for emotional content for profit through ad sales. Les Moonves, executive chairman and CEO of CBS, said, "It [political bomb-throwing of the press and Donald Trump] may not be good for America, but it's damn good for CBS [stockholders] (Hendricks & Vestergaard, 2019, p. 42)." Catering to the biased audience

has proven to be a very good business model for Fox news and MSNBC. Both serve views at opposite ends of the ideological spectrum. Streaming and cable channels have added to media supply and consumption polarization. Political groups now watch different, biased news channels and programs (p. 41).

The behavioral impact of disinformation on the population appears to be easier to identify in health crises since disinformation is easier to link to concrete behaviors, such as the decision to vaccinate for COVID-19 or to take ivermectin (Colley et al., 2020, p. 98). Social media receives the blame for over 40 percent of French citizens' distrust of vaccines compared with only 13 percent worldwide (p. 97). In the 1980s, the Soviet Union successfully propagated the falsehood that AIDS was created in a US government laboratory. Operation Infektion is one of the most prominent historical cases of disinformation; by 2012, about one-third to one-half of African Americans still believed in this story (p. 98). A recipient’s trust in the sender significantly influences the acceptance of a message. Governmental officials and organizations can lose trust through a lack of transparency, perceived partisanship or bias, and overbearing restrictions. Senders can gain trust by creating appealing and culturally appropriate narratives (Eagly & Chaiken, 1984; Lindell, 2018). Disinformation campaigns like Operation Infektion are designed to damage trust between citizens and government and weaken social cohesion by exacerbating division (Colley et al., 2020, p. 92).

People frequently classify messaging, such as disinformation, misinformation, fake news, etc., based on the sender's intent. Disinformation can be spread and passed on by people ignorant of its beginnings and true intent. Determining the original propose for transmitting information, such as misinformation versus disinformation, can be difficult

and problematic, as exemplified in the subjective vision ‘One person’s terrorist is another person’s freedom fighter.’ For this study, misinformation terms are defined in Appendix B, and no distinction will be made between misinformation and disinformation.

Individualism versus Collectivism

Individualism promotes or cares for a person’s and their immediate family’s self-interest, personal autonomy, privacy, self-realization, individual initiative, independence, individual decision-making, and an understanding of personal identity as the sum of individual attributes. This class of people is less interested in the needs and interests of others while emphasizing individual rights over group responsibilities. Australia, Great Britain, Canada, and the Unite States are typical individualistic societies (Darwish & Huber, 2003). On the other end of the social spectrum is *collectivism.* It prioritizes the common good of society as a whole. In this situation, people feel they belong to larger in-groups or collectives. These societies emphasize loyalty to the group (which in turn cares for the well-being of the individual), emotional dependence on the groups, interdependence, and concern about the needs and interests of others. China, Hong Kong, India, Japan, Pakistan, and Taiwan are typical collectivistic societies (Darwish & Huber, 2003; Koons, 2019). At their extremes, individualism and collectivism are polar opposite worldviews that people can hold. As such, they can generate quite different perceptions of risk, interpretations of dangers, and opinions of possible mitigation efforts. Some people may shut out certain perceptions of dangers, while others choose to highlight those same risks (Kahan, 2012).

In American Society

A person's values may be derived from both social and individual origins. In the United States, social origins of values can be a part of the heralded American Creed, e.g., democracy, equality, and individualism (Suhay, 2008, pp. 5-6). While life, liberty, and the pursuit of happiness are unalienable rights, a person is free to exercise those rights insofar as they do not encroach upon the rights and liberties of others (U.S. National Archives and Records Administration, 2020; Page, 1921, p. 9). In addition, the more we think of our duty toward others, the better our government will be for all of us (Page, 1921, p. 12). One of society's primary duties is to socialize its individuals to ensure that they are aware of and attend to their collective responsibilities as citizens of the nation and the world (Kamens, 2019, p. 5-6). However, American society has seen an eclipse of citizenship in the late twentieth century via the larger forces of individualism and globalization, as evidenced by the decline of classic civic consciousness to induce lower levels of local volunteering, voting, local political participation, and organizational memberships. Overall, Americans have a reduced sense of solidarity and that we are all together in this journey through life (p. 7). Individualism surpassed citizenship as the key social construct of American society, and rights are more important than responsibilities (pp. 11-12).

Effect on Information Processing and Mental Models

With this modern rise in individualism, society sees an increasing fear of the state as an enemy of personal freedom and a decrease in expertise and knowledge's role in political and public affairs. Public discourse is freed from the obligation to rely on verifiable information in debates. Partisans feel justified in using fraud, lies, and

deception across media platforms to obtain their objectives (p. 17). Biased assimilation and polarization characterize this type of information processing. Individuals are unconsciously motivated to persist in their beliefs, selectively focus on evidence and arguments that reinforce their beliefs and dismiss any opposition as noncredible. As a result, individuals tend to harden their views when exposed to arguments that challenge their views, such as fact-checking (Kahan, 2012, p. 742). This challenge motivates people to seek support for their contested views through increasing biased forms of informational search. They tend to notice and recall more readily material that supports their mental model and risk perception. This constant state of culture conflict develops over so-called my-side facts and not over the greater concepts, principles, and values (p. 746). Kahan labels this as the *cultural availability effect* and describes it as follows: "People are more likely to notice risk-related contingencies congenial to their cultural predispositions, assign them significance consistent with their cultural predispositions, and recall instances of them when doing so is supportive of their cultural predispositions (p. 747)." When this concept is applied to experts, people are more likely to notice, assign significance to, and recall the expression of an expert opinion that agrees with their cultural views and be dismissive of experts who defy their mental models (p. 747). Likewise, Kahan describes the opposite effect in the *cultural credibility heuristic* as: "The tendency of individuals to impute the sorts of qualities that make an expert credible – including knowledge, honesty, and shared interest – to the people whom they perceive as sharing their values (pp. 749-750)."

Just countering misinformation by bombarding people with factual information will fail to achieve the desired effect of changing a person's or group's mental models.

This tactic will more likely provoke a cultural identity-protective backlash that will make the targeted group even more disposed to disbelieve the factual and reality-based position. For an information campaign to work, public officials need to frame the effort in a way that affirms rather than threatens the cultural identities of the skeptics. Kahan suggests not trying to convince the targeted audience to accept a solution by showing them there is a problem, but rather showing them a solution they can find culturally affirming. Then, they might be more disposed to adapt their mental model to see there really is a problem that needs certain actions to be taken (p. 753).

CHAPTER III

METHODOLOGY

Research Aim and Question

Given the lifesaving capabilities of the current COVID-19 vaccines and the risk of injury and death from COVID-19, why would one out of three Americans have yet to be vaccinated and about one in five say they will not get the vaccine (Jones, 2021)? The same people that will not get the vaccine, do without fail, use their seatbelts in their cars even though their risk of death is greater due to COVID-19 than an auto accident (Woolf et al., 2021, p. 123). Lindell's PADM (2018) fails to give a satisfactory explanation and insight into why some people would accept the completely rational choice of vaccination and other people with similar characteristics and access to the same information would make the irrational and illogical decision to reject the vaccine. PADM also cannot capture long-term crises and protective actions. Heuristic and bias theories give a potential method and explanation of how logical people can make irrational decisions. Using a person's decision to vaccinate against COVID-19 or not as a rich source of data, this endeavor will be a constructivist grounded theory (GT) investigation with the aim of formulating a substantive theory of how individuals use heuristics and biases to create mental models and make protective action decisions and judgments under uncertainty.

Research Question: Why would almost one-third of Americans make a seemingly illogical and nonrational decision to forego a COVID-19 vaccination?

Statement of the Broader Impact

A theory/model better explaining how people consume and employ information to form mental models and to make protective action decisions would help public officials improve their warning messaging to a targeted populace to achieve higher compliance with the desired protective action. Greater acceptance of warning information and observance of recommended protection actions would save lives and reduce losses in future disasters and epidemics. A more thorough understanding of how people incorporate heuristics and biases into their protective action decision-making would enable better academic research in this field.

Research Paradigm

Three interconnected, generic activities define the qualitative research process: ontology, epistemology, and methodology (Denzin & Lincoln, 2018, p. 16). Ontology theorizes about the nature of reality and how things and phenomena are made real (Bell et al., 2019, p. 26). Epistemology conjectures about what is known or what can be known and imparts an understanding of how to gain knowledge of that ontological described reality (p.18; p.29). A constructivist paradigm takes a relativist ontology with a subjectivist epistemology (Denzin & Lincoln, 2018, p. 20). This paradigm assumes people, including the researcher, construct the realities in which they participate. So multiple individuals can create and experience many different realities (p. 19). A human's knowledge and perception of the external word is never direct but mediated by their

concepts, language, and practical interests (Erickson, 2018, p. 58). This type of inquiry starts with the phenomenon and asks how people build their version of it. To the best of their ability, constructivists try to view realities from the mind of the studied individuals and to gain multiple perspectives of the researched phenomenon (Bryant & Charmaz, 2019, p. 655). Thus, a research study is a process of reconstructing those realities (Birks & Mills, 2015, p. 177). That generated data is a product of reconstructed process in which the researcher and researched coconstruct the data and is affected by both researcher and participants' positionality (Charmaz, 2008, p. 402). Constructivist investigators acknowledge that their interpretation of the studied phenomenon is itself a construction (Bryant & Charmaz, 2019, p. 655). This paradigm best fits the research aim of examining pilots' vaccination decisions from their personal reality and mental models.

This study uses an inductive-abductive research approach to create theory. By taking detailed observations and findings in an inductive process, patterns, categories, themes and concepts emerge from the bottom up to form increasingly more abstract units of information into a final generalized theory (Bell et al., 2019, p. 23; Creswell & Creswell, 2018, p. 181). Abduction logic then confirms, dismisses or modifies the newly discovered patterns, categories, themes and concepts with the freshly collected data as a part of the constant comparison process thus aiding the inductive theory conceptualization. This cycle continues until the researcher achieves most plausible theoretical interpretation of the observed data (Birks & Mills, 2015, p. 177; Bryant & Charmaz, 2019, pp. 649-650).

Grounded Theory

This investigation used constructivist grounded theory (GT) with interpretivist assumptions to formulate a substantive theory/model to explain how information consumption affects an individual's decision-making process to take a protection action (O'Connor et al., 2018; Charmaz, 2008; Glaser & Holton, 2004). Grounded theory has three major traditions. Classic GT associated with Glaser has a positivist viewpoint and aims to generate a conceptual theory that accounts for a pattern of behavior. Glaser emphasizes emergent codes, categories and ideas that come by means of studying the generated data. Strauss and Corbin's evolved GT takes a postpositivism stance and uses symbolic interactionism to explain the subjective meaning that people place on objects, behaviors or events. They stress a structured and systematic approach with a well-defined coding system. Both types of GT assume a single reality that a passive, neutral observer discovers through value-free inquiry. Charmaz's constructivist GT perspective looks to develop theory based on how people construct reality from experience and meanings. In this type of GT, people construct multiple realities while the researcher and the researched co-construct the data. Constructivist GT seeks to answer the what, how, and why of the studied phenomena. Instead of giving priority to the researcher's positions, constructionists see participants' views and voices as integral to the analysis and emphasizes their presentation. Constructivist GT adopts the methodological strategies of classic GT. All three traditions of GT have commonalities, but differences occur in approaches to the use of literature and the approach to coding, analysis and theory development. Grounded theory represents both a method of inquiry and a resultant product of that inquiry (Chun Tie et al., 2019, p.2; Charmaz, 2008).

In order to study this type of decision-making, researchers need to see the world through the eyes of the people being studied, allowing the participants to reveal their multiple perspectives of reality used to make their choices (Chowdhury, 2014, p. 433). A constructivist grounded theory approach allows for the generation of descriptive-rich information from the individual's perspective, allowing a distinctive understanding and insight into a particular phenomenon. For this case, this qualitative method is better than other more quantitative techniques because it gives a “voice” to the pilot participants and promotes our understanding of how each person arrives at their decision through their own unique words and thoughts (Samuel & Siebeneck, 2019). However, the needs of this research required a deviation from traditional grounded theory. In order to identify certain phenomena such as heuristics, biases, and misinformation and revise current warning/protective action decision models, a considerable amount of literature review needed to be accomplished prior to the start of interviews. The intent was not to confirm the existing theory but to discover and propose new or revised theory. In this regard, an informed grounded theory offered several distinct advantages. First, a survey of the current literature can indicate if the desired topic has been previously studied and that a dissertation research project will generate new knowledge that is relevant and significant instead of just repeating earlier investigations. Second, it allows a literature review in the beginning to fit standard dissertation proposal and final paper formats. Third, a review increases sensitivity and attention to details in data, thus assisting the researcher in going beyond the literature in their analysis. Fourth, it helps to define phenomenon that has been discovered to date, thus allowing the researcher to more easily identify those

phenomena and avoid conceptual and methodological issues that affected earlier researchers (Thornberg, 2012).

Participant Recruitment and Sampling

The two comparative groups will be formed; those who are vaccinated or willing to get vaccinated, and those who are not vaccinated and not willing to get vaccinated (Urquhart, 2019). For grounded theory sample sizes, Creswell and Creswell (2018) recommend 20-30 people (p.186), while Morse and Clark (2019) suggest a minimum of 10 individuals (p. 155). A maximum of 30 subjects in five rounds were planned. The first round of interviews purposefully recruited six airline pilots from the unvaccinated, vaccinated, and mandated groups to explore the similarities and differences of each group's characteristics. For the successive rounds of interviews, subjects were selected by the GT process's needs which dictated a sampling of different ethnic, foreign born and female gender backgrounds. Theoretical saturation was reached, and the sample size was reduced to 25 interviews (Beitin, 2012, p. 244).

Using airline pilots has three distinct advantageous for this research. First, pilots are a very homogenous group with personality traits and dimensions consistent across backgrounds and circumstances (Fitzgibbons et al., 2004). Even female pilots have similar characteristics to male pilots (Callister et al., 1999). American professional pilots are substantially more reserved, intelligent, emotionally stable, dominant, enthusiastic, conscientious, bold, trusting, self-assured, conservative, socially precise, and relaxed than the general population (Wakcher et al., 2003, p. 797). They also take a structural approach to problem-solving, which stresses planning, logical analysis, and attention to detail (Fitzgibbons et al., 2004). The vast majority also have the same four-year level of

college education. This uniformity helps reduce the chance of decision differences due to dissimilarities in message receiver characteristics. Second, the researchers have easy access to a pool of both vaccinated and unvaccinated pilots. Third, pilots are cheap and will do the interviews for free. Recruited pilots lived in different regions of the United States. No regional differences were noted.

A total of 25 pilots were interviewed when no new insights were being developed, and theoretical situation occurred. Subjects are employed by three major U.S. Airlines and actively fly domestic routes. The U.S. Bureau of Labor Statistics (2021) states about 93 percent of U.S. airline pilots are white (non-Latino), and about 5.3 percent are female. Minorities, females, and foreign-born individuals were oversampled for this study to explore any possible differences that these demographics might have on COVID-19 vaccination willingness, information consumption, and individualism (see Table 3). The mean age of the subjects was 49.16 years old, with an attempt to sample each five-year age category from 35-60 years old. Again, this age grouping was an effort to see if age was a factor in vaccination willingness and information consumption. About half of the pilots had military experience. Only 28 percent reported never having COVID-19 (6 of these seven were vaccinated & boosted).

Table 3

Pilot Demographics

Age	#	Ethnic Background		Education		Relationship Status	
35-39	2	White Non-Latino	84%	Masters	28%	Married	88%
40-44	5	Black	8%	Bachelors	68%	Divorced	12%
45-49	5	Latino	4%	Associates	4%		
50-54	7	Asian-Indian	4%				
55-60	6	Foreign Born	8%				

Data Collection

Semi-structured Zoom video interviews were used to collect data about the pilots' views and opinions of the COVID-19 disease and COVID-19 vaccines and how information sources affect the formation of mental models. Since the COVID-19 lockdowns, businesses, academics, and the general population have widely used and accepted the Zoom video platform. Zoom is a highly suitable and effective platform for collecting qualitative interview data. Archibald et al. (2019) found users liked its convenience, ease of use, security, interactivity, unique features (e.g., screen sharing, video record option), and the ability to facilitate personal connections between participants over some distances (p. 7). In fact, over two-thirds of participants identified Zoom as a preferred method compared to in-person interviews, telephone, or other video conferencing platforms (p. 3).

A semi-structured interview guide helped steer the investigator and the subject through the semi-structure discussions used to collect the qualitative data and explore the comparative groups. This guided method provided a loose framework of open-ended questions which aided this novice grounded theory researcher in managing the interview without stifling the discovery of immerging new themes (Morse & Clark, 2019, pp. 164-165). Directed by previous research detailed in the earlier literature review and data gleaned from publicly posted comments from people below the line (BTL) in internet-based news articles about COVID-19 and COVID-19 vaccines (Urquhart, 2019, p. 100), the researcher created a semi-structured interview guide consisting of six open-ended questions with multiple points to be covered. The idea was to allow the participants to naturally express their views on the question with as little prompting by the researcher as

possible to avoid induced bias. Only when the subject had stopped providing information on the question did the interviewer tease the remaining unanswered points from the pilot. Notes on the subject's non-verbal communication and interviewer impressions were captured in a designed section of the interview guide. This process was piloted using family, friends, and coworkers. During the study, the GT process dictated adjustments to the guide (questions and points). Zoom audio and video were recorded. The interviews lasted an average of 48 minutes, with the shortest at about 29 minutes and the longest taking about 78 minutes. *Otter.ai software Pro* version was used for audio transcription. As needed, parts of the Otter transcription were manually corrected by the researcher listening to the audio section of the recording.

Since transcription is, in essence, a translation of the interview subject to the interpretive process of the researcher, the investigator added relevant features of the subject-researcher interaction (such as non-verbal cues) to the interview guide while editing out extraneous and identifying information (Davidson, 2009, pp. 38-39). The raw data in the form of recorded audio and video files was locally stored on an AES-256 encrypted drive in a secured place per IRB subject privacy protections. After the first conceptual memo, the researcher found it easier to manually documented codings, memos, categories, relationships and data tables and managed the qualitative analysis process using MS Word and Excel than *Atlas ti*. All files were stored on the primary encrypted drive. All data was backed up on an identical encrypted drive.

Memo Writing

This pivotal step in the GT process is where researchers document their ideas and thoughts (Bryant & Charmaz, 2019, p. 657). In this study, investigators used case-based

and conceptual memos. After each interview, the researcher wrote a case-based memo reflecting on what they had learned from that interview. These memos generally contained the interviewer's impressions of the participants' experiences, the interviewer's reactions, and the examination of pre-existing concepts related to the interview discussion. At the end of each group of six interviews, a conceptual memo described the researcher's thinking on the meaning of initial codes and focused codes being developed, defining categories and emerging concepts. These four memos also detailed the comparisons between data, cases, and codes to find similarities, differences, relationships, and new questions to be answered in subsequent interviews (Sbaraini et al., 2011, p. 5).

Analysis

Constant comparative analysis was used throughout the research process with simultaneous data collection, coding, memo writing, developing and refining categories, and theoretical coding and sampling. This examination raised questions, suggested relationships, and highlighted existing data and knowledge gaps. The process started with initial (open) coding, which breaks down the raw interview data into discrete parts which reflect the ideas, events, or incidents conveyed by the participate. This phase generated as many codes as possible in the early data and identified social processes and actions. In fact, too many codes were initially created and used. The next step, focused (axial) coding, transformed basic data into more abstract concepts and categories, allowing the theory to emerge from the data. The natural pauses produced by memo writing made for an outstanding time to reflect on the interviews, codes, categories, emerging patterns, and researcher performance. The first block of six interviews saw the most change and chaos.

During this block, the interview guide and researcher interview techniques were adjusted to increase the effectiveness of the Zoom interviews. The GT process created new avenues of inquiry such as information overload and dropped dead ends like children's influence on parent's behaviors and views. The writing of the first conceptual memo drove a major overhaul of the first set of codes and categories in order to simplify coding and better align categories with the emerging patterns and data. The second set of six interviews required far less fine-tuning of the guide and interview techniques and accomplish much more exploration of emerging themes. The second conceptual memo encompassed a great amount of literature review to understand discovered notions like *digital amnesia* and *individualism*. During the third set of interviews, the researcher became more efficient and practiced and the GT process sped along like a well-oil machine. The developed categories formed around core concepts, and relationships between categories appeared and strengthened. The third conceptual memo incorporated theoretical (selective) coding to cultivate a storyline from core codes connecting the categories and documented the first embryonic theory explaining the observed phenomena. The last group of interviews reached theoretical saturation, or the point when the interrelated categories have been synthesized into an emerging theory whose concepts are well understood and can be substantiated from the collected data. No new ideas or leads were observed. Subject responses became repetitive and predictable. Pilot 25 was the last interview. Conceptual memo number four reflected the final categories and codes and summed up the research to that point. All the generated memos proved invaluable to writing the findings section. However, far more concepts were developed than needed to support the substantive theory and much pruning of the results were required to avoid

reader distraction from the core theory. What remained was a set of interrelated concepts that was expressed as a substantive theory of how individuals use heuristics and biases to create mental models and make protective action decisions and judgments under uncertainty (O'Connor et al., 2018; Chun Tie et al., 2019; Sbaraini et al., 2011; Samuel & Siebeneck, 2019).

Procedures Ensuring Research Ethics

The research was conducted per Oklahoma State University research and Institutional Review Board (IRB) guidelines. No known risks associated with this project are greater than those ordinarily encountered in daily life. All participating researches have completed and are current in the OSU CITI IRB Social, Behavioral, & Educational (SBE) Researchers training for the duration of the study. The Oklahoma State University IRB approved the study plan and the semi-structured interview guide. The IRB approved application number: IRB-22-41 on February 1, 2022. The OSU Oral Consent Script Guidelines were used to obtain the subject's informed consent. A copy of the tailored oral consent included with the interview guide was emailed to each participating subject with the required supervisor and IRB contact information. Subjects were advised that their participation in this interview was purely voluntary. They could end the interview or opt out of it at any time without reprisal or penalty. They can request that any materials associated with them be destroyed. They were free to remain silent on any topic. Subjects were asked for their permission to video and audio record each session and to use the gathered data for this study. They were advised that their responses and participation are strictly confidential and all information collected was anonymized. IP addresses were not tracked. All identifying information, raw audio, and video recordings were encrypted and

kept in a secure location. It will be destroyed no later than 12 months after the completion of this study.

Transparency and Potential Bias

All research is interpretive; as such, it is guided by the researcher's set of beliefs and feelings about the world and how it should be understood and studied (Birks & Mills, 2015, p. 9). The grounded theory method is a deeply personal research method where theory is constructed by the researcher who views the world through their particular lens (Chun Tie et al., 2019, p. 3). This researcher made decisions based on his theoretical sensitivity on how data is collected, generated, interpreted, and analyzed. This theoretical sensitivity reflected his level of insight into himself and the area he is researching and is the sum of all he has experienced, absorbed, and learned. As the grounded theorist becomes immersed in the data, his theoretical sensitivity to analytical possibilities increases (Birks & Mills, 2015, p. 12). In this case, the researcher is a senior airline captain with a major U.S. airline and a retired Lieutenant Colonel in the United States Air Force with an undergraduate degree in biology. This background helped create a connection and fostered trust with the targeted pilot group, aided in subject recruitment, and supported candidness in interview responses. Most pilots were comfortable expressing their reality and views and not just what they thought the interviewer wanted to hear. All this shared experience worked to increase the accuracy and validity of the collected data (Creswell & Creswell, 2018, p. 201). Recognizing that being a part of the pilot fraternity can cause objectivity issues, the researcher strived to remain neutral on views and generated data during the interactions with the subjects.

Additionally, in the current COVID-19 pandemic world, both the researcher and the study participants share the same fears, crises, economic concerns, public health interventions, and ever-changing information ecosphere. As such, the researcher risks participating more in the ongoing drama than a neutral observer of phenomena and unduly influencing the study. To address this and reduce bias, the researcher adopted the currently accepted medical and scientific views on COVID-19 and COVID vaccines as explained by the CDC, American Medical Association, and the National Academics of Science and Medicine. Most people with COVID-19 have mild symptoms, but some become severely ill and die. COVID-19 vaccines are safe and effective. These vaccines are the single most effective mitigation action for COVID-19 disease (Najjar-Debbiny et al., 2022, p. 6).

Creswell and Creswell (2018) define qualitative validity as using certain procedures to check the accuracy of the findings and is associated trustworthiness, authenticity, and credibility (p. 199; Bitsch, 2005, p. 77). Qualitative traditions value transparency in the reporting of data-collection and data-analytic strategies as well as communicating how the researcher's procedures and perspectives might influence the investigative process (Levitt et al., 2018, p. 29). Transparency and adherence to methodology promote a reader's confidence and trustworthiness in qualitative research studies. Transparency is aided by communicating the researcher's perspectives; in this case, a traditionally trained biologist employed a constructivist viewpoint with interpretivist and subjectivist assumptions. Presenting quotes allows readers to see and evaluate data for themselves and lends authenticity to this study (Levitt et al., 2018). The triangulated use of two independent media rating organizations with the author's

assessment imparts credibility to the study's information source evaluations (Creswell & Creswell, 2019, p. 200; Bitsch, 2005, p. 82). However, the reader does not see the memo writing and constant comparison that are hallmarks of grounded theory, but they only view the results of the process in the form of the final coding and findings write-up. Only the author's description of the methodology indicts that the process has been dutifully accomplished.

CHAPTER IV

FINDINGS

Mental Models

The pilots naturally separated into five different groups based on their protective action decisions on the COVID-19 vaccine: those who willing took the COVID-19 vaccine and the booster (Vaxxed-Boosted), two who willingly got vaccinated but will not get the booster (Vaxxed-Only), those who refuse to get vaccinated no matter what the consequences were (Anti-Vax), three who deemed receiving the vaccine was better than the consequences of not getting the government or spouse mandated shot (Mandate), and two pilots whose stance was changed by side effects of the COVID-19 vaccine or disease (Weak Anchor Point). Pilots' mental models were evaluated by assessing their information sources, comparing their descriptions of COVID-19, and analyzing their answers to interview questions. In response to a novel disease, people tended to substitute the unknown COVID-19 for the more familiar disease, influenza (*Exemplar*), as their anchor point. Our subjects used a wide range of information sources to build their mental model, which had the effect of adjusting and solidifying their anchor point. Factors such as age, race, gender, military status, education, relationship status, or number of children do not significantly influence the study pilots' mental models. Only in one case did a past COVID-19 infection of a close family member seem to influence the decision

to get vaccinated. Pilots made logical decisions to take or not to take the vaccine/booster that were consistent with their mental models of COVID-19 and COVID-19 vaccines.

Pro-COVID-19 Vaccine-Vaccinated and Boosted (Vaxxed-Boosted)

Individuals in this set view COVID-19 vaccines as lifesaving and safe and comprise 52 percent of the total interviewed group. All of these members chose mRNA vaccines. However, this group split on the use of COVID-19 vaccines for children. About half of the vaccinated pilots with young children still think the COVID-19 vaccines are too new and untested to be given to children and that COVID-19 is not a problem affecting young people. These individuals want more data on how COVID-19 and COVID-19 vaccines affect children before they are willing to vaccinate their children. This category regarded COVID-19 as much worse than the flu. These people tended to use information sources that were more neutral in political bias. They also were much more likely to discuss COVID-19 and vaccines with their personal physician.

Pro-COVID-19 Vaccine-Vaccinated only (Vaxxed-Only)

The two pilots (8 percent) willingly got the mRNA COVID-19 vaccines, but their commitment to getting the booster has waned. They believe their personal situation has changed, and getting the booster no longer makes sense. Pilot 25 and his wife received the vaccine (Pfizer and J&J, respectively) based on the recommendation of a trusted family doctor. However, they both contracted omicron COVID-19, and now he is fed up with the whole COVID thing. He doesn't think he will ever take another COVID shot and believes the whole COVID-19 situation is baloney. He seems to exhibit COVID fatigue and just wants to be done with everything COVID. The other pilot developed a medical

condition and believed the booster might add complications to his situation. These two view COVID-19 about like the flu. This group can best be characterized as booster hesitant and is considered a part of the larger vaccinated group for most of this analysis.

Weak Anchor Point (WAP)

Two individuals whose COVID-19 stance was changed by side effects of the COVID-19 vaccine or disease. Their established anchor point was not as firmly set by their information sources to prevent experiences from shifting their mental model. Initially, Pilot 11 supported COVID-19 vaccines and thought they were safe. After the second Pfizer booster, he had a minor side effect, a small lump in the lymph nodes under his booster shot arm. He then believed that mRNA vaccines are unsafe and "has somewhat wreaked havoc on my cardiovascular system." Pilot 24 genuinely has anti-vaccine leanings, with Joe Rogan and Dr. Robert Malone (noted mRNA vaccine opponent) as declared information sources. However, his wife had serious long-term COVID-19 issues. He was the only pilot to overestimate his risk of injury from COVID-19 and "thought the risks were like, for me personally, would were less to get it than that it would be without so…. it's not necessarily negative or positive [that] I am vaccinated. I got a vaccine. I did not get the booster because I ended up getting COVID." Both weak anchor point individuals rated COVID-19 slightly less impactful than the flu.

Mandate Drove Decision (Mandate)

These three pilots would not have gotten the COVID-19 vaccination except it had been mandated for them to get it. The military required two people to get the vaccine, while one (former military) was mandated by his wife to get it. All three felt COVID-19

was pretty much like the flu and not enough risk to them to get vaccinated. They did not think the vaccine was unsafe, but the consensus was that COVID-19 vaccines were not tested enough and did not have an extensive track record to prove long-term efficacy and safety. Ultimately for these individuals, the risk of the unproven COVID-19 was not worth the certainty of getting kicked out of the military or enduring the wrath of his wife.

Anti-COVID-19 Vaccine (Anti-Vax)

The anti-vaccine category comprised 24 percent of the study population. They appear to pivot away from COVID-19 as a significant threat to themselves and their family to the COVID-19 vaccine is dangerous and those who seek to impose the vaccine upon them as a threat. These pilots tended to under estimated the risk of COVID-19 death and serious injury for their age group (*Probability Neglect*) and thought they were protected due to their better health (*Overconfidence Effect*). The consensus of this group was that COVID-19 is milder than the flu and COVID-19 vaccines are unproven experimental treatments that could even be deadly. However, this group embraces ivermectin and hydroxychloroquine as effective treatments for COVID-19. They tend to distrust the known orthodoxy, which appears to be seeded and perpetuated by their selected information sources populated with highly effective misinformation. The most commonly presented misinformation points were: COVID-19 vaccines are gene therapy and therefore dangerous, the Pfizer vaccine being given is not the FDA approved version and still is experimental, and the vaccine will cause long-term harm to people. They would rather get fired from their coveted, high-paying jobs than take the COVID-19 "jab." However, these people all sought and received vaccine exemptions. Cognitive resources were allocated toward the perceived threats (COVID-19 vaccine & mandates).

Table 4

Vaccination Mental Models Coding

Quotes	Initial	Focused	Theoretical
The risks of not getting a shot were much worse than actually getting the shot. (P3)	COVID vaccines are effective; vaccinated	COVID-19 vaccines are good and willing got vaccinated	People make logical decisions on vaccination based on their mental models
I think they work. I think, especially for the vulnerable. (P10)	COVID vaccines are effective; vaccinated		
They came up with the vaccine so quickly. So that was a good thing. (Pilot 13)	COVID vaccines are good; vaccinated		
They're [vaccines] good. And it's a good tool to have in our toolbox. It's kind of dumb to not get vaccinated. (P19)	COVID vaccines are good; vaccinated		
I looked at it [COVID-19] like every other vaccine. (P23)	Just like every other vaccine we take; vaccinated		
Will not [get the booster] based on my current [health] condition. (P20)	COVID vaccines are safe; my situation changed	Willing got initial COVID vaccine, but booster no longer makes sense	
I trust my doctor, so I went and got it [initial vaccine]. [Now] I'm fed up with the whole [COVID] thing. I don't think I'll ever take another COVID shot. (P25)	COVID vaccines are safe; COVID fatigue		
Actually [the vaccines are] very dangerous. (P9)	COVID vaccines are harmful; not vaccinated	COVID-19 vaccines are bad and will not get vaccinated for any reason	
It's [mRNA vaccines] more of a gene therapy. (P16)	COVID vaccines are harmful; not vaccinated		
Spike protein weakens your body's immune response. (P17)	COVID vaccines are harmful; not vaccinated		
I think the vaccine is a complete hoax. (P21)	COVID vaccines are ineffective; not vaccinated		
I think the vaccine has some effect efficacy. They're less safe than they initially publicize them to be. It has somewhat wreaked havoc on my cardiovascular system. (P11)	Had a bad experience with vaccine; vaccinated	Experience changed my vaccine position (anchor point)	
It's not necessarily negative or positive, I am vaccinated. I did not get the booster. I got it for personal health. (P24)	Neutral on vaccine but family member had bad COVID experience; vaccinated		
I think so [COVID-19 vaccines are safe]. I wouldn't got it, but she [wife] said go get them. We got to get them. (P1)	Vaccine not bad, but not worth me getting; vaccinated	Any perceived risk posed by COVID-19 vaccines was not worth the consequences of not complying with a mandate	
I don't think that the risk of contracting COVID is high enough to get the vaccine. (P6)	Vaccine not bad, but not worth me getting; vaccinated		
I probably would not have taken the vaccine. Because I had COVID and it was mild. (P8)	Vaccine not bad, but COVID exposure protected me; vaccinated		

Information Overload

General versus COVID-19 Information

Roughly half of the pilots in this study experienced general information overload. When asked to describe the amount of total information they are exposed to daily, the average response of the subjects was slightly too much information. However, when queried about COVID-19 information, 83 percent of pilots stated they faced a substantial information overload. The ubiquitous nature of the cell phone means individuals are constantly tied to their primary portal of information and its incessant demand for attention. Since constant travel limits other reliable methods of obtaining information, pilots are especially joined to their cell phones as their primary communication and information gateway. Thus unsurprisingly, the majority of pilots experienced information overload, especially with COVID-19 information.

Information Overload Mitigation Techniques

Some pilots were more successful than others in using mitigation techniques to control the information overload environment to receive acceptable levels of information. However, most of these mitigation efforts seemed to limit consumption and acceptance of certain types of information, which appears to lead to *narrowcasting*. For example, Pilot 2 focuses on sports and local information and filters out other information and sources. Pilot 3 dumped Direct TV (multi-channel cable type feed) and just streamed through YouTube TV, where he gets to select sources (a greatly reduced amount of information). Pilot 24 unsubscribed to emails, canceled or turned off alerts, and limited the amount of

time watching TV news. However, their efforts do not seem very effective, with all three pilots reporting significant COVID-19 information overload.

Table 5
Information Overload Coding

Quotes	Initial	Focused	Theoretical
[When following friends,] start getting opinions and what they want you to see. It's not very productive. (P2)	Too much information	In the modern internet and cell phone environment, people are overloaded with information	In an information overload, people limit the amount and type of information competing for their attentions
Way too much to what's out there. (P10)	Too much information		
You're just being constantly bombarded with information. (P20)	Too much information		
Way too much, I think false and slanted information. (P21)	Too much COVID information		
You're overloaded with…that part that makes it difficult to determine whether it's accurate. (P20)	Too much COVID information		
I ignore anything with COVID in the title. (P11)	Attempts to reduce information exposure	Overload mitigation effort aim at reducing sources of information	
Silence my phone during the day so that I don't have to hear it. (P12)	Attempts to reduce information exposure		
Decided that I'm not going to pay as much attention to it as I once did. (P15)	Attempts to reduce information exposure		
I just don't turn anything on. (P17)	Attempts to reduce information exposure		
I've cut out most of the noise. It [cable and TV news] was not valuable. (P19)	Attempts to reduce information exposure		

Information Validation

Subjects seem unable to systematically determine mis/disinformation from accurate and generally accepted and vetted correct information that would be indicative of System 2 processing. Pilots appear to validate the information and sources just to the surface level consistent with System 1-type information processing. The subjects use feelings and gut impressions to determine information and source validity. They are more accepting of information sources similar to their beliefs (*Fluency*) and are more doubtful

of dissimilar material. Many pilots exhibit *confirmation bias* and *belief perseveration* to alleviate *cognitive dissonance* when faced with evidence countering their mental model. They also seem to look for and select the information that completes their story (*Associative Coherence*). Despite lacking the needed methodology, most individuals are overly confident in their ability to determine truthful information and sources from those less factually reliable ones (*Dunning–Kruger effect*). Only Pilot 12 had a systematic way of reviewing information. He used skills learned during copy writing jobs to determine which articles or stories to read and believe. This brings up the question; how can a person exercise 'informed consent' if the informed part is flawed?

Table 6

Information Validation Coding

Quotes	Initial	Focused	Theoretical
I guess just in my own head, whatever I decide, is this truthful? (P3)	No systematic method for validating information	Inability to decern factual information from misinformation	Factors affecting how people select information sources
It's kind of just a gut feeling. (P9)	No systematic method for validating information		
It just boils down to believability. (P15)	No systematic method for validating information		
If it doesn't sit well with my gut, I pretty much don't believe it. (P17)	No systematic method for validating information		
I just want the CliffsNotes. I don't spend a lot of time. (P19)	No systematic method for validating information		
Our natural tendency is when you hear things that you agree with…that confirms my biases (P22).	No systematic method for validating information		
The more enticing they [headlines] are, the less it gives me trust in your intent to share information with me. (P12)	Systematic method for validating information		

Information Sources

Shift away from Traditional News and Information Sources

In the last 20 years, people's information consumption has shifted from broadcast television, printed books, magazines, and newspapers to digital and online websites and blogs, videos, social media, and cable television/video feeds. The audience for the tradition media like local TV, radio, and newsprint was mostly bound by geographic and not ideological limitations. To capture the attention of most people in their area, these information sources had to present information with a neutral bias and in a factually true fashion to appeal to both political sides. However, many non-geographically constrained outlets found they could grab the attention of more viewers and therefore increase revenues by focusing on a particular political side or cultural view. Pilots obtain the vast majority of their information through digital sources that did not exist 20 to 30 years ago. Many view podcasts and YouTube videos. Just adopted in the last 10-15 years, smart phones have become most pilots' favorite way to access news, video, websites, channels, streaming, and other digital media forms and communicate with family and friends. Pilot 20 expresses the group's general sentiment, "Having a mobile device where everything's at your fingertips if you got time to sit around and read it makes it accessible." However, social media is not popular among the study participants, with only 4 of 25 individuals actively using Twitter; one pilot followed Joe Rogan and UFC, and another signed up for Republication and Democratic party, Congressional leader, and SCOTUS tweets for professional interests. A few others have old and infrequently accessed Facebook accounts. None used Instagram or Tik-Tok. The pro-vaccine group employed the CDC, local news, and hometown doctors for their COVID-19 information. In contrast, the anti-

vaccine group preferred ideologically-based internet national news sources like the *Epoch Times, One America News* (OAN), and the *Daily Wire* and internet doctors such as America's Frontline Doctors, Pierre Kory, Peter McCollum, Joseph Mercola, and Children's Health Defense (Robert F. Kennedy Jr).

Table 7
Traditional & Non-traditional Information Sources Coding

Quotes	Initial	Focused	Theoretical
You've developed a relationship with them [Dallas Morning News & WFAA local news]. (P2)	Tradition information sources	Greater number and newer types of information sources to select from	Factors affecting how people select information sources
YouTube and Spotify will take down the broadcast, so then you have to go to like…Rumble. (P9)	Non-tradition information sources		
A majority of those tertiary news sources, in some ways, may actually be more factual. (P11)	Non-tradition information sources		

Politization of National News and Information Sources

Both pro and anti-vaccine pilots judged that COVID-19 information was manipulated and weaponized for political and financial gains for governmental entities, media companies, political groups, and individuals. This weaponization of information has led pilots to distrust certain governmental and media organizations. People view them as trying to push an agenda or false narrative. Each camp (Vaxxed & Anti-Vax) seemed to have adopted *my side bias* and saw the other side's information as misleading, controlling, and false.

Table 8

Politization of Information Sources Coding

Quotes	Initial	Focused	Theoretical
[Governmental organizations] used COVID as a political tool to push whatever agenda they wanted to push. (P9)	Perceived politicization of COVID information	Distrust of traditional public health information sources	Trust affects how people select information sources
I don't have a lot of trust… CDC especially has bowed to politics. (P12)	Perceived politicization of COVID information		
We've gotten to the point in our society now where everything is political. There is nothing that's not. (P22)	Perceived politicization of COVID information		

COVID-19 Information

Pilots cannot accurately describe COVID-19 disease, how it affects the body, how it is transmitted through a population, the effectiveness of mitigation efforts (masks, social distancing), how COVID-19 vaccines work, and the efficacy of COVID-19 vaccines. These notions are just vague ideas with lots of inaccurate conceptions. None of the pilots had a good comprehension of R0 (the basic reproduction number/rate) of COVID-19 or how the contagiousness and transmissibility of the disease affect them or their families. Nobody understood what role viral loads play in transmission and infections or how vaccines and masks reduce viral loads projected by infected people. Several people use the term herd immunity, but they lack an understanding of the concepts behind herd immunity or how to achieve it. Based on unsubstantiated stories and rumors, many pilots determined that Federal, state, and local governmental agencies and mainstream media sources exaggerated the severity of the COVID-19 disease, overstated the magnitude of the pandemic, and inflated COVID-19 deaths to create “Fear Porn” for political and monetary reasons. Pro-vaccine people tended to trust CDC and their private doctor’s guidance without much questioning. However, the anti-vaccine group rejected governmental and CDC information and believed much more in

alternative and less tradition information sources. Many people in this group also trust the unproven and potentially hazardous COVID prevention protocol for the Front Line COVID-19 Critical Care Alliance (FLCC) and think Ivermectin and Hydroxychloroquine (HCQ) are effective COVID-19 treatments. Here too, pilots did not question the political and financial motives of the alternative information sources.

Table 9

COVID-19 Information Sources Coding

Quotes	Initial	Focused	Theoretical
If the CDC would just stop lying and admit…that it affects this [old age, high BMI] certain group of people. (P9)	Perceived manipulation of COVID information	Distrust of traditional public health information sources	Trust affects how people select information sources
In reality, the death count is probably not unlike the flu, especially in the elderly population. (P11)	Perceived manipulation of COVID information		
The numbers that we [CDC] gave you, when we were trying to push the vaccine were wrong, were inflated. (P17)	Perceived manipulation of COVID information		
My trusted source right now is my family doctor. (P22)	Trust my doctor	Trust of traditional public health information sources	
[Do you trust the CDC guidance?] Yes, because I don't know what else there is to trust. (P23)	Trust the CDC		
The government just flat out saying you have to do it doesn't seem right to me. (P3)	Lack of trust in public health authorities	Distrust of public health interventions	
I think the [mask and vaccine] mandate was seen more as a political football than it was for health. (P12)	Lack of trust in public health authorities		
Feeling about this whole entire thing [vaccine mandates and lockdowns] was it…ties into the trust issue. (P19)	Lack of trust in public health authorities		

COVID-19 Vaccine Information

While a highly educated and trained group, the pilots have little background and knowledge of how COVID-19 mRNA vaccines work. Like the rest of America, they were subjected to a great deal of misinformation about those vaccines. One common theme was that most individuals thought vaccines did not reduce the transmission of

COVID-19 through the population. These vaccines only helped prevent death and hospitalization, if they worked at all. People viewed breakthrough cases among the vaccinated as evidence that the COVID vaccine did not work or that it only prevented serious injury and did not reduce transmission. Public messaging failed to inform the population that breakthrough cases commonly happen in established and well-used vaccines like for measles and that even breakthrough cases produce less COVID-19 viral load and hence a reduction in the virus's transmissibility through the population. In the absence of accurate information in the public sphere, even pro-vaccine pilots concluded that vaccines do not reduce COVID-19 transmission through the population. Pilot 20 states a representative example of this thought: "Reduces transmission? No, because I know, people that have been vaccinated that have gotten ill."

Another theme was that those interviewed appear to have substituted more complex questions about COVID-19 vaccines to the much more simple questions of: "Are COVID-19 vaccines safe?", "Are COVID-19 vaccines effective?" and "Should I get vaccinated?". Vaccinated people deemed COVID-19 vaccines were safe enough, while anti-vaccine people believed COVID-19 vaccines were experimental and dangerous. Ultimately, the vast majority of individuals simply lack the technical understanding of COVID-19 vaccines to make an informed decision on their effectiveness and safety. They have to rely on the opinions and pronouncements of others for their decisions.

Probability Neglect and Overconfidence Effect

Individuals in our group were very poor judges of the risk of COVID-19 presented to themselves and the greater society as a whole. The probability that an average middle age person like those in the study would die from any cause is very low at

roughly about 0.4 percent (Ahmad & Cisewski, 2022). Before the development of the vaccines, the overall COVID-19 infection fatality rate (IFR) for all ages and groups ran about 0.2 percent, with COVID-19 rated the third leading cause of death for our study age group exceeding all transportation accidents. However, pilots in the anti-vaccine and the mandate groups downplayed their risk of COVID-19 death as much lower because they were much healthier than the average American (*Overconfidence Effect*). Because the risk of death to any one person is so low, the pilots had a hard time quantifying the COVID-19 risk of death and injury to other causes of death. The same pilots who refused the vaccine protection because they deemed their personal risk of death from COVID so small would also put their seatbelts on every time they drive to prevent a traffic death or injury (a much lower risk). Overall, most pilots thought COVID-19 posed a much lower risk to the general population than other causes (*Probability Neglect*) and had a hard time comprehending that a very low disease death rate can greatly impact society.

Table 10

Risk Analysis of COVID-19 Coding

Quotes	Initial	Focused	Theoretical
I'm not willing to bankrupt my child's future. For even 10 percent of the population died. (P4)	Poor risk analysis of interventions	Perceives recommend public actions as more harmful than COVID-19	Trust affects how people select information sources
I would rather get COVID, then the flu. [COVID has] a really low kill rate for humans. The best medicine so far was omicron. (P9)	Poor risk analysis of interventions		
If you do take care of yourself, the percentage chance you're at actual risk of losing your life, or a long-term illness from it is incredibly low [less than 1.0-0.5%]. (P11)	Poor risk analysis of interventions		

Digital Information Effect

In general, pilots mostly use digital media resources for their information. As a group, 76 percent of all information came in digital forms and 84 percent of all questions were explored (Googled) through an online search engine. Pilots' answers to COVID-19 and vaccine questions lacked detail and were represented more by feelings and impressions about each queried subject. This lack of detail may indicate *digital amnesia* and the *Google effect*. Individuals using digital media are more apt to forget the actual piece of information and more likely to remember where they accessed it. They only have impressions and feelings left by the original material to base decisions on when the time comes.

Information from Emergency Managers

None of the pilots could recall any COVID-19 information coming from state or local emergency management officials. Only Pilot 11 could recollect FEMA having a program that helped with the funeral expenses of people who died from COVID-19. The rest of the subjects did not remember any information from FEMA. What official government messaging the pilots did remember was about federal, state, and local mask mandates, distancing requirements, and lockdowns. Most pilots also remembered conflicting guidance from the CDC and its website. Missing from emergency management and public health officials was direction and assistance on how Federal, state, and local governments could continue to provide the everyday services that citizens need while providing a level of protection to all involved. The same type of help to business and commerce was also lacking. Pilots found the practice of lockdowns, shuttering governmental and private operations, and impositions of mask and vaccine

mandates unacceptable. Those restrictions created a distrust of governmental organizations and the information that flowed from them.

Assessing Information Sources

As detailed earlier, our information ecosystem is radically different now than it was 30 years ago. The Internet should not be considered a depository of knowledge but an information recommender system in which people seek to construct some form of shared reality (Citton, 2021, p. 49). In response to information overload, the pilots in the different vaccination groups seem to focus their attention on information sources with similar political bias and factual characteristics (*Narrowcasting*). The vaccinated group commonly seeks information from more politically neutral and more factually reliable sources. Whereas the anti-COVID-19 vaccine group tended to pursue more politically right and less factually reliable information providers. The choice of information sources appears to affect the pilots' mental model on COVID-19 and their commitment to getting COVID-19 vaccines. Ad Fontes (Otero, 2021) and Media Bias/Fact Check (2022) media ratings augmented and triangulated the researcher's subjective analysis of the factual content of the information sources used by the pilots.

Table 11

Assessing Information Sources Coding

Quotes	Initial	Focused	Theoretical
Local News WFAA (ABC), Dallas Morning News (P2)	COVID-19 information sources	Information sources used by vaccinated people	How information sources shift anchor points and affect mental models
New York Times, Wall Street Journal (P3)	COVID-19 information sources		
CDC, WHO, Google Scholar, ResearchGate (P5)	COVID-19 information sources		
Johns Hopkins, Texas and local county health department websites (P19)	COVID-19 information sources		
Local TV news. Wall Street Journal, BBC, France 24, EURO News, CDC, Private Doctor (P22)	COVID-19 information sources		
The Daily Wire, Robert F. Kennedy Jr, OAN (P4)	COVID-19 information sources	Information sources used by anti-vaccine people	
The Blaze, Breitbart, Louder with Crowder, Buck Sexton, Clay Travis, Dan Bondgino, Ben Shapiro (P9)	COVID-19 information sources		
Breitbart, Epoch Times, Newsmax, Dan Bongino, Joe Rogan, Rumble (P16)	COVID-19 information sources		
Daily Wire, Epoch Times, Children's Health Defense.org (P17)	COVID-19 information sources		
Epoch times, Locals (like Rumble), America's Frontline Doctors, Peter McCullough, Pierre Kory, Front Line COVID-19 Critical Care Alliance (P18)	COVID-19 information sources		

Mandates

In general, the vast majority of pilots were strongly against all forms of governmental mandates, whether it was a requirement to wear the mask, shutdown of business and events, or get the COVID-19 vaccine. Many viewed masks, shutdowns, and vaccines as ineffective in preventing or reducing COVID-19 transmission. Individuals perceived any Federal, state, or local agencies attempting to impose such restrictions and requirements as an unconstitutional overreach and abuse of governmental powers. The vaccine mandate had the most negative reaction, with 23 of 25 subjects interviewed flatly rejecting forcing people to get the vaccine. Additionally, to some extent, everyone in the group exhibits COVID fatigue or a reduced commitment and willingness to continue with

COVID-19 mitigation efforts. Their sentiments can be best described by Pilot 2, “Let me just try to …. get back to normal life and society as we know it,” and Pilot 10, “What's going on? For two years, and all this? It's like, move on.”

The study group seems to display a great deal of individualism or promotion of their desires above the welfare of the greater society. People with high individualism qualities are generally less interested in the needs and interests of others and emphasize individual rights over group responsibilities. They have a reduced ability to internalize the external consequences of their actions. Pilot 8 said, “If I want to risk my life driving a sports car 150 miles an hour down the highway. That's my choice.” He had no thought that this action may also cause the death of other individuals. This individualism also makes collective actions such as mass public vaccines to achieve herd immunity much more difficult. Many pilots used the same refrain, “My body, My choice.” The interviewees that have an aversion to the vaccine, mask, and social distance mandates view governmental, corporate, or societal COVID-19 mitigation efforts as the loss of freedom, personal choice, and control of their lives (*Loss Aversion*) instead of useful actions to help protect fellow citizens. This viewpoint of COVID-19 protective actions has the effect of increasing the severity of the COVID-19 crisis and hindering both the economic and medical recovery from it (Bian et al., 2022).

Vaccines Mandates

As earlier stated, the vast majority (23 of 25) of pilots erroneously think vaccines do not reduce transmission of COVID-19 though the population. This belief seems to be largely due to the failure of public health and governmental officials to counter/shutdown disinformation sources and to explain breakthrough cases as a normal and expected

occurrence even in well-established and properly functioning vaccines. Without an adequate explanation by legitimate and trusted public health sources for breakthrough cases, the mind searches for information to rationalize its observations and accepts the readily available misinformation to complete the mental model (*Associative Coherence*). In this case, the majority of pilots accepted that COVID-19 vaccines failed to work or failed to prevent transmission of COVID-19. With this in mind, why mandate vaccines when they fail to protect others from getting the disease and only protect the vaccinated person? Using this mental mode, leaving the decision up to the individual is a very logical choice for the pilots.

Pro-Mandate

The pro-mandate minority strongly believes that people have a moral responsibility to stop the spread of COVID-19 throughout America. Like during World War II, society must unite and sacrifice for the greater good. They view vaccines as reducing transmission of COVID-19 and the quickest way to recover from the health crisis. However, this group views the anti-vax group as self-centered individuals who do not care for the harm they may do to others.

Table 12

Vaccine Mandate Coding

Quotes	Initial	Focused	Theoretical
If people would just, you know, be like the greatest generation and World War Two and, take one for the team and get vaccinated. (P5)	Get vaccinated to protect the greater population	Vaccine mandates are good	People make logical decisions on vaccine mandates on their mental models
So to protect everybody, the best way to do it is everybody get vaccinated. (P14)	Get vaccinated to protect the greater population		
I believe …everyone should get it. I also believe that everybody has a right to live and, you know, say and do whatever they think is [best]. (P13)	Loss of personal freedoms	Vaccine mandates are bad	
[The vaccine mandate] kind of goes against our ability to be free thinkers and make choices for ourselves. And, that's kind of what this whole country is built on. (P17)	Loss of personal freedoms		
Vaccine mandate is an overreach… personal responsibility has to be something that is, has to be respected. (P20)	Loss of personal freedoms		

Proposed Theoretical Model: Information and Decision-Making Theory using Heuristics and Biases

People's response to an informational overload environment is to limit the amount and type of information vying for their attention. Individuals prefer to accept like-minded information, so most people will limit sources to a similar type of information in what is termed narrowcasting. An individual's mental model of a novel threat or hazard will be formed and anchored by this information flow and previous personal experience. The formed mental model is influenced by the bias and veracity of their information sources. The attention of competing information sources is either accepted or rejected based on the congruence of the new information source with the established mental model and the person's trust in the source of information. More exposure to extreme information and the lack of moderating sources will push and harden the anchor point of a person's mental model to a more extreme position. Most people lack the expertise to identify and process

factual information from misinformation to make appropriate risk analysis and protective action decisions. The least skilled in this area tend to be the most confident in their information validation and newly formed mental models. Individuals use impressions and feelings of the information (System 1) to form these mental models instead of analyzing a series of facts (System 2). People make logical action decisions and judgments based on their mental model, no matter how extreme or moderate the position is.

CHAPTER V

DISCUSSION

For people to act on warning and emergency information, people have actually to receive and accept that information. However, since the dawn of the Internet and smart phones, people have been faced with an overload of information. An avalanche of different sources and media channels compete for the individual's attention. Most people are overwhelmed by the onslaught and choose to eliminate or ignore whole areas and categories of information sources and media channels. Those information selections affect a person’s mental model. In the proposed model, warnings are treated just like any other piece of information. They may be a part of the rejected or ignored information stream and thus not reach the intended target. Any additional search for information will seek out already familiar and accepted sources and most likely reject information sources deemed untrustworthy or incongruent with their established mental model. However, the majority of decisions that people make to protect themselves are not related to emergency warnings but mitigation actions. Preventive measures are much more effective and less costly than reactive feats.

Theory/Model Comparison

The Warning Response (Mileti & Sorenson) and Protective Action Decision (Lindell & Perry) Models address individuals' responses to warnings of immediate threats and cover a short window of time. Neither address the effect of misinformation on decision-making nor the existing information overload environment. Conversely, the proposed model describes how people select and use information sources to build mental models over a longer period to make evaluations and decisions on threats, protection actions, and mitigation efforts. Those information sources can move weakly affixed anchor points in newly formed mental models to extreme positions. The new model also claims most people lack the skills to validate the integrity of their information sources and conduct an appropriate risk analysis. The older warning models state that people will seek additional information to be convinced to engage in protective actions (Mileti & Sorenson, 1990, p. 5-9). The new model indicates that people will seek additional information to support their current course of action and mental model. The old theories foresee that the public will perceive warning messages to be convincing and reasonable if they are specific, consistent, accurate, certain, and clear as to the location of the area of risk, guidance about what the public should do, the character of the hazard, and the amount of time until its impact (p. 5-10). The proposed new model predicts warning messages will be considered convincing and reasonable if they come from trusted sources and are congruent with an individual's mental model. The PADM uses a complex multistage model with several decision points. Multiple mental models result in four responses: terminate the process (no action needed), a search for more information, a protective response (problem-focused coping), or an emotion-focused coping method

(denial or panic) (Lindell & Perry, 2012). PDAM is characteristic of System 2 processing with detailed analysis and complex questions requiring cognitive effort. The proposed new theory postulates that people use System 1 cognitive processes to form a single, unified mental model to explain the situation and simplify protective decisions to "Am I safe or not?", "Do I need to get the vaccine or not?" and "Is the vaccine safe?". The use of gist (bottom-line meaning like "Vaccination is the best way to protect your child") is more effective than listing statistical information and fact-based evidence in patient-healthcare provider communications of vaccine safety and efficacy (Broniatowski et al., 2016). Lindell (2014a) seems not to support the dual-system of cognition as outlined in this paper (p. 19), while Mileti (1999) later modified his position by saying that people used flawed cognitive heuristics to reach decisions on protective actions (p. 137).

Misinformation in the Public Sphere

As this study highlighted, most people now use the Internet as the primary source to answer their questions and get their information. An estimated 80 percent of Internet users search for health information online (Kata, 2012, p. 3779). COVID-19 and vaccines are no exception. In this respect, high-quality information competes with equally available misinformation that is often difficult to identify (Betsch & Sachse, 2012). However, this coexistence tends to give it some sense of legitimacy, and the more something appears, the more willing our minds are to accept that piece of information (*Fluency, Illusory Truth Effect*). As with the subject pilots, most people lack the skills needed to determine misinformation from legitimate content on subjects where they have little expertise. Many items of misinformation are highly sophisticated and are created to look like genuine scientific papers. Other times carefully examined evidence is placed

next to the opinions of anti-vaccine crusaders, critics, and conspiracy theorists, thus defusing messages from qualified experts. Evidence-based views from genuine vaccine experts become just another opinion among many self-proclaimed "experts" with the notion that multiple "truths" based on different worldviews are equally valid. In this postmodern society, everyone is an expert whose wacky ideas must be respected (Kata, 2012, p. 3779). A key component of a successful risk analysis is the ability to identify and select appropriate expert opinions and accurate facts.

According to the proposed theory, an effective method for reducing misinformation's influence on people's mental models would be to limit or eliminate its availability to people. Two major contributors to vaccine misinformation are individuals pursing profit and power and state actors promoting discord and distrust. According to the Center for Countering Digital Hate (CCDH) (2021), 65 percent of anti-vaccine content on Facebook and Twitter is attributable to dozen individuals who still have active social media accounts and websites (p. 10). Many are medical professionals, and all are hawking alternative COVID-19 treatments. State actors like Russia use disinformation campaigns to sow distrust of social institutions and promote discord among the American population to further their national political goals. Russian bots, cybogs, and trolls actively manipulate online public health discourse to skew discussions to promote antivaccination messages in an on-going antivaccine effort. They frequently retweet or modify content from human users; thus, well-meaning posts containing pro-vaccine content may have the unintended effect of "feeding the trolls" (Broniatowski et al., 2018, p. 1813). The effect of this misinformation is that those willing to take COVID-19 vaccines are lowered by 6.4 percent in the United States (Loomba et al., 2021, p. 340). A

rise in nonmedical exemptions for childhood vaccines lead to the 2014-2015 Anaheim, California measles outbreak (Olive et al., 2018). A major increase of excess death rates among Republicans after COVID-19 vaccines became widely available resulted in Republicans dying at a rate of that is 153 percent greater than Democrats (Wallace et al., 2022). A major issue is that Internet hosting services are not good at identifying and removing vaccine and COVID-19 misinformation (if they desire it at all). However, they cannot be held accountable for their failure to do so. Section 230 of Communications Decency Act of 1996 (47 U.S.C. § 230) provides certain immunities for Internet-based technology companies. They shall not "be treated as the publisher or speaker of any information provided by another information content provider." Thus Section 230 effectively exempts Internet social media and networking services from liability under laws that normally apply to publishers, authors, and speakers (National Academies of Sciences, Engineering, and Medicine, 2021). Congress needs to amend Section 230 to allow social media and networking services to be held liable and accountable for the harm caused by medical misinformation hosted on their websites and digital media.

Implications for Emergency Management

In earlier times, emergency managers and governmental officials could take for granted that disseminated warning messages and information would grab the target audience's attention. However, many study participants use non-traditional means of information sources (web-based sources versus local newsprint and broadcast media). Combining this with many pilots who distrust the same organizations creating and issuing the information, warning communications most likely will not capture the attention of the individuals in today's information-overloaded society. Even if the information happens to

be viewed through an accepted third-party news source, the message may be filtered and distorted and not have the desired effect on the targeted person. In this study, very few pilots could recall any messaging and information from the state, county, and local public health and emergency managers during the past two years of the COVID-19 pandemic. By this measure, local public health messaging was a failure. Public officials must change with the times and analyze public information patterns then engage individuals on platforms and medias that they actually use. Just providing more total information will not change attitudes. The message must be tailored in a culturally affirming way that supplements instead challenges a person's mental model to shift that anchor point.

Across the United States, Federal, state, and local officials didn't speak with a unified voice and message. As a result, citizens faced a patch work of conflicting guidance and restrictions. Local and state public health officers were not effective in communicating the rational for interventions or frame the discussion as enhancing COVID-19 protection for society. Instead, people viewed such measures as a loss of personal freedom and destruction of their livelihood (*Loss Aversion*) rather than temporary measures to reduce loss of life. To be successful, risk communication must include community engagement and be responsive to public needs (Fischhoff et al., 2022, p. 6). However, public health, emergency management, and political figures didn't effectively engage community leaders and stakeholders in the business, religious, and minority communities.

Consequently, people lost trust in public health and emergency management apparatuses, and officials were personally attacked in many cases. Public health and emergency managers began to withdraw from engaging with the public (Resnick, 2022).

Many politicians, emergency managers, and first responders, like the pilots in this study, lack a basic understanding of the dynamics of pandemics, viruses, vaccines, and mitigation strategies. This leaves them vulnerable to misinformation, negatively affecting support for mitigation efforts and public messaging.

Pre-crises education is an effective way to influence mental models on vaccines. Throughout different times and grades in public schools, health and science classes must include education on pandemics/epidemics, disease transmission, mitigation procedures, and vaccines. Locally, public health and emergency management officials need to conduct community involvement activities and public education projects targeting stakeholders and community leaders in business, minority, religious, and special needs segments of their population to increase trust and raise awareness of epidemic mitigation efforts, disease transmission, and vaccine effectiveness. Dallas County in Texas provided an excellent example of an emergency manager's successful role as incident commander (IC) in a public health crisis during a 2012 outbreak of West Nile disease and again in 2014 with emergence of an Ebola infected person, Thomas Eric Duncan (Lundberg, 2016). However, for COVID-19, emergency managers across America were mainly pushed to the sidelines by public health and political officials. Finally, the emergency management community must reexamine and define its role in pandemic/epidemics, disease prevention, and mitigation at both the practitioner and academic levels. Using an often-repeated old refrain, "the body cannot go where the mind has not been," classes in an epidemic/pandemic response and mitigation should be added to undergraduate and graduate emergency management programs.

Limitations

A substantive theory is an abstract of time, place, and people (Glaser, 2012, p. 3). As such, this nascent theory has only been explored in the United States during the COVID-19 pandemic of 2020-2022 with airline pilots looking at their decision to vaccinate or not. Other more inclusive investigations using broader and more diverse populations, different types of hazards, and information need to be accomplished to shape and develop this concept into a formal theory.

Future Research

A formal, more comprehensive grounded theory is generated using comparative conceptual analysis of different substantive areas to modify and broaden the scope of the original theory. Thus, the new substantive theory needs to be explored and modified using a larger, much more diverse demographic sample size. Possibly a structural equation modeling (SEM) based study to refine the newly created substantive theory using IBM's SPSS Amos. SEM allows for the simultaneous estimation of multiple interrelated dependence relationships and the ability to represent unobserved concepts in those relationships. The actual construction of the SEM model will depend on the final form of the substantive theory to be tested; however, for planning purposes, about five to seven constructs will be anticipated, with an average of four variables per construct (Hair Jr. et al., 2019, Chapter 9). A survey of about 35 questions and 10 minutes in length should be able the measure 20-28 variables needed. Demographic information, including political and religious preferences, will also be sampled. A Likert scale or a sliding bar rating scale will capture the subject's answers to variable questions. Depending on costs, the researchers are looking at sampling 1,000 subjects using Lucid Marketplace or the

MTURK survey platform. Later studies must branch out and examine the substantive theory using hazards other than human diseases, like prolonged blackout preparations or tornado protective actions.

CHAPTER VI

CONCLUSION

COVID-19 rapidly spread through the world in 2020 and became a pandemic that killed hundreds of thousands of people in the United States. For those age 45 and older, COVID-19 became the third leading cause of death in America and ranked ahead of transportation accidents. In December 2020, the first COVID-19 vaccines were authorized and highly effective with few side effects. Yet, many of the population passed on getting these outstanding and lifesaving vaccines. Included in that group were many pilots who risked losing their job over refusing to get vaccinated. That raised the question that started this research project, "Why would rational pilots make a seemly irrational decision not to get vaccinated against COVID-19?"

Given that pilots are a very homogenous group, the Warning Response and Protective Action Decision Models failed to explain why pilots with highly similar receiver characteristics should make radically different decisions when exposed to the same basic information. This researcher chose an informed, constructivist grounded theory interpretivist and subjectivist assumptions to examine the cognitive processes and formulate a substantive theory. The study recruited 25 airline pilots from 3 different major U.S. carriers for Zoom interviews using a semi-structured interview with a guide.

Analysis of the interviews found that information overload and information source selection played a large part of people's mental model formation. Pilots lack the skills to successfully validate information sources' truthfulness and use System 1-type heuristic cognitive processing to determine their trust in information sources. Individuals also used other heuristics such as fluency, associative coherence, substitution, anchoring, and adjustment. Narrowcasting, selective attention, and confirmation bias appeared to guide many pilots to highly biased and less factually reliable sources. The disinformation from these sites seemed to highly influence the pilots' mental models and decision not to vaccinate.

Additionally, misinformation and lack of explanation for breakthrough cases influence people's views on vaccine mandates. The developed substantive theory explains the role of information and misinformation on mental models and protective action decisions. For emergency management, the theory can be instructive of the roles of information, disinformation, and messaging in mental model building and adoption of desired protective actions. However, this proposed theory needs to be more broadly researched, evaluated, and modified.

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APPENDICES

Appendix A - Heuristics and Biases Definitions

Affect Heuristic

This heuristic describes when people let their likes and dislikes help determine their beliefs about the world. In accessing risk, an inverse relationship between perceived risk and perceived benefit of an activity (such as a vaccine) is linked to the strength of positive or negative affect associated with that endeavor. People base their risk judgments on what they think about an activity or a technology but also on how they feel about it. A liked activity is perceived to have low risk and high benefits while a disliked technology as high risks and low benefits. In many situations, people unconsciously form opinions and make choices that directly express their feelings. A person substitutes the answer to an easy question (How do I feel about it?) for an answer to a much harder question (What do I think about it?) (Kahneman, 2011; Slovic et al., 2007).

Anchoring and Adjustment

This judgmental heuristic occurs when people consider a particular value for an unknown quantity or position as a starting point before appraising that quantity or position. The starting point can be supplied to a person or can be a result of an incomplete analysis. Subsequent estimates stay close to the original number or position that people considered hence the image of an anchor. The reflective System 2, responsible for

adjustment, requires significant cognitive effort and many times mind lacks the resources (distracted, tried or overtasked) or will (people stop when they are no longer certain that they should move farther) to keep System 2 activated to further move the anchor reference point.

In a classic experiment by Tversky and Kahneman (1974), subjects were asked to estimate the number of African countries in the United Nations by first indicating whether an arbitrary number derived by a spinning a wheel of fortune was too high or too low and then estimating the actual number. People who began from a low suggested number of 10 gave a median estimate of 25 (too low) while those who began with a high figure like 65 gave a median estimate of 45 (too high). Using payoffs for accuracy did not diminish the anchoring effect (Colman, 2015; Kahneman, 2011; Thaler & Sunstein, 2009; Tversky & Kahneman, 1974).

Associative Coherence

The method by which humans form most of our judgments. Our mind takes present information and stimulus and tries to link or associate it with stored, past memories in an attempt to make sense of the current situation and produce a coherent mental model (story). The important part for the mind is how the pieces fit together as a story and not quantity (adequacy) and quality (correctness) of information. When data pieces are not associated, the mind will, consciously or unconsciously, continued to try to find a link between two unrelated items thus using more cognitive resources and degrading mental performance. As a result, System 1 is geared to create an acceptable and internally consistent interpretation of the present situation (story) as soon as possible

and to jump to conclusions based on the coherence of that story. The activation of compatible associations is a primary mechanism of both anchoring and framing effects. A new stimulus can evoke a coherent and self-reinforcing pattern of activation (a confirmatory bias) in the associative memory by reinforcing the current links between information (right or wrong). Examination of the mental model increases the accessibility of story consistent information. An example is the level of benefit verses risk that people attributed to the technologies. When people view a technology favorably, they rate it as offering large benefits and imposing little risk. When individuals disliked a technology, they can think only of its drawbacks while few advantages come to mind (Afiki & Bar, 2020; Kahneman, 2011; Morewedge & Kahneman, 2010).

Attentional Bias

A person selectively attends to a certain category or certain categories of stimuli in the environment with enhanced saliency or relevance (such as a threat) for that individual while tending to overlook, ignore, or disregard other kinds of more neutral stimuli. Key subcomponents include initial orienting and maintenance stages of information processing (Drobes et al., 2019, p. 145; Fadardi et al., 2016, p. 78).

Attributional Bias

A systematic misrepresentation of the causes someone's behavior. The propensity to attribute one person's behavior to internal motives and characteristics rather than external factors and situational causes if the action is perceived different from how other people would act in the same situation but consistent with that person's past behavior. However, if said behavior seems similar to what others would do in the same situation

but unusual of that person's past conduct, then the actions are attributed to external causes. Important attributional biases are the actor–observer difference, base-rate fallacy, fundamental attribution error, positivity bias, and self-serving bias (Colman, 2015).

Availability

This heuristic is the process of judging frequency or probability of an event by the ease with which instances come to mind. Availability is useful in assessing frequency or probability, because instances of large classes are usually recalled better and faster than examples of infrequent groups. However, it can generate biased or incorrect judgements (Kahneman, 2011; Tversky & Kahneman, 1974). An example of this is when people are asked whether the English language contains more words beginning with the letter k or more words with k as the third letter. Cases of words beginning with k are more easily recalled and therefore a person concludes that there are more words beginning with k. However, a typical long text contains twice as many words with k as the third letter (Colman, 2015).

Biased assessments of risk can perversely influence how we prepare for and respond to crises. Vivid and easily imagined threats (tornadoes) often get inflated estimates of probability while more mundane causes of death (asthma attacks) receive low estimates, even if they occur with a far greater frequency (twenty times more for asthma attacks). More recent events have a greater impact than earlier ones (Thaler & Sunstein, 2009, p. 25). Traditional and social media coverage and feeds are geared toward novelty and poignancy. The mental model of the world that we create is not a precise replica of reality. Our perceptions about the frequency and importance of events are distorted by the prevalence and emotional intensity of the messages that we are

exposed to. This false sense of importance may initiate a self-sustaining chain of events (availability cascade) which may originate from emotional media reports of a minor event amplified into public panic and large-scale government action (Kahneman, 2011).

Base-Rate Fallacy

A person fails to account for the base rate or prior probability of an event when subjectively judging its conditional probability. Tversky and Kahneman (1974) demonstrated that people's judgements as to whether a student (Dick) who was described in a personality sketch was more likely to be a student of engineering or of law tended to ignore the crucial piece of data that the student was drawn randomly from a group of 70 engineering students and 30 law students or from a group of 30 engineering students and 70 law students. The subjects deemed the probability of Dick being an engineer to be 50 percent regardless of which was presented. Being insensitive to prior probabilities, the representativeness heuristic best explains this bias.

The human mind treats statistical and causal base rate information differently. Statistical base rates are generally undervalued or altogether neglected while causal (more descriptive and vivid) base rates are treated as information about the individual case. Causal evidence is easily combined with other case-specific information as the mind attempts to create a model or story of the events. The causal version of the cab problem resulted in a stereotype. Green cabs are involved in 85 percent of accidents therefore green drivers are dangerous. Stereotypes are statements about the group that are accepted as facts about every member (Colman, 2015; Kahneman 2011).

Belief Bias

A reasoning error that happens when a person has difficulty evaluating conclusions that conflict with what they know about the real world. It is often evaluated with syllogistic reasoning tasks in which the believability of the conclusion conflicts with logical validity (Stanovich, 2021, p. 6)

Belief Perseverance

The tendency or desire to retain a belief in the face of evidence that is inconsistent with, contradictory to, or total discredits that belief (Reisberg, 2013).

Causal Schema

A mental model of a sequence of events in which some are identified as causes and others as effects. Causal data is the perceived cause of the events of interest while diagnostic data is the result of said events. Incidental data is seen as neither a cause nor consequence of the events. Prior causal information has in import role in how people form judgments. Individuals will not use base-rate information in an inference that conflicts with other beliefs (Colman, 2015; Kahneman, 2011).

Cognitive Dissonance

Cognitive dissonance occurs when people believe that two of their psychological representations or cognitions are inconsistent with each other and this inconsistency creates uncomfortable mental tension. A cognition is any ‘piece of knowledge’ a person may have whether it is knowledge of a behavior, one's attitude, or about the state of the world. A pair of cognitions is said to be inconsistent if one cognition follows from the

obverse (opposite) of the other. For example, if a person holds cognitions A and B such that A follows from the opposite of B, then A and B are dissonant.

Cognitions can either be relevant or irrelevant and only when two or more relevant are in conflict does a person experience the uncomfortable, unpleasant state of cognitive dissonance. This tension drives people to find some way of resolving their mental inconsistencies. Humans use three kinds of behavior to reduce dissonance: changing one of the cognitions, decreasing the perceived importance or validity of dissonant cognitions, and/or adding further supportive (justifying) cognitions (Colman, 2015; Cooper, 2007).

Cognitive Miserliness

The inherent and evolutionary tendency for humans and other biological organisms to minimize their cognitive demand, avoid additional cognitive effort, and conserve energy (Kang, 2022, p.1).

Confirmation Bias

The human tendency to test or support one's beliefs or conjectures by seeking evidence that might confirm them and ignoring information that might disprove them. This bias helps to maintain prejudices and stereotypes and usually occurs automatically, without explicit intent to do so. A method to deal with cognitive dissonance (Colman, 2015; Morewedge & Kahneman, 2010).

Conjunction Fallacy

A widespread error that people commit when they access a conjunction of two events (Linda is a bank teller and feminist) to be more probable than just one of the events (Linda is a bank teller) in a direct evaluation. The classic example from Kahneman and Tversky has undergraduate students given personality sketches of a hypothetical person called Linda (young, single, deeply concerned about social issues, and involved in anti-nuclear activity). They are then asked the likelihood that Linda is (a) a bank teller, or (b) a bank teller who is active in the feminist movement. A whopping 86 percent of the students judged (b. bank teller and feminist) to be more probable than (a. bank teller). This decision is erroneous since is an elementary principle of probability theory dictates that the probability of the conjunction A and B can never exceed the probability of A or the probability of B. The representativeness heuristic is at work due to Linda seems more typical of a feminist bank teller than of a bank teller (Colman, 2015; Kahneman, 2011).

Cultural Credibility Heuristic

When an informational source or expert shares the same cultural predispositions, related values, or similar positions of an individual or group, they have tendency to ascribe the positive qualities that make an expert or informational source seem credible to include knowledge, honesty, and trustworthiness. However, if a source or person has a differing viewpoint, people have a propensity to impart negative traits to their opposition (Kahan, 2012, pp. 749-750).

Digital Amnesia

The experience of forgetting information that a person trusts a digital device or medium to store and remember for them. In this process, the human brain is outsourcing the information storage and thereby saving cognitive resources. Similar to the Google effect (Kaspersky Lab, 2016, p. 4).

Dunning–Kruger Effect

When people lack skill or knowledge, they tend to greatly overestimate their expertise or ability and are oblivious to their deficiencies. The lower the skill or knowledge level is, the greater the overconfidence is. Additionally, these low-achievers are less capable of rating and comparing peers' performances. This tendency of the average person to believe they are above average defies the logic of descriptive statistics. However, those who are incompetent have little insight into their own incompetence and are unaware of the extent of their ignorance because they lack the needed metacognitive skills. This meta-ignorance appears to people in everyday life. Related to overconfidence effect (Kruger & Dunning, 1999; Dunning, 2011; Krueger & Mueller, 2002).

The Dunning-Kruger effect seems to also apply to on line searches. When people "Google" for online information, they are more confident in their own ability to think and remember information that they falsely attribute to their prior knowledge. Moreover, these people predict they will have greater knowledge on the Googled subject in the future without the help of the internet. This misattribution of online knowledge to the one's self may be facilitated by the swift and seamless interface between internal thought and external information that occurs during online searches. Online searches are faster

than a person's internal memory search, thus preventing people from fully realizing the limitations of their own knowledge and cognition (Ward, 2021). Also, see Google effect.

Egocentrism / Egocentric Bias

A person overestimating the degree to which their perception of the world (mental model) is accurate and the extent that others share their vision of the world. Also known as self-centeredness, this unconscious personal bias entails a failure to differentiate subjective from objective aspects of experience. A person only sees the world from their own point of view and genuinely is unaware that other people's views differ from its own (Colman, 2015; Morewedge & Kahneman, 2010).

Elimination by Aspects

Multi-attribute decision making by which a choice is reached through a repeated series of eliminations. At each point, the decision maker selects an attribute (aspect) that is most important to them at the time and eliminates all alternatives lacking that attribute. The person repeats the selection process until all but one of the alternatives have been eliminated (Colman, 2015).

An example of this is a person looking for a home first decides what aspect is most important (commuting distance), and establishes a cutoff level (less than a 30-minute commute). Then, all alternatives that are greater than 30 minutes are eliminated. The process is repeated, attribute by attribute (no more than $2,000 per month; at least two bathrooms; cats permitted), until a choice is made or the surviving group is small enough for a compensatory evaluation of the finalists. When people are using this

method, alternatives that do not meet the minimum cutoff scores may be eliminated even if they are marvelous on all other characteristics (Thaler & Sunstein, 2009, p. 97).

Endowment Effect

The tendency to demand much more to give up an object than one is willing to pay to acquire it. In a representative experiment, participants were supplied either a lottery ticket, mugs or pens. Sometime later, each subject was offered the opportunity to trade the item for money, or vice versa. Most people preferred to keep the item they were endowed with. In the few instances when exchanges occurred, the median selling prices were about twice as much as the median buying prices and trading volume was less than half of what was expected. This price difference demonstrated endowment because buying prices are significantly lower than selling prices when it is more painful to give up a possession than it is pleasurable to obtain it. This phenomenon is closely related to loss aversion and demonstrations that preferences must be understood in relation to status quo reference points (Colman, 2015; Kahneman & Tversky, 1984; Kahneman et al., 1991)

Framing Effect

How alterations in the description, labelling, or presentation of the same problem can elicit different responses and evoke different emotions. People are normally unaware of this effect and how alternative frames influence the relative attractiveness of available options. The classic Tversky and Kahneman (1981) example is when subjects had to choose between two programs for combating an unusual disease that was anticipated to kill 600 people. One group was told that program A would save 200 lives, whereas program B had a one-third probability of saving 600 lives and a two-thirds probability of

saving no one. This presentation focused on gains and 72 percent of the people preferred A to B. In the second group, members were told that in program C 400 people would die while in program D there was a one-third probability that no one would die and a two-thirds probability that 600 would die. This representation focused on losses and 78 percent of the subjects preferred D to C. The majority of participants were risk-averse in their preference of A over B in the gain frame but risk-seeking in their preference of D over C in the loss frame, even though the two presentations were just different ways of describing the same problem. Equivalent results also happen when both situations are presented to the same group of subjects (Colman, 2015; Tversky & Kahneman, 1981). Even experts succumb to the effects of framing. When medical doctors are informed of the results of a procedure is that "ninety of one hundred are alive," they are more likely to recommend the operation than if told that "ten of one hundred are dead (Thaler & Sunstein, 2009, p. 36)." The emotion effect of framing can be demonstrated by the gain example that "the odds of survival one month after surgery are 90%" is much more reassuring than the equivalent loss statement that "mortality within one month of surgery is 10%." Similarly, meats described as "90% fat-free" are more attractive than when they are described as "10% fat (Kahneman, 2011, p. 87)."

Fluency (Cognitive Ease) Heuristic

The technical term for cognitive ease is fluency (Kahneman, 2011, p. 454). This sense of fluency or cognitive ease leads to illusions of truth, pleasant feelings, and reduced vigilance (p. 106). An importance of an idea or judgment of a probability of a particular situation is often determined by the fluency that the idea or scenario came to mind. A state of cognitive ease is generally characterized by a good mood, believing in

what you see and hear, trusting your intuitions, and feeling comfortable with the current situation. Thinking is relatively casual and superficial. A person in this state is primarily using System 1. However, a high level of effort and the presence of unmet demands creates cognitive strain in a person. In this state, individuals are more likely to be vigilant and suspicious, invest more effort in tasks, feel less comfortable, and make fewer errors. But, they will be less intuitive and less creative than usual (pp. 59-60). This System 2 thinking is more likely to reject the intuitive answer suggested by System 1 (p. 65).

The impression of familiarity or perceiving that a person has seen something before decreases cognitive strain and increases fluency. Frequent repetition breeds familiarity, which is comforting to an individual (p. 66). Therefore, cognitive ease becomes both a cause and a consequence of a pleasant feeling (p. 69). Because familiarity is not easily distinguished from the truth, repetition is a reliable way to make people believe in falsehoods. Repetition of an entire phrase is not necessary, just repeating a few words of a phase is enough to trigger familiarity and fluency and for people to believe the misinformation to be true (pp. 61-63). People's confidence in a belief is related to both cognitive ease and coherence that their mind adopts the story. When both happen, a person accepts that statement as true and that adopted story becomes easily recalled in their mind with no contradiction and no competing scenario (p. 87; p. 239).

Google Effect

When a person has easy and readily available access to digital information, they are less likely to memorize the particular piece of information and are more apt to retain how they searched for and where they accessed that information (Sparrow et al., 2011; Kang, 2022).

Halo Effect

A generalization from the perception of one prominent or salient characteristic, trait, or personality attribute resulting in inflated correlations between the rated trait and an overvaluation or devaluation of the personality as a whole. This bias leads to a tendency to like (or dislike) everything about a person including things you have not observed. The halo effect increases the weight of first impressions at the expense of subsequent information. Can also led to the exaggerated faith in researches, doctors, experts or prominent public figures (Colman, 2015; Kahneman, 2011).

Hindsight Bias

The tendency for people who know that a particular event has occurred to overestimate in hindsight the probability with which they would have correctly predicted the future event (I knew it all along). The human mind cannot reliably reconstruct past states of knowledge, or beliefs that have changed so a person's recall of past predictions is biased towards what had actually occurred. An individual's mind retrieves the current position (an instance of substitution) instead of the past one and many cannot believe that they ever felt any differently. People justify this new position to themselves by perceiving information supporting this outcome as more relevant than other information (Colman, 2015; Kahneman, 2011).

If/Only Bias

This occurs when people to have differential responses to outcomes based on the differences in counterfactual alternative outcomes that might have occurred. For example, subjects will rate a decision leading to a negative outcome as worse than a control

condition and will view the same choice as good when a positive outcome occurs (Stanovich & West, 2000, p. 647).

Loss Aversion

The observation that a loss generally has a greater subjective effect than an equivalent gain on a person's decision-making process. Changes that make things worse are generally viewed as losses and loom larger than improvements or gains. Not all transactions have this effect. In normal, everyday commercial transactions, a seller does not suffer a loss when trading a good and a buyer does not view the money spent as a loss. Loss aversion primarily affects owners of items obtained and kept for use and pleasure rather than for eventual resale.

Differences between buying and selling prices are much too large to be explained by garden-variety loss aversion and involve a moral perspective in cost benefit analyses. These extreme responses can be seen in the feelings of outrage when communities are faced with the prospect of accepting a new risk such as a nuclear power plant or waste disposal facility. Offers of reasonable compensation are typically perceived as bribes and people demand very large or infinite amount of reparation for the perceived loss of their pristine homes or livelihood (Colman, 2015; Kahneman et al., 1991).

Mere-Measurement Effect

The tendency when people are asked what they intend to do, they become more likely to act in accordance with their responses. For example, a person is asked about their intent to exercise, their answers seem influence their behavior to exercise. This inspiration may be explained by when the subject's intentions are measured after

participants elaborated on their viewpoint, their mindset becomes more accessible and their choices more consistent with their attitudes. This effect can be an effective nudge (Morwitz & Fitzsimons, 2004; Thaler & Sunstein, 2009, p. 71).

Myside Bias

This bias happens when people evaluate evidence, generate data, and test hypotheses in a manner biased toward their own prior beliefs, opinions, and attitudes. These beliefs need to be held with high conviction and have emotional commitment and ego preoccupation. While they have greater cognitive elaboration, the views are distal beliefs which cannot be directly verified by experience, nor easily confirmed by experts or scientific consensus (Stanovich, 2021, p. 8; Stanovich et al., 2013, p. 260).

Non-Regressiveness Bias

The propensity for a person to make insufficient adjustment for regression towards the mean when predicting outcomes based on an imperfectly reliable predictor. The individual is highly confident in their intuitive judgments even when that judgement is based on non-regressive assessments of weak evidence. System 1 cannot adjust for smaller weaknesses in the evidence. As a result, intuitive predictions are insensitive to the actual predictive quality of the evidence (Colman, 2015; Kahneman, 2011)

Overconfidence Effect

Exemplified by one who has unwarranted or excessive faith in the correctness of their judgements or beliefs (Colman, 2015). This overconfidence depends on the quality of the story a person can create about how they perceive the situation (mental model). However, they often fail to account for the possibility that evidence critical to the

judgment can be missing. In addition, the associative system tends to build on a coherent pattern of activation and suppresses doubt and ambiguity (Kahneman, 2011).

When people overestimate their personal immunity from harm, they are at great risk for not taking sensible and timely protective actions. Students often reply when asked about their future that they are far less likely than their classmates to be fired from a job, to have a heart attack, to get cancer, or to be divorced after a few years of marriage. Older people also underestimate the probability that they will be in a car accident or suffer major diseases. Most smokers believe that they are less likely to be diagnosed with lung cancer and heart disease than nonsmokers even though they know the statistical risks. Hopeful people keep state lotteries successful partly because of unrealistic optimism. This "above average" effect is pervasive. Ninety percent of all drivers think they have above average skills (Thaler & Sunstein, 2009).

A person's confidence in a belief is related to two impressions: cognitive ease and coherence. We have high confidence in our story when it comes easily to our mind, with no contradiction and no competing scenario. But, this confidence does not guarantee that a belief is true. No relationship exists between a person's confidence level and the correctness of their mental concept. The human mind's associative machine suppresses doubt and evoke ideas and information that supports the current dominant story and ignores items that do not. Notably, the confidence that people have in their intuitions and gut feelings is not a reliable guide to their validity (Kahneman, 2011).

Outcome Bias

A judgement with a positive outcome is rated superior to a decision with a negative result even when the information available to the decision maker was the same (Stanovich & West, 2000, p. 647).

Planning Fallacy

The systematic tendency toward unrealistic optimism about the time, money and effort it takes to complete projects. Project leaders view the world as simpler and kinder than it really is, their own attributes as more advantageous to the project than they truly are, and the goals as more achievable than they are likely to be. This mental model leads to an exaggerated view of their ability to forecast the future and nurtures optimistic overconfidence. While this situation frequently happens in construction projects and major land developments, it also occurs in products like the Boeing 787 Dreamliner (using cost-saving sub-contractors resulted in larger cost overruns and product delays) and military operations, such as Operation Market Garden (a bridge to far). When plans and forecasts are unrealistically close to best-case scenarios, estimates can be improved by looking at the performance of similar cases (Kahneman, 2011, p. 250; Thaler & Sunstein, 2009, p. 7).

Prefactual thinking

Imagining how a falsehood might become true in the future makes the broader meaning that the untruth (gist) conveys seem more truthful. Therefore, the perceived verity of gist or essence of the information seems to overshadow the false impression of the incorrect details and primes a person to more likely accept and spread the

misinformation. This effect will be more pronounced when the prefactual fits, rather than conflicts, with individuals' motivations and beliefs because individuals more easily imagine how the falsehood might become true (Helgason & Effron, 2022)

Priming

Priming refers when the automatic system of the brain subtlety increases the ease which certain information comes to mind. Sometimes the merest hint of a simple idea, concept, common gesture or seemingly irrelevant cue will trigger an association that can stimulate action. These "primes" can be surprisingly powerful and affect actions, behaviors, thoughts, and feeling while people are not consciously aware of the influence of the cue on their mind (Thaler & Sunstein, 2009).

The word EAT primes the idea of SOUP, and that WASH primes SOAP. In the business office, briefcases and boardroom tables make people more competitive, and less cooperative. Smelling the scent of a general cleaner triggers people keep their environment cleaner while they eat. The thought of money primes individualism with a reluctance to be involved with, depend on, or accept demands from others. Through priming, the environment of the moment influences our thoughts and behaviors to much greater extent than we know or want (Kahneman, 2011; Thaler & Sunstein, 2009).

Probability Neglect

The human mind is limited in its ability to deal with small risks. Our psyche usually responds with extreme positions and no middle ground. These risks are either ignored or given way too much weight. The result leads to gross exaggeration of minor

threats such as the rare probability of a child being a victim of school shooting versus the much greater chance of injury by school bus design or influenza (Kahneman, 2011).

Prospect Theory

Prospect theory starts off with a framing and editing phase that uses heuristics then progresses the evaluation phase. The issue is framed in terms of a relevant set of alternative actions and their corresponding consequences. The editing phase conducts a preliminary analysis of the offered options in which the prospects are translated into subjective values and the probabilities of those outcomes into decision weights yielding a simpler representation of the options. Editing operations of the prospects consist of coding, segregation, cancellation, simplification, and the detection of dominance. Next, edited selections are evaluated, and the prospect with the highest value (utility) is chosen.

The prospect theory has multiple characteristics that violate utility theory: people prefer to evaluate outcomes as gains or losses relative to their current situation or the status quo (hedonic reference point) rather than in terms of absolute value or final wealth; they assign a greater weight to losses than to corresponding gains; humans tend to be risk averse for gains but risk seeking for losses; people generally discard items that are shared by all prospects under consideration; and they tend to overweight very small probabilities and underweight moderate and high probabilities (Colman, 2015; Kahneman, 2011; Kahneman & Tversky, 1979; Kahneman & Tversky, 1984; Mileti, 1999).

Regression Fallacy

An erroneous interpretation of regression towards the mean as being caused by something other than normal chance (Colman, 2015). Tversky and Kahneman (1974)

detailed their experiences observing pilot training in the Israeli Air Force. Experienced flight instructors noted that praise for an exceptionally smooth (good) landing is typically followed by a poorer landing by the student pilot on the next try, while harsh criticism after a rough (poor) landing is usually followed by an improvement on the next try. Contrary to accepted psychological doctrine, the flight instructors concluded that verbal rewards were detrimental to learning, while verbal punishments were beneficial. Inexperienced student pilots at that stage of their training are subject to wide variations of their performance. The flight instructors were clueless and didn't realize that their verbal praise and criticism had no real effect on the student's next flight. The next flight performance was returning from a more extreme point to a more normal, average point. Their landing scores regressed to the mean. This fallacy can be abstractly represented in a scoring set in which two variables X and Y which have the same distribution. If one selects individuals whose average X score deviates from the mean of X by k units, then the average of their Y scores will usually deviate from the mean of Y by less than k units.

Kahneman (2011) criticizes stories of how businesses rise and fall. Readers like these stories because they are what the human mind needs: a simple message of triumph and failure that identifies clear causes and ignores the determinative power of luck and the inevitability of regression (p. 207). Because people have a difficult time recognizing patterns that are occurrences of regression, they often invent phony causal explanations. The human mind is strongly biased toward causal explanations and does not deal well with mere statistics. This bias can also apply to intuitive predictions if they are not corrected for regression (Kahneman, 2011; Tversky & Kahneman, 1974).

Representativeness Heuristic

A cognitive heuristic by which people estimate the probability that object or event A belongs to a particular class or stereotype B by judging the degree to which object or event A is representative or typical of B item or stereotype. Representativeness ignores prior probabilities causing people to commit the base-rate fallacy. If obtained from a known population, it is insensitive to sample size information and can cause sample size fallacy. Representativeness also affects predictability by the degree of the reliability of the description that permits accurate prediction. Hence, if people predict solely in terms of the favorableness of the description without concern for the reliability of the evidence, the accuracy of their prediction will be lower. This lack of accuracy includes the failure to address regression to the mean. People are also subject to an illusion of validity. Individuals often predict by selecting the outcome (like an occupation) that is most representative of the input (the description of a person). The confidence in their prediction depends on the degree of representativeness while they disregard the factors that limit predictive accuracy (Colman, 2015; Tversky & Kahneman, 1974).

Use of the representativeness heuristic can cause serious misperceptions in everyday life by people confusing random fluctuations with causal patterns. Using chance events such as a sequence of coin tosses, people expect the resulting string of heads and tails to be representative of what they think of as random. However, the vast majority of humans lack accurate perceptions of what random sequences look like. In random events, people often detect patterns that they ascribe significate meaning to but these sequences are just due to chance. A person might flip a coin three times, see heads land every time,

and conclude something is amiss with the coin. However, with any significant number of flips, seeing three heads in a row will not be unusual (Thaler & Sunstein, 2009, p. 27).

Representativeness belongs to a collection of closely related mental assessments that are usually generated together to produce the most coherent stories. These stories are not necessarily the most probable, but they form a plausible mental model with consistency and credibility. This indiscriminate substitution of plausibility for probability has negative effects on judgments and forecasting. An excessive inclination to predict the occurrence of unlikely (low base-rate) events can result (Kahneman, 2011).

Risk Seeking

The propensity among humans to reject a sure thing in favor of a gamble of lower or equal expectation in order to avoid the sure loss. People as a whole experience the pain of certainly losing $900 is more than the of a 90 percent chance of losing $1,000 and they become risk seeking when all their existing options are perceived as bad or painful. Experiments demonstrate that human decision makers typically value the pain of a 50 percent probability of losing 100 units equally to a sure loss of about 40 units.

Overweighting of low probabilities emboldens people who face very bad options to take desperate gambles. They accept a high probability of a much worst situation in the small hope of avoiding a large loss. This risk taking often turns manageable failures into disasters. Overall, humans tend to prefer the sure thing over the gamble (risk averse) when the outcomes are good. But, they reject the sure thing and choose the gamble (risk seeking) when both outcomes are perceived bad (Colman, 2015; Kahneman, 2011; Kahneman & Tversky, 1984).

Sample Size Fallacy

Both lay and expects fail to properly account for sample size when estimating the probability of getting a certain value in a sample from a known population. An example by Tversky and Kahneman (1974) has the majority of subjects judging the probability of having more than 60 percent boys in one year to be the same in the small hospital as it is in the large hospital. People presumed these events are equally representative of the general population because they are described by the same statistic. Insensitive to sample size, the representativeness heuristic illuminates that people assume small samples are representative of their larger group or population. With all things equal, the larger sample size will almost always give more accurate estimates of a population value and the smaller sample size is more likely to deviate from the population value (Colman, 2015; Kahneman, 2011; Stanovich et al., 2016).

Satisficing

A decision-making method described by searching through the available options just long enough to find the first one item that achieves the minimum set of requirements or acceptability and not the optimal solution. The speed and ease of the result and not its correctness is prioritized. This method is often used when a thorough examination of all available options would be impracticable or waste too much time and energy. An illustration is when a newly married couple looking for a house to buy, they purchase the first home that meets their minimal requirements of price, location, number of rooms, and local amenities (Colman, 2015).

Self-Serving Bias

An attribution bias leading people to credit their successes to internal personal factors, like ability, and their failures to external situational causes, such as bad luck (Colman, 2015). In the realm of negotiations, it is the tendency to think of an outcome as objectively fair when in reality the outcome sought is skewed in one's own favor (Thaler & Sunstein, 2009, p. 227).

Status Quo Bias / Inertia

People have a general tendency to stick with their current situation. The many possible reasons for this include inattention, lack of will, takes energy to do something, doing nothing is plain easier, or the perceived disadvantages of a change loom larger than its advantages. This tendency to do nothing will be reinforced if the default option in decision making represent a normal or recommended course of action. Defaults are ubiquitous and powerful in our society. The combination of mindless choosing and the fear of selecting the wrong action (loss aversion), infers the designated "default" option will attract a large market share. Thus, default options are powerful nudges (Kahneman et al., 1991; Thaler & Sunstein, 2009)

Stereotype

A relatively fixed and oversimplified generalization about a group or class of people and is a function of representativeness. The characteristics of a group are attributed by personal representations of normal or typical members of the group in their storied memory. Stereotypes are a part of the how the human mind organizes information in categories and thinks of the items within. These cognitive categories simplify

information processing and are quite resistant to disconfirming information. Since a stereotype provides specific expectations about members of a group, it can favorably or unfavorably influence our perceptions and behavior towards that group or class. Some people can maintain strong stereotypes of typical group members without those stereotypes influencing how they view individual members of those same groups (Ariely, 2009; Colman, 2015; Kahneman, 2011)

Substitution

A fundamental example of a heuristic. People when faced with a difficult question, will often answer an easier one in their mind instead the more difficult question without even noticing the substitution. System 1 intuitively provides answers to related questions if the answer to the original question is not readily available. As a good evolutionary strategy for solving difficult problems, the human mind follows this rule; if you can't solve a problem, then there must be an easier problem you can solve. You need to find it. (Kahneman, 2011, p. 98). However, it can lead to biased and erroneous results through the neglect of base rates and the improper weighting of evidence. Substitution can be based on intensity matching and availability in addition to cognitive difficultly (Kahneman et al., 2021).

A good example of this substitution is when the more technically challenged question "Is climate change real?" is replaced with "Do I trust the people who say climate change is real?." Now, the answer to the trust question will vary from one person to the next, depending on that person's social circles, preferred sources of information, political affiliation, and so on and also on similar social and political factors of the messenger (Kahneman et al., 2021). In heuristics, the System 1 answer is not necessarily simpler,

more frugal or better than the original question; it is only more accessible and computed more quickly and easily (Kahneman, 2011, p. 416).

Unrealistic Optimism / Positivity Bias

A judgmental bias that affects people's subjective estimates of the likelihood of future events in their lives, causing them to overestimate the probability of positive or desirable events and to underestimate the prospects of negative or undesirable events. As a pervasive feature of ordinary human life, unrealistic optimism affects most people and social categories. States create large revenue streams through lotteries due to unrealistic optimism. When people overestimate their own immunity from harm, they may fail to take sensible preventive steps. As such, a young person may forgo health insurance or flu shots because they feel they are too healthy to get sick. Marriage is a great example of unrealistic optimism. Studies show that people have an accurate view of divorce rates (about 50 percent), but nearly 100 percent of people getting married are almost certain they will not to get divorced. Basic human nature overvalues what we own and reflects a tendency to fall in love with, and be overly optimistic about, anything that has to do with ourselves. Most people think that they are a better than the average driver. They will not get a divorce. They will not die young. Nobody thinks they will get a speeding ticket.

Optimistic bias is a significant source of risk taking. Individuals take risks when the odds are favorable. People accept some probability of a failure since they perceive the prospect of success out weights the chance of failure. However, because humans focus on what they know and neglect what they do not know, they are overly confident in their beliefs, misread the risks, and down play the odds of failure. People believe they are

prudent, even when they are not and reminding them of a bad event might temper their optimism (Colman, 2015; Kahneman, 2011; Thaler & Sunstein, 2009).

Appendix B – Misinformation Definitions

Activity Mobilizing Emotions

Strong emotions such as anger and fear (negative) and awe and fascination (positive) motivate people to act. In the information environment, acting means to share, retweet, like, and make other online gestures that fuel the social transmission of media material enabling red-hot angry or scared people to cause content to go viral (Hendricks & Vestergaard, 2019, p. 96).

Activity Demobilizing Emotions

Opposite to mobilizing emotions, conditions like sadness or being comfortable dampen the will to act. An example is if a candidate's statements sadden a person, they may not care to vote even though they find the alternative candidate much worse (Hendricks & Vestergaard, 2019, p. 96).

Belief Echoes

The phenomenon that, even after an alleged political scandal or rumor has been established to be false, the belief still influences people's perception of the person at the center of the rumor or the scandal (Hendricks & Vestergaard, 2019, p. 73).

Bullshit

When a person tries to deceive someone by misrepresenting their real intentions, motives, and purpose. Unlike a lie, the bullshitter totally ignores questions of truth and false and topical facts. In their attempt in faking it, they may present heaps of irrelevant but factually correct information to take attention away from the real subject. This act

may give the impression that the bullshitter is trying their best to answer the question at hand while they are just buying time and avoiding give an appropriate answer based in reality. Thus, bullshit is unavoidable whenever circumstances require someone to talk, write or speak about some subject that exceeds their knowledge of the facts relevant to the topic. The bullshitter's goal is not necessarily to get people to believe what they say, but to get people to act in a particular manner without being discovered unknowledgeable about the subject. In this way, bullshit is a bigger threat to truth than lies and is toxic in nature (Frankfurt, 2005; Hendricks & Vestergaard, 2019).

Conspiracy Theories

Defined as an explanatory belief involving multiple actors that collude in secret agreement to pursue malevolent goals (van Prooijen et al., 2021, p. 1). These theories can be true such as the case in Watergate or be false as in Pizzagate. This belief in secret agendas may go into hyperdrive and become a paranoid perception of the world in which everything is perceived as being run by the others. Critical thinking becomes conspiracy thinking, where motivated reasoning and fact resistance thrive and misinformation is accepted uncritically as long as blame is attributed to the groups with the secret agenda (Hendricks & Vestergaard, 2019, pp. 100-101). Large numbers of normal, well-functioning citizens believe them, yet these beliefs are largely detrimental for people's well-being and psychological functioning. They are associated with anxiety, self-uncertainty, anomie, and feelings of powerlessness (van Prooijen et al., 2021, p. 1). However, people find conspiracy theories entertaining and the more regaling they are, the more people believe in them. Conspiracy theories function a lot like fictional stories, scary movies or detective novels. They have a plotline that often includes brave heroes

and bad villains in a classic battle between good and evil, involving innocent victims and scoundrels who will stop at nothing to achieve their twisted goals. These stories supply interesting and attention-grabbing information that is easier to mentally process than boring facts. Known as fluency, people associate greater ease of information processing with a higher probability of being true. Additionally, the intense emotions triggered by conspiracy theories suppresses an individual's capacity to critically asses the facts. The reality is the truth can be quite boring. (van Prooijen, 2021; van Prooijen et al., 2021).

Counter-Public

Describes groups that organize themselves in opposition to mainstream civic discourse, often by aggressively using communications media (Lee et al., 2021, p. 2).

Counter-Visualizations

Data visualizations using orthodox methods to make unorthodox arguments in order to challenge mainstream narratives like the COVID-19 pandemic is urgent and ongoing. By asking community members to "follow the data," these groups mobilize data visualizations to support significant political and societal changes and an alternative view like COVID-19 is just like the flu. Data visualizations are turned from a neutral window of an observer-independent reality into an arena of political struggle (Lee et al., 2021, p. 1-2).

Disinformation

False or misleading content spread intentionally to deceive and to produce a particular judgment or course of action in message recipients, irrespective of the veracity, or bias of what is shared. (Colley et al., 2020, p. 93; Oyserman & Dawson, 2021, p. 174).

To distinguish from misinformation, disinformation is intentional while misinformation may be false, but not meant to harm. In the digital age, large amounts of information are generated and distributed automatically which complicates this distinction and obscures the determination of intent, apparent source, or original context (Bennett, 2020, p. 3).

Fake News

Fake news is fabricated information that is cleverly manipulated as to mimic journalistic media content in form but not in organizational process or intent. The aim is to have a large audience that is willing to believe the stories and spread the message. By posing as real news, fake news pretends to have enlightenment or truth as its end goal while pushing its hidden political or monetary goal. This news can include realistic websites with cleverly manipulated testimonials, pictures, and video footage. Fake news is not a recent phenomenon. Benjamin Franklin faked a publication containing a fictional letter that incorporated a false report on an American Indian tribe slaughtering and scalping of more than 700 individuals, including peasants, women, children, and infants on the behalf of the British. The purpose was to create European outrage and put pressure on the United Kingdom. Four main reasons to submit fake news and pseudo journalistic products onto the market are:

(1) Fun/trolling,

(2) Web traffic/money,

(3) Marketing/sales,

(4) Propaganda/power struggle (Hendricks & Vestergaard, 2019, p. 76; Ali & Zain-ul-abdin, 2021, p. 110).

False Amplifiers

Coordinated activity by inauthentic accounts with the intent of manipulating political debate by amplifying sensationalistic voices to drown out other views or by discouraging specific parties from participating in discussion (Derakhshan & Wardle, 2017, p. 7).

Filter Bubble

Selecting mainly consistent sources of information that reinforces a person's or group's worldview and presents few challenges to them. This uniformity of data leaves people confident that their own views are correct and the views of others at best are mistaken and at worst are malicious (Greifeneder et al., 2021, p. 4).

Fringe Theories

Ideas and beliefs on the outer edges or fringes of the center of culturally accepted collection of doctrines, ideas and beliefs. The accepted collections are a set of beliefs that are taken as authoritative and settled and represent orthodoxy. Unconventional fringe theories are on the blurry edges of orthodoxy. Like-minded people form complex, interconnected social substructures to discuss what they believe are important and correct ideas. These theories serve as sources of identity and as social magnets (Gordin, 2022).

Illusory Truth Effect

Repeated exposure to false facts or information increases the acceptance of the false material as true. In studies, previously qualified statements were rated as more likely to be true than new statements. This acknowledgement occurs if a person was

ignorant of the falsehood of the statement, if labeled with a negative qualifier or was told if was blatantly false. However, a floor limit appears to exists on how improbable a statement can be that people are willing to accept such as 'the earth is a square.' This effect may explain why correcting misinformation or fact checking doesn't always change attitudes (Marsh & Stanley, 2021, p. 138).

Information

Shared content to inform message recipients which is generally assumed to be truthful (Oyserman & Dawson, 2021, p. 174).

Information Disorder

An umbrella term given to the different categories of misinformation, disinformation, and mal-information (see Figure 5), and the broad societal challenges associated with them (Couric et al., 2021, p. 9; Derakhshan & Wardle, 2017).

Figure 5

Categories of Information Disorder (Derakhshan & Wardle, 2017, p. 8)

Information (or Influence) Operations

Actions taken by governments or organized non-state actors to distort domestic or foreign political sentiment and to influence target populations' emotions, motives, objective reasoning, and ultimately behavior to strategic, tactical, and/or geopolitical outcomes. These operations use a combination of methods, such as false news, disinformation, or networks of fake accounts aimed at manipulating public opinion (false amplifiers) (Derakhshan & Wardle, 2017, p. 7; DoD, 2014, p. II-9)

Lies

Lies and bullshit are both attempts of deception. However, the difference relates to the deceit by the liar who consciously misrepresents the facts to create a false belief and tamper with the subject's perception of the truth. The liar acknowledges the distinction between true and false but needs to hide the truth. Telling a lie is an act with a sharp focus and requires skill to observe the objective constraints imposed their believed truth. The liar is inescapably concerned with truth-values. In order to invent a lie at all, he must think he knows what is true (Frankfurt, 2005, p. 51; Hendricks & Vestergaard, 2019, p. 75).

Mal-information

Harm can be inflicted a person, organization, or country by spreading factually correct information with detrimental implications. An example of this would be leaking the confidential physiatrist notes and records of a governmental dissent which has no bearing on the anti-war discussion to discredit him and his public position (Greifeneder et al., 2021, p. 2; Derakhshan & Wardle, 2017, p. 9).

Mediatization

The tendency of societal institutions to depend on the media and thus adapt themselves to its conventions and to media logic. In such a society, the media establishes the conditions for social interactions and relationships, commerce and marketing, science and debate, and activism and politics. Like nobody will hear the sound of a falling tree in an empty forest, the media must cover protests and demonstrations such as Occupying Wall Street for the activists to get their message heard by people other than themselves. As a sign of increasing power, the media gets to set the agenda and other institutions and actors subjugate to their media logic. In this type of society, politics has lost its autonomy and independence relating to the media (Hendricks & Vestergaard, 2019, p. 53)

Narratives

Selective interpretations of the past, present and future designed to achieve political objectives through persuasion that form a plot in which events play out over time. The narrative is the master strategic concept and employed at the tactical level through the telling of stories that relate coherently to the overall strategic message. It taps into the assumption that humans understand the world through narratives. The narrative plot seeks to create a coherent framework of meaning that makes sense of events as a whole by using a selective mixture of facts, half-truths, exaggerations, and omissions combined together to present a plausible and coherent interpretation of reality rather than a logically binding one. This coherence makes narratives less likely to be challenged, harder to refute, and more adapt to be accepted. People are primed for narratives through heroic tales that societies tell their children. Almost since birth, their minds will have

been fed a steady diet of compelling, coherent stories. Narratives are a highly effective form of propaganda (Colley, 2020, pp. 4-6).

Narrowcasting

Also known as disintermediation, producers and consumers of information are able to select the flow of desired information to a small and tailored group via online social networks. People now have a much easier way to possess fine-grained control over particular information sources (e.g., follow users on Twitter who share your political or vaccination beliefs) (Ackland & Gwynn, 2021, p. 29).

Persuasion

Attempt to influence attitudes or change behavior in a person, group, or population when the intent or purpose of the message is transparent. Persuasion differs from propaganda in that propaganda aims to deliberately mislead and deceive while persuasion promotes a mutual understanding between the two parties by being outspoken and open about their intentions. However, propaganda's covert nature may make it more effective. A decreased perception of a message's intent stimulates attitude and behavior change by reducing resistance to persuasion (Ali & Zain-ul-abdin, 2021, p. 112).

Political Bubble

A situation in which a political item receives much more media attention than the political substance justifies (Hendricks & Vestergaard, p. 60).

Populism

An effective media strategy design to play on the emotions of ordinary people and to attract attention and set the agenda in the media by using the excluding, and polarizing narratives of us-versus-them. The ordinary people battling the villainous political and intellectual elite narrative is very efficient in mobilizing anger and fear. Populism simplifies cases and circumstances, cherry-picks facts, and frames topics and discussions according to good versus evil conflict. If facts run counter to that core narrative, they may be left out or reasoned away as not valid. In populism, stereotypes often replace facts. Scapegoats and simplified explanations become replacements for the world's more complex and less than transparent cause and effect associations (Hendricks & Vestergaard, 2019, p. 96).

Post-Factual State / Post-Factual Democracy / Post-Truth

In post-truth politics, facts obtained and verified by reliable methods are subjugated to politically opportune but factually misleading narratives and alternative facts as the basis for political debate, decision, and legislation. These misleading narratives may consist of lies and tall tales, false, fake, distorted news stories, and populist/conspiracy narratives. Facts are reduced to strategic armaments in a political power struggle. They are employed or deployed, regarded or disregarded, accepted or denied and used or replaced according to tactical and strategic needs of a particular party or group. On this battlefield, all organizations, groups, individuals, and their positions are suspected and regarded as purely political and partisan in their interests and goals. Anyone trying to be neutral risks becoming cannon fodder by all sides. Emotion and personal belief drive public opinion. Science, journalism, and law are politicized and

categorized as friends or foes. You are either with us or against us, and if you are against us, then you are fake news. Acknowledgment of reality and truth disappears in the heat of battle and a new version of reality is constructed by those who have the power to do so (Hendricks & Vestergaard, 2019, pp. 112-113; Ali & Zain-ul-abdin, 2021, p. 110; Lexico, n.d.).

Propaganda

The deliberate and systematic attempt to shape perception, manipulate cognitions and direct behavior of an individual, group, or population to achieve a desired response or objective. The propagandist hides their intent or goal and do not engage in genuine argument and debate, but use predetermined answers at the outset (Colley, 2020, pp. 4-5). Lies, deception, biased ideas and opinions promote a particular desired point of view to the recipient while the manipulator attempts to shield them from opposing facts and opinions. Thus, the target is skillfully guided into accepting the chosen one-sided position as their own point of view by exploiting their beliefs, values, and group norms (Ali & Zain-ul-abdin, 2021, p. 112).

The elements in a propagandist message are:

(1) reduction of complex situations into simplistic cause and effect relations,

(2) use of abstract language and physical representations,

(3) a heavy reliance on authority figures or spokespersons,

(4) a finalistic or fixed view of in-groups (friends) and out-groups (enemies),

(5) a time focus with an under or overemphasis on the past, present, or future,

(6) a greater emphasis on conflict rather than on cooperation. (p. 113)

Stacking of Fringe Theories

People usually believe in more than one fringe theory due to like-minded individuals tend to consume information from similar sources: social networks, publications, cable television, radio shows, pod casts, YouTube videos, etc. Theories emerging in one of source can quickly migrate across platforms to reach other similarly inclined persons (Gordin, 2022).

Technocracy

In a technocracy, all issues are turned into questions of facts simply requiring a response from a scientific expert or organization. Even normative, value-based matters related society, its operation and organization are turned into factual matters for science and experts to decide upon. Nothing exists to democratically debate or hold a political opinion about. Just the facts. A society and its citizens have to follow the experts' directions. If they fail to, they don't just disagree, they are wrong. Public anger may arise from the tendency to employ too factual and technocratic policies that lack the sense and acknowledgment of the pain they cause to publics. The anger and resentment caused by such deft polices may lead to post-factual tendencies and spontaneous popular resistance (Hendricks & Vestergaard, 2019, pp. 115-116).

Truthiness

The belief in what you feel to be true rather than what the facts will support and was coined by Stephen Colbert, the host of The Colbert Report. Truth comes from a person's gut and not from facts (Hendricks & Vestergaard, 2019, p. 90).

Weaponized Narratives

The use of information and communication technologies, media, services, and tools to create and spread stories intended to subvert and undermine an adversary's institutions, identity, and civilization. Many times, these narratives use strong emotions and target traditionally marginalized or perceived aggrieved groups and operate by sowing and exacerbating complexity, confusion, political divides, and social schisms (Hendricks & Vestergaard, 2019, p. 79).

Whitewashing Information

The situation where satire or entertaining stories are circulated, repeated and eventually find their way to news platforms and media houses for both the authorized and the alternative press to be used as legitimate news stories. These creations are later shared or referred to in books, journals, and articles as examples of polarized party politics or geopolitical misinformation (Hendricks & Vestergaard, 2019, p. 83).

Appendix C - Institutional Review Board Approval

Oklahoma State University Institutional Review Board

Date:	02/01/2022
Application Number:	IRB-22-41
Proposal Title:	A Study of Information Gathering and Protective Action Decision Attitudes among Airline Pilots
Principal Investigator:	John Cisar
Co-Investigator(s):	
Faculty Adviser:	Haley Murphy
Project Coordinator:	
Research Assistant(s):	
Processed as:	Exempt
Exempt Category:	

Status Recommended by Reviewer(s): Approved

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in 45CFR46.

This study meets criteria in the Revised Common Rule, as well as, one or more of the circumstances for which continuing review is not required. As Principal Investigator of this research, you will be required to submit a status report to the IRB triennially.

The final versions of any recruitment, consent and assent documents bearing the IRB approval stamp are available for download from IRBManager. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be approved by the IRB. Protocol modifications requiring approval may include changes to the title, PI, adviser, other research personnel, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms.
2. Submit a request for continuation if the study extends beyond the approval period. This continuation must receive IRB review and approval before the research can continue.
3. Report any unanticipated and/or adverse events to the IRB Office promptly.
4. Notify the IRB office when your research project is complete or when you are no longer affiliated with Oklahoma State University.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact the IRB Office at 405-744-3377 or irb@okstate.edu.

Sincerely,
Oklahoma State University IRB

VITA

John Joseph Cisar

Candidate for the Degree of

Doctor of Philosophy

Dissertation: EVOLUTION OF INFORMATION AND DECISION-MAKING THEORY USING HEURISTICS AND BIASES TO ANALYZE PILOTS' DECISION NOT TO VACCINATE AGAINST COVID-19

Major Field: Fire and Emergency Management

Biographical:

Education:

Completed the requirements for the Doctor of Philosophy in Fire and Emergency Management at Oklahoma State University, Stillwater, Oklahoma in December, 2022.

Completed the requirements for the Master of Science in Border Security at Angelo State University, San Angelo, Texas in 2013.

Completed the requirements for the Bachelor of Science in Biology at Texas A&M University, College Station, Texas in 1987.

Experience:

Adjunct Professor, Department of Security Studies and Criminal Justice, Angelo State University, Fall 2016 – present.

Co-Managing Student Editor, Journal of Homeland and National Security Perspectives, Center for Security Studies, Angelo State University, 2014.

Captain, B-737 Pilot, Southwest Airlines, Dallas, Texas 1998-present.

Lt. Colonel, U.S. Air Force (Ret.) KC-135 Instructor, Evaluator, Test Pilot, 1988-2015. First Gulf War 1990-1991, Bosnia 1997.