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A Framework for Understanding How People Can Draw Different Conclusions Based on The Same Information

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A FRAMEWORK FOR UNDERSTANDING HOW PEOPLE CAN DRAW DIFFERENT CONCLUSIONS BASED ON THE SAME INFORMATION

by

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SYNTHESIS*

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*The Synthesis can take a variety of forms, from a position paper to curriculum or professional development workshop to an original contribution in the creative arts or writing. The expectation is that students use their Synthesis to show how they have integrated knowledge, tools, experience, and support gained in the program so as to prepare themselves to be constructive, reflective agents of change in work, education, social movements, science, creative arts, or other endeavors.

ABSTRACT

At least partially fueled by misinformation, political polarization is growing in the United States, leading to a breakdown of confidence in our traditional academic and political institutions. A popular belief is that a solution is to train people to think more rationally by eliminating the cognitive biases embedded in their subconscious thought patterns. This paper identifies the influences on my thinking and the framework used to look at these issues from a different perspective through methodological believing and the application of models of learning and conversation. The paper also points out that the methods of scientific inquiry often assume that problems have single knowable answers where objective truth is incontrovertible. However, many real-world problems include randomness, which can lead even rational thinkers to draw incorrect conclusions in some circumstances. Through this analysis, I suggest that cognitive biases should not be classified as flaws, but rather understood as pragmatic mechanisms that humans rely on for allocating limited cognitive bandwidth, and for prioritizing focus to balance the tradeoffs between accuracy and efficiency that most individuals face in their daily lives. The goal of this paper is not to propose solutions, but rather to identify a framework for a greater understanding of others, and for beginning to explore additional solutions. While education on rationality and information literacy are important tools to combat misinformation, I believe that additional tools and approaches are also needed.

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Introduction

Many of us have been distressed by the proliferation of misinformation and growing political polarization in the United States and around the world. As someone who has valued the western ideals of democracy, where thoughtful differing viewpoints are valued and respected, these trends are quite disturbing.

I grew up in an environment that encouraged and valued the importance of education, collaboration, and a vigorous exchange of ideas based on accurate information, logic, and scientific methodologies with the goal of gaining a higher truth. An incorrect conclusion based on sound reasoning was valued above an ultimately correct conclusion based on opinion or misinformation. And dialogue was vigorous but respectful. As Massachusetts Governor Charlie Baker has said about his dinner table growing up: "we disagreed without being disagreeable" (English, 2010). This approach reflects what I believe is at the core of science and academia, so the partisanship and seeming loss of respect for scientific and academic institutions has been troubling. For example, a 2019 Pew Research poll showed that only half of Americans think that colleges and universities are having a positive effect on the U.S. Among Republicans, the number is 33%, down from 53% in 2012 (Doherty and Kiley, 2019). These statistics confirms the observation that public debate and discussions have become more contentious; less about finding consensus, and more about winning. Intimidation and partisan ad hominem attacks have become an acceptable norm on social media, in political debates and even in public statements from elected officials.

In addition, the world around us is changing rapidly. Buckminster Fuller (1982) noted that until 1900, human knowledge doubled approximately every century, but that by 1982, it was doubling every 18 months. With the number of sources expanding exponentially via the Internet,

significantly enabled by social media, David Schilling (2013) estimates that available knowledge will soon be doubling every 12 hours. As success is increasingly judged by popularity rather than accuracy, traditional journalistic standards of objectivity have yielded to more partisan and opinion-based reporting. These factors all combine to enable misinformation to proliferate quickly and widely, both intentionally and unintentionally.

Democracies value liberty and free speech not only because these are important human rights, but because the free exchange of ideas through constructive dialogue can create synergies and outcomes that are greater than any individual could achieve on their own. The success of institutions such as Congress and the Supreme Court, is reliant on upholding these concepts of collaborative and reflective dialogue to promote Constitutional values of equity. True dialogue depends on the participants acting in good faith and respectfully valuing all opinions, especially differing opinions, and new perspectives. Over time, as relationships grow, dialogue participants can tackle increasingly complex problems. Science also relies on these norms of constructive dialogue and respect, implemented through methodologies such as peer review and conferences to advance scientific knowledge. All these approaches share a common assumption that logic and rational thought will determine the best ideas and help lead to objective truth.

I too believe that complex issues such as pandemics, climate change, and institutional racism, are best addressed when constructive dialogue can occur to build consensus. And in many cases, solutions require participation from a broad population to be effective. For example, a vaccine is only effective if people are willing to get vaccinated. Political and ideological polarization, and the accompanying unwillingness of citizens to cooperate with each other, can undermine the best scientific solutions to the complex problems facing our world.

A major impetus of my decision to enroll in the University of Massachusetts Boston Critical and Creative Thinking Master of Arts Program (CCT) was to learn to think more critically about these current trends, to better understand the reasons underlying them, and to learn new methodologies and approaches to dealing with them. A fundamental assumption of all critical thinking is the value of objectivity, measures of truth, and the value of intellectual standards such as clarity, accuracy, precision, relevance, depth, breadth, logic, significance, and fairness (Paul and Elder, 2004), as well as the importance of seeing things from different perspectives.

Foundation and Influences

My early education in mathematics taught me how to think critically using reason, objectivity, and logic, as well as the importance of objective truths. As I furthered my education in applied science and business, I learned the importance of pragmatism when applying academic principles in the real world. Two of the most important elements were recognizing the importance of marketing to gain acceptance for one's ideas and implementing the operations to support and sustain them. "Building a better mousetrap" only works if others know of its existence and are able to obtain it. History is filled with examples where the best products were not the winners. For example, McDonald's isn't necessarily successful because people think they make the best hamburgers, but rather because of outstanding operations, marketing, and understanding that are other factors such as convenience and consistency that are valued by consumers.

Working together in groups in a variety of settings helped me realize the importance of a diverse set of opinions and perspectives. I discovered that I usually learned more from those I

disagreed with, than from those I agreed with. I also learned about the dangers of "groupthink" and how that could lead to overconfidence and missing key facts.

In 2012, I first became involved with the Mill Cities Leadership Institute (MCLI) which greatly influenced my perspectives on social justice and reinforced the importance of engaging a diverse audience in dialogue, and taught me how difficult it is to achieve truly open dialogue in our society. This training further opened my eyes to the value of seeing situations from different perspectives and the importance of reserving judgment. I became aware of how the exact same evidence can appear very different depending on one's frame of reference. Through MCLI, I became acquainted with UTEC, a non-profit in Lowell, Massachusetts that works with criminally involved young adults. Among UTEC's core values are the importance of seeing "beyond the mask" and to "assume goodness" (UTEC, 2022). This means not judging people only by their outward actions, but also trying to understand what might have led an otherwise reasonable person to those actions. For example, when we see someone commit a violent act, it is common to assume that the perpetrator is a violent person. However, some youths who joined gangs and committed violent acts, may have joined the gang because they were bullied and threatened by someone else, and they saw the gang as a form of protection from those threats. "Assuming goodness" means taking a step back and looking deeper, wondering about the circumstances that could cause a non-violent person into those violent actions.

Another important influence that has shaped my thinking is Daniel Kahneman's book *Thinking Fast and Slow* (2013). His work discusses how our minds have evolved to support both fast, intuitive thinking (System 1) as well as the slower, more deliberative thinking (System 2) that we commonly have in mind when we think about "thinking." Kahneman describes how humans, when faced with uncertainty, use System 1 thought processes to identify patterns and to

quickly draw conclusions by using intuition and "rules of thumb." These processes are called heuristics. Heuristics are efficient System 1 mental shortcuts, allowing us to make quick decisions, but those decisions are less precise than those that would result from more thorough System 2 thinking. These important concepts and terms are a cornerstone of much of this paper and will be used throughout.

I have long been interested in the workings of the human mind, and Kahneman's model reignited that interest and helped me make better understand something that I'd been fascinated with for my entire adult life, something that can be summed up by the question: "Why do logical people sometimes draw illogical conclusions?" I can trace this curiosity back to a single event that occurred in high school after I first learned about the mathematical field of probability and statistics. At the time I was working in an afterschool work/research program at a hospital affiliated with the University of Miami. A doctor, a brilliant man who was the head of a surgical department at the hospital, had just returned from a trip where he had witnessed an improbable string of winning dice rolls at a craps table. And, despite his knowledge of science and mathematics, he was convinced that this could not be explained by probability alone. Although I was just a high school student, I knew that it could. I was astonished that someone so bright and well-educated, and clearly a rational thinker, would not see that.

All of these past experiences, and the internal questions they engendered, led me to join the CCT program in 2019, just before the COVID pandemic began and changed our lives in many ways. Since both our academic and economic systems are geared toward specialization, I was excited about the opportunity to look at these issues through a multi-disciplinary lens with the goal of synthesizing my business and educational backgrounds, along with new learning from CCT, into a better understanding of the world in which we live.

Schools of Thought

The spread of misinformation, and radically differing views on issues such as vaccinations and election fraud spurred me to consider multiple approaches to better understanding the causes. A 2020 systematic literature review of scientific journals by Machete and Turpin (2020) uncovered many articles focused on themes of fake news, critical thinking, and information literacy. The authors point out that the proliferation of information sources, most specifically social media and news apps, have contributed to the spread of alternative facts. The research they cited found that "Facebook accounted for 20% of total traffic to reliable websites and up to 50% of all the traffic to fake news sites." The article makes the case that academic institutions of higher learning need emphasize information literacy training for students and staff members. For their study, the authors define critical thinking as "the ability to analyse and evaluate arguments according to their soundness and credibility, respond to arguments and reach conclusions through deduction from given information" (p. 238).

Steven Pinker's influential book *Rationality* (2021), blames the spread of misinformation largely on a lack of rational thinking skills. Pinker points out how our ability to think rationally is influenced by our subconscious cognitive biases, and how we often depend on fallacies of logic in making decisions. He feels that the key is to educate people on the role that cognitive biases play in their decision-making, and to try to eliminate cognitive biases from their thinking, so that they will become more rational thinkers. Pinker defines rationality as "using knowledge to attain goals," where knowledge is defined as "justified true belief" (p. 36). He defines critical thinking as having the goal of exposing fallacies and coaxing people into renouncing them (p. 74).

Michael Shermer's book, *Why People Believe Weird Things* (2002), offers reasons why people are susceptible to pseudoscience, superstitions, and other confusions. He discusses evolutionary psychology and points out that humans are pattern seeking animals that seek to find meaning from a complex world. The problem humans face is figuring out which patterns are meaningful, and which are not. The modern, scientific way of thinking is only a few hundred years old, whereas humanity has existed for hundreds of thousands of years.

> *Since civilization arose only about 13,000 years ago with domestication of plants and animals, 99.99% of human evolution took place in our ancestral environment… The conditions of that environment are what shaped our brains, not what happened over the past 13 millennia. Evolution does not work that fast (xxiii).*

Shermer classifies erroneous thinking as either believing a falsehood or rejecting a truth. Interestingly his book was published before Facebook's founding in 2004, indicating that believing misinformation or rejecting truth existed well before social media made this issue more prevalent. So, while social media may have exacerbated this problem, social media didn't create it.

In philosopher Martha Nussbaum's book, *The Monarchy of Fear* (2018), she attributes the political crisis of division to the role that fear plays in human thought processes. She argues that fear of helplessness and being treated unfairly results in anger. Anger can manifest itself in retribution or in pushing others down in order to maintain relative status. She points out that humans have a tendency to overestimate trivial wrongs and underestimate significant ones. Nussbaum also documents a common belief that people cause their own misery through laziness or bad conduct.

Although less scientifically reasoned, popular books like *The Psychology of Stupidity* (Marmion, 2018) attempt to explain current trends in more direct terms. For example, "uncertainty makes you crazy, certainty makes you stupid" (p. xi) is a rather succinct summary of the paradox. Our brain architecture does not deal well with uncertainty, we always want to find an answer. And yet, being certain of uncertain events leads us to make "stupid" decisions.

Impetus for This Paper

These schools of thought propose some very important and useful insights, but their conclusions left me unsatisfied. In all these cases, the authors seemed to be identifying the problem as "them," and the proposed solution is essentially that "they" need to think more like "us." Even if correct, this advice isn't pragmatic since that is what "they" think about "us." And while educating more people on critical thinking and information literacy is an important and necessary component of any strategy for encouraging more cooperative dialogue, that strategy only works for those who are attending school. In reality, a majority of our population is past school age with little desire or opportunity for classroom learning. I believe it would be a mistake to ignore large segments of our population and leave them out of the solution. Additionally, the anger from being excluded from the process can fuel additional antagonism toward academia. Without addressing that issue, a growing suspicion of academia from those past school age may negatively influence future students.

Reading Steven Pinker and Michael Shermer, I felt myself nodding along. They confirmed my beliefs, and succinctly pointed out the flaws in opposing points of view. Which led me to the question: If these ideas are so good, why aren't they more widely adopted? Why is confidence in academia waning instead of growing?

I had tried, for the most part unsuccessfully, to reach out to those who had radically different views, e.g., those who were distrustful of science, or who didn't believe in vaccinations. I found that the issues were too emotional to be able to be talked about objectively. And the norms of dialogue were different without the common language of science and logic. Many of my mentors whom I had relied on for objective viewpoints had given up. The sentiment was "you can't reason with these people."

Perhaps inspired by my love for the spirit of Cervantes' Don Quixote, I was not ready to give up. I wanted to search for other approaches to understanding the fundamental issues. Throughout my life, and in my CCT classes, I had learned tools for solving difficult and complex problems. My goal was to try to use these tools to look at this issue from new perspectives to gain a deeper understanding of the fundamental issues.

Setting the Stage

IMPORTANT NOTE: This paper is focused on the cultural and political systems of the United States at the beginning of the 21st century and assumes Western concepts of democracy, market-based economics, work, time, customs, and values. When I discuss human biology and brain functions, these are generalizations that apply to the majority of humans, but it is important to note that not every individual has the same brain architecture and chemistry.[1] I recognize that in some sense I am reinforcing institutional stereotypes by not discussing the existence of other cultural perspectives and exceptions to western biological "norms." However, the realities of the scope of this paper, as well as my own interests, are focused on our current U.S. political environment, and the evolution of our brain architecture as experienced by the majority of American adults.

One of the tools learned in the CCT program was the SCAMPER process, which teaches us to repurpose tools to use them in in different ways for creative problem solving (as cited in Davis, 2004). SCAMPER stands for Substitute, Combine, Adapt, Modify, Put to another use, Eliminate, and Reverse. In reflecting on my own problem-solving process, I realized that is very much akin to a dialogue where multiple different points of view come together to collaborate and identify a solution. Each point of view brings in a different perspective and context which get combined, modified and otherwise repurposed to create a new collective thought.

[1] These specialized brain functions exist for the vast majority of humans, but not all. There are individual exceptions to almost all of these statements about human biology. For example, some people have the disorder prosopagnosia, the lack of ability to easily recognize faces. In general, these exceptions are relatively rare.

One of the difficulties with having a dialogue on political polarization is that the sides are polarized to the point where cooperation becomes difficult. However, we as humans have the ability for empathy and the ability to represent differing points of view. My goal in this paper is to use the SCAMPER process to put tools to another use, by adapting them to help address complex problems where it is difficult to have all points of view equally represented. For example, Scharmer's four fields of dialogue (2016) can be used to model an internal dialogue, the triple loop theory of learning can inform different perspectives (Reynolds, 2014), and methodological believing and doubting can ensure that all points of view are fairly represented (Elbow, 1986). These models will be discussed in more detail later in this paper.

Terminology

Human language, and certainly the English language, is imprecise in that words can have many different definitions. How we each interpret words can differ subtly depending on context, perspective, and individual experiences. Dictionary definitions serve as guidelines, but they are not usually precise. It is my experience that sometimes there are heated disagreements between people that essentially agree, but who are basing their arguments on different definitions of specific words.

The terminology used to describe the thinking process is particularly problematic. Terms like critical thinking, logic, reason, and rationality are often used interchangeably, and dictionaries may even use circular definitions to define these terms. E.g., rationality is defined as using reason and logic (Oxford Languages), and "reason" as using rationality (Merriam-Webster). Other words like knowledge, evidence, facts, proof, and truth can be synonymous in

some situations, and very different in others. E.g., Pinker defines knowledge as "true belief," but does that mean the belief has to be true, or that one truly believes it?

The terminology of thinking is very dependent on context. For example, the Euclidian logic of geometry is very different than the sort of logic one uses to determine which is the "most logical" choice of automobile to purchase. Telling a car purchaser that their thought process was not actually "logic" is not a good way to make friends or begin a constructive conversation.

The imprecision of definitions has been a surprisingly difficult obstacle for me in writing this paper, as well as a great lesson in pragmatic communication. I initially thought that I could avoid confusion by providing a specific definition of each of the terms in this paper, but I have come to realize that pragmatically, that doesn't solve the problem. These terms are so ingrained and used in so many contexts, that it is not easy to override implicit definitions that vary by individual. The definitions of many words are embedded in our System 1 thinking and cannot be overridden easily even if each term could be defined with precision and without circularity. I feel that this is an important point that is sometimes missed by the scientific community I belong to, especially when trying to communicate specialized concepts across a wide audience. While in some scientific contexts, terms like "proof," "evidence," or "rationality" can have very precise definitions, others may not share that same point of view. For example, I believe that most people believe they are being quite rational when they come to conclusions, even if a scientist might see flaws in their logic, and therefore consider it irrational. Even when conclusions are based on inclusive or misleading evidence, there is often still an identifiable line of inferential reasoning where each step follows the other. Calling that person illogical or irrational is not likely to change their minds, and on the contrary, might make them less likely to listen, and may make them more distrustful of science and academia.

The following are dictionary definitions of some terms that will be used within this paper, some of which will be discussed in more detail.

Belief – a state or habit of mind in which trust or confidence is placed in some person or thing.

Cognition – conscious intellectual activity (such as thinking, reasoning, or remembering).

Doubt – to call into question the truth of: to be uncertain of. To lack confidence in.

Inference - the act of passing from one proposition, statement, or judgment considered as true to another whose truth is believed to follow from that of the former.

Information – knowledge obtained from investigation, study, or instruction.

Knowledge – the fact or condition of being aware of something.

Metacognition – awareness or analysis of one's own learning and thinking processes.

Observation - an act of recognizing and noting a fact or occurrence; a judgment on or inference from what one has witnessed.

Source – one that supplies information to another.

(*The above definitions are consistent with definitions in the Merriam Webster online dictionary.)*

Heuristics – simple procedures that help find adequate, though often imperfect, answers to difficult questions (Kahneman, 2013).

Debate and Dialogue

Debate is a respected model for settling disputes between two parties. In an ideal debate, the two parties demonstrate critical thinking skills to construct the best arguments and advocate for their side, and an impartial third party (judge) determines a winner. Our U.S. legal system is based on the debate model where attorneys representing both sides argue their cases before a judge. Schools teach debate skills, field teams, and host competitions. Presidential debates have

become a traditional method for evaluating candidates. We often see talk shows featuring proponents of two different points of view "debating" each other.

Otto Scharmer (2016) identifies some problems with the debate approach and illustrates how they can lead to polarization. Debate is often based on "talking tough" where sides just harden their positions and "download" the same information without any active listening to each other. This is arguing, not conversing. Nuance and context get lost. Like a sports competition, the winner is often based on who was tougher, or who had the most power, not who proposed the best solution that was most factual and/or best represented the interests of all stakeholders.

In practice, debates in the media have evolved to often simply be shouting matches between two extremes, and somehow this is seen as balance. That is the equivalent of setting one's thermostat at 40 degrees in the morning, and 100 degrees at night, and declaring it comfortable, because the average temperature is 70 degrees.

In debate the goal is to win. While many real-world problems involve multiple "sides", debate typically breaks down problems into two competing sides. The goal of problem solving should be to find the best solution to the problem at hand, taking all of the stakeholders into account. Typically, that involves combining multiple ideas, and working collaboratively together to find even better solutions. One important mechanism for doing so is via dialogue.

Scharmer (2016) proposed a framework that divides conversation into four "fields" that range from politeness to generative dialogue. Most conversations start with politeness, where a relationship is established between the parties, move into debate, and ideally move into reflective dialogue.

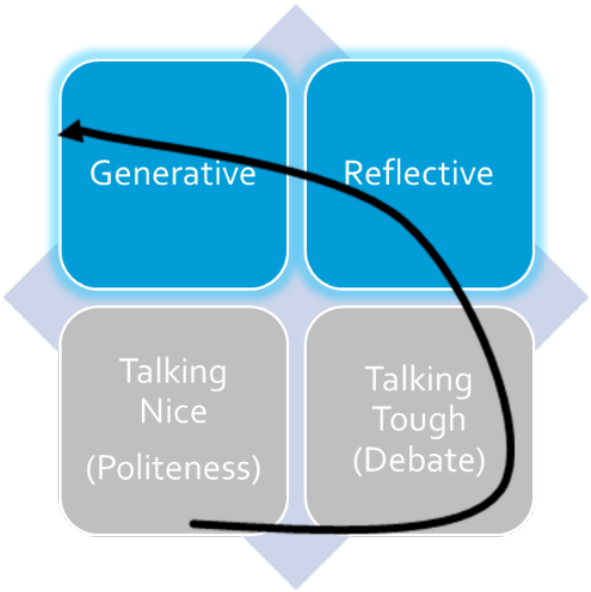

Figure 1 Scharmer's Four Fields of Conversation

William Isaacs defines dialogue as a "shared inquiry, a way of thinking and reflecting together. It is not something you do *to* another person. It is something you do *with* people." (Isaacs, 1999). Historically, before the invention of books and other means of communication, dialogue would have been the primary method of communication between people.

Reflective dialogue is what most commonly comes to mind when I think of working collaboratively with others. Each member offers some insights into the conversation, asks questions, and the group functions with respect for each other. This is the benefit of working together in groups that I've experienced. Throughout my formal education, my work life, and volunteer life, such collaboration has been used, encouraged, and valued. One of the unique abilities of humans is to work together, to utilize our strengths and minimize our weaknesses, and to help impart information from one to another. Sometimes the greatest value of collaboration is simply asking a question that sheds new light. This field of dialogue is the essence of the old saw that "two heads are better than one."

When groups are really humming, the conversation can result in what Scharmer calls generative dialogue. Here is where synergies happen, where the result of the collaboration is greater than the sum of the individual parts. Synergy is not something one can manufacture, it is not a process, but rather the result of a well-tuned system. This is the group equivalent of what Csikszentmihalyi called "flow" (as cited in Davis, 2004).

The process of dialogue is not linear, we often move back and forth between the various fields of conversation. For example, any good collaboration requires politeness, and debate is often helpful for identifying the strengths and weaknesses in arguments. However, being stuck in either of those fields keeps us from reaching the field of reflective dialogue that is necessary to create synergy. This model of dialogue is similar to Bruce Tuckman's theory of the stages of small group development identified as "forming, norming, storming and performing" (Tuckman, 1977).

A key takeaway is that dialogue and group performance are dependent on some conflict and differences of opinions. When all agree, when all are so polite as to not offer alternative points of view, when harmony becomes the goal, "groupthink" can occur and result in sub-optimal decisions.

I believe the four fields of conversation can also serve as a useful model for critical thinking, inquiry, and problem-solving. When we read books or articles, or listen to lectures, we are essentially listening to debate. We are listening to one side present its case. Ideally, the author or lecturer emulates dialogue by representing different points of view, but typically this is done to show why the other side is wrong. Opposing arguments are narrowly interpreted or trivialized. In some lectures, there are opportunities for others to respond through questions, but

there is an inherent inequality. The amount of conversation is controlled by the author or lecturer.

In theory, social media allows for conversation and dialogue. But the reality is that social media often results in two sides talking at each other instead of with each other, resulting in more debate. Each talks tough, presenting their best arguments. Additionally, the nature of platforms such as Twitter makes it difficult to discuss anything very deeply. Speed and clever sound bites are favored over thoughtful, deliberate replies. Most social media conversations tend to either reside in field 1 politeness, where all confirm each other's thoughts, or field 2 talking tough.

True dialogue is not easy. It relies on members acting in good faith with common goals. It requires active listening as much as speaking, and it requires respect among members. Power structures, whether explicit or implicit, can hinder all members being valued. In many situations, such as much of the current political situation, dialogue can seem futile. This is especially the case when the participants are not acting in good faith and/or many of the arguments seem based on misinformation, emotion, and/or questionable logic. Intentional misinformation can be used to scuttle any progress. This makes reflective dialogue especially difficult in our current information age. Dialogue takes time, and we have many demands competing for our time. We must be selective as to where we allocate our cognitive energy and listening.

The demands on our time and energy do not obviate the need for understanding multiple points of view. As J.S. Mill pointed out, "he who knows only his own side of the case knows little of that" (Mill, 1859 p. 35). The reason I place so much emphasis on the need for more reflective dialogue is because I feel that many have given up on this important and essential method of conflict resolution, leaving us stuck in the field of debate. And when debate mode and talking tough cause us to reach an impasse, when disputes can't be resolved any other way,

this can escalate to the point that humans perceive civil war as a means of resolution. While this may seem like a dramatic leap, we are seeing such rhetoric used in everyday discourse where political opponents are routinely labeled as traitors, there was an insurrection at the U.S. Capitol with the goal of overturning election results, and a bill was introduced into the Texas legislature supporting a referendum on secession from the United States (Texas, 2021).

Triple Loop Approaches

In an ideal dialogue, all sides and perspectives are equally represented. We can rely on others to bring alternative viewpoints to the table. However, that is difficult to fully attain in real life. Instead, I believe it is important to model dialogue in our own internal thought processes, analysis, and problem solving. A goal of this paper is to model that dialogue process in my own analysis of misinformation and political polarization.

One of the most useful frameworks from my CCT education has been the triple loop model of learning. The first loop of learning focuses on actions and asks the questions "Are we doing things right?", the second loop focuses on assumptions and asks "Are we doing the right things?", and the third loop focuses on context and asks "How do we decide what is right?" (Reynolds, 2014).

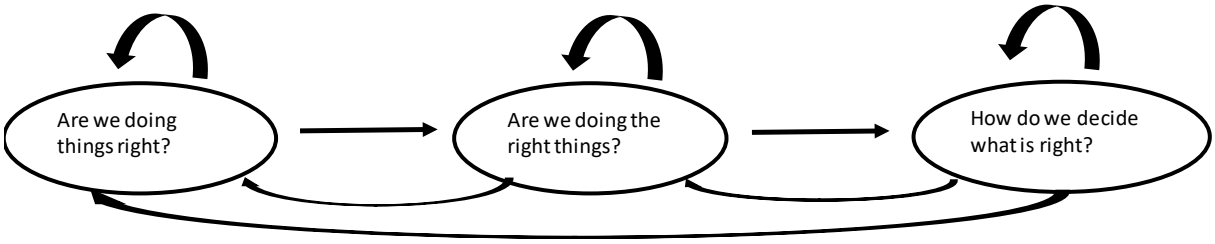

Figure 2 Triple Loop Model of Learning

In each loop we are constantly asking those questions. As we gain knowledge and confidence, we move to the next loop. And often those questions lead us back to a previous loop. In real life, we tend to stop at one of the loops. The triple loop model reminds us that our work isn't done; we need to consider each loop.

I have found this mental model so useful, that I have adapted it for many other areas of thinking to help promote the principles of good dialogue. This very much fits with the SCAMPER concept. At its most fundamental level, the triple loop model can be seen as representing micro, macro, and meta views of an issue. Each loop represents "stepping back," looking at the problem from a broader perspective and level of abstraction. In an ideal dialogue, we rely on others to present these perspectives, but by using this model, we can emulate that function.

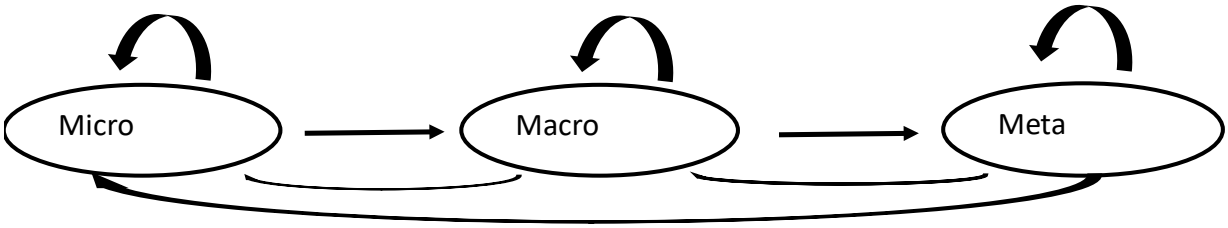

Figure 3 Universal Triple Loop Template

Now, we can put this same model to other uses by substituting other micro/macro/meta concepts. For me, the most useful is the concept of a triple loop model of perspective. Here, we look at how problems appear from three specific lenses. First, how does the issue look from the perspective of the individuals involved. Next, we "go to the balcony" and observe the individuals from a more objective point of view, observing how they interact with each other. I was first made aware of this basic two-step concept in a business school class on negotiations

and conflict resolution (Fisher & Ury, 1981), and have found this to be a very useful paradigm for seeing the world.

More recently, my CCT education in the fields of Critical Theory and Science and Technology Studies helped me see the value of a meta-perspective, a third loop, where we step back even further than the balcony, we go outside the theater. We not only are able to observe the actors and audience members, but we also recognize those that aren't even in the theater, those who aren't part of the negotiation, but nevertheless have a stake in it. I believe that this is an essential loop in the process, which is sometimes overlooked by conventional scientific approaches.

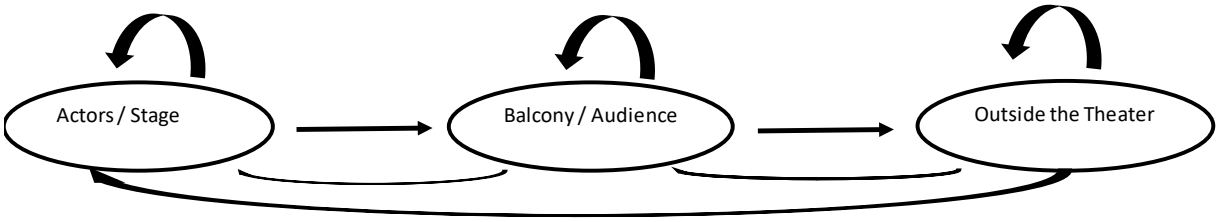

Figure 4 The Triple Loop Model of Perspective

Interestingly, this exercise has led me to see Scharmer's fields of conversation approach in terms of a triple loop model, instead of the grid that Scharmer suggests. Here, each loop corresponding to one of the first 3 fields, where the 4th field, generative dialogue emerges as a product of the first 3 loops.

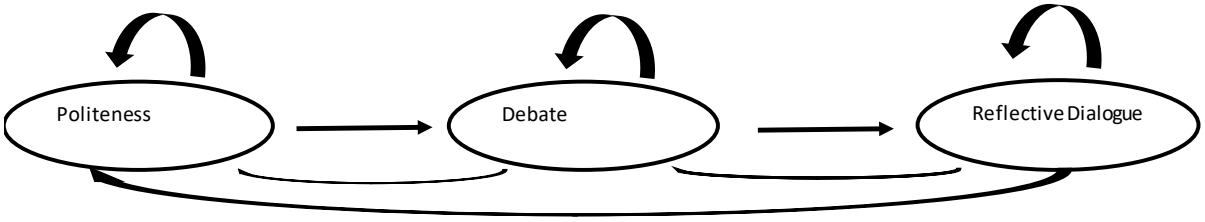

Figure 5 Triple Loop Model of Conversation

Developing this approach reminded me of the importance of visual images such as these to map human thought processes. As someone who never considered himself to be a visual learner, the CCT program has shown me the great value of graphical vehicles to illustrate processes, much as Venn diagrams or cartesian coordinate systems serve in mathematics for illustrating complex concepts. The triple loop model has served me as a useful visual aid for viewing problems from different perspectives, and it is one I will refer to throughout this paper.

Methodological Believing and Doubting

Debate typically occurs when we are certain of something, and someone else is certain of a different conclusion. We argue our points, highlight our reasoning, and point out flaws in the other's reasoning. We each assume that our side is right, the other is wrong. Implicit in debate is a lack of respect for the other side: they're wrong, they are flawed and need to be corrected. We believe our side and doubt the other. In reflective dialogue, we are empathetic with the other side. We reserve judgment, we try to see it from different points of view.

A core aspect of critical thinking is skepticism and doubt. We don't just accept opinion, we want proof. This is at the core of what is considered rational thinking. In debate and conversation, we practice this by critiquing the other side. Peter Elbow (1986) points out that Descartes systemized this method of doubting, which became the foundation of much scientific thinking. Certain truth is discovered by eliminating all doubt. As Elbow says: "We encounter here that curiously pregnant asymmetry in logic by which only negative claims can be certain. We can never be certain that all swans are white no matter how many swans we examine, but we can absolutely be certain that all swans are not white by just seeing one black swan" (p. 256).

Elbow calls this approach "methodological doubting." Elbow makes a strong case that this is only half of what is needed:

> *Yes we need the systematic, disciplined and conscious attempt to criticize everything no matter how compelling it might seem- to find flaws or contradictions we might otherwise miss. But thinking is not trustworthy unless it is also includes methodological belief; the equally systematic, disciplined, and conscious attempt to believe everything no matter how unlikely or repellant it might seem – to find virtues or strengths we might otherwise miss. (p. 257)*

I see this as the key to reflective dialogue. We have respect for the others in the room, we reserve judgment, and we try to see it from their perspective. As Elbow says, this differs from most academic inquiry in that we are "not trying to construct or defend an argument but rather to transmit an experience, enlarge a vision" (p. 261). Our goal is not just to listen to others, but to try to believe other views and hypotheses. If a person expresses an odd view, we refrain from quarreling with it, and try to believe it. At the same time, we practice methodological doubt on our own perspectives. We look at how they sound and appear from differing perspectives.

Some critical thinkers might reject Elbow's idea as "flaming relativism" as Elbow describes it (p. 261). However, he says the key to methodological believing is *not* that you must accept the other arguments, but simply that you are not allowed to reject an idea until you have succeeded in believing it

Taken to the extreme, I find Elbow's ideas impractical. In a world of misinformation, we can't take the time to "believe" every piece of misinformation out there. In fact, that can lead to part of the problem ─ we spend so much time responding to misinformation as if it were true that

it keeps us from ever getting to the core issues. Sometimes acknowledging opposing viewpoints based on misinformation only encourages more misinformation, especially when the goal of some participants is to distract. Some truths are absolute and knowable with certainty and entertaining other points of view is a waste of time and may serve to enable misinformation. We know that 3+4=7 and no amount of dialogue will change that.

Nevertheless, the basic truth of Elbow's argument remains, and he raises some very important fundamental questions: Given that we don't know what we don't know, how do we know with certainty when we are absolutely right? What do we do when the truth is not certain? Here, methodological doubting and believing can provide a framework that is consistent with any objective academic inquiry by acknowledging these questions. I would propose a pragmatic implementation of Elbow's methodological doubting and believing as follows:

- We should doubt/critique our own arguments with the same scrutiny as we do others.
- We should give the same benefit of the doubt to others' arguments as we do to our own.

I believe this concept fits well with Scharmer's emphasis on empathy, and UTEC's model of "assuming goodness." This is the framework I will try to use for the remainder of this paper. In the words of J.S. Mill (1978), "Though the silenced opinion may be in error, it might and often does contain a portion of the truth."

Understanding Human Thinking

Each individual human makes thousands of decisions each day. Faced with a choice, we apply tools in our toolkit to choose the best fit for the problem at hand. Each of us has a different toolkit and experience. While science provides us with some advanced tools such as mathematics and logic, those are relatively recent advances in evolutionary terms and need to be

learned and practiced. Evolution has also equipped us with a variety of tools for making decisions that come innately, do not require formal training, and which operate efficiently at our System 1 levels, freeing up our System 2 thinking to take on other tasks.

These System 1 mental processes are called heuristics. Kahneman defines heuristics as "simple procedures that help find adequate, though often imperfect answers to difficult questions" (p. 98). System 1 thinking is seldom stumped. It always finds an answer. If the question is too difficult to answer, System 1 substitutes a simpler question, which Kahneman calls "the heuristic question" (p. 97). This approach allows humans to make quick decisions based on perceived patterns. While the decision may not always be correct, it allows for decisiveness.

Human thinking is greatly affected by the limits of our brain architecture and our biology. Our brains have limited bandwidth, so being efficient and making quick decisions allows us to maximize the value of our brainpower. Similar to the strategies we use to take standardized timed test, it is better to answer all of the questions at 80% accuracy than it is to be fully accurate but only get to 20% of the problems.

Heuristics, and all human thinking, rely on existing knowledge. We gain knowledge not only via direct observation, but also via sources. Similar to the way we learn in a traditional schoolroom, we often gain knowledge because a source tells us it was true. Our learning is much more efficient if we don't have to verify everything through personal observation and testing, but instead can rely on others to have done that observation and testing for us. In fact, in the modern world, "almost all of secondary knowledge stored in long-term memory is borrowed from other people" (Sweller, Ayres and Kalyuga., 2011 p. 28). And by collaborating with multiple sources,

we can create a "collective working memory" that effectively and efficiently increases our mental capacity (Paas and Sweller, 2012).

Sources are so evolutionarily important to humans, that our brains have specialized functions to help us manage information acquired from sources. We don't only remember what knowledge we learned, but this wiring helps our brains also remember the source, where and when we acquired it. This is called "source monitoring" (Johnson, Hashtroudi, and Lindsay, 1993). This all happens unconsciously at the System 1 level, so we don't even realize it is happening.

At this point, our System 1 thinking is practicing methodological believing. Believing is more efficient than doubting. "System 1 is gullible and will believe almost anything. System 2 is in charge of doubting and unbelieving" (Kahneman, 2013, p. 81). "System 1 is not prone to doubt. It suppresses ambiguity." We store information we trust to be true and "the associations that it provokes will spread as if the message were true" (Kahneman, 2013 p. 114). Only System 2 is capable of doubt.

One of the most important functions of System 1 thinking is to act as a gatekeeper for the limited bandwidth of System 2. This limited bandwidth is known as cognitive load. This explains why we are not able to perform two complex multiplications in our heads simultaneously. This is an extremely important point when we think of the task of identifying of misinformation. Identifying something as potential misinformation requires doubt, which means that it will require System 2 focus. Meanwhile System 1 is tasked with trying to limit what System 2 focuses on. The more other things that System 2 is dealing with, the less likely it is that it will focus on identifying misinformation.

Scientific Thinking

The other side of belief is doubt and skepticism. Truth doesn't come simply from belief, it comes from providing evidence of truth. Yet, "It is an effort to learn to question that which the context and our culture lead us to take for granted. The development of logic has been crucial in this battle. It is logic that permits the individual to outvote this group" (Elbow, 1986, p. 262). And, following Elbow's insights, as academics and critical thinkers, we have a special role as doubters, which can create an "inevitably combative or adversarial element" (p. 262).

Scientific thinking also allows us to view individual thinking "from the balcony." We can observe multiple individuals and see the results of their thought processes. We can see how each may optimize their own thinking based on their own knowledge, but we can also see where those thought processes can lead to flaws when viewed from an objective perspective. Science has also developed additional tools, such as logic and statistics, which can be applied to make more accurate determinations.

In addition, scientific thinking also can take advantage of hindsight. We can see the results of each individual's decisions, and we can identify where those decisions produced a less than optimal result. Cognitive psychologists have begun to study and classify the heuristics that can lead to a suboptimal result into categories called "cognitive biases." Cognitive biases are defined as systematic errors in thinking (Cherry, 2020). An example of this would be "confirmation bias," where we give greater weight to information that confirms our beliefs. If System 1 is less likely to consider as misinformation something that confirms what we already believe, then it is less likely to pass this on to System 2 for doubting. And thus, misinformation can propagate.

A similar cognitive bias is the Dunning-Kruger effect. This is a bias whereby people with limited knowledge overestimate their own knowledge or competence in that area (Anson, 2018), adding to the difficulty of correcting misinformation once it is believed. Closely related to cognitive biases are "fallacies." Fallacies are defined as mistaken beliefs or faulty reasoning. This is the focus of Steven Pinker's work: identifying and correcting these biases and fallacies. He believes that the goal of critical thinking is to expose fallacies and coaxing people into renouncing them (p. 74).

But an important factor that also tends to get missed is that all of us, including scientists, are also susceptible to cognitive biases such as the Dunning-Kruger effect. System 1 thinking is still our predominant method of thinking. This means that as much as we invoke methodological doubt when looking at other's reasoning, we are subconsciously invoking methodological believing of our own thought processes, and those that confirm these beliefs.

The Problem With Problems

> *"You have probably heard it said that truth is subjective and personal, or that each person creates truth to his or her own specifications. This belief is common today, and it means that believing something is so actually makes it so. In other words, reality is whatever we wish it to be. This idea directly contradicts the view that has been generally accepted since ancient times—the view that truth is the accurate representation of objective reality. In this view reality is unaffected by our wishes, preferences, and assumptions. Is the new view that truth is created and subjective more reasonable than the traditional view that truth is objective? Perhaps the best way to tell is to consider what the new view of truth implies about everyday issues. If truth is created by each*

> *person, then . . .. . . Galileo's assertion that the sun is the center of the solar system, a view that shocked most people of his time, is not true for everyone but just for those who want to believe it. . . . Those who believe that the earth is flat, the Holocaust never happened, and Saddam Hussein was a benevolent leader of his people are correct. And so are those who take opposite views." (Ruggiero, 2009)*

This quote, from Vincent Ruggiero's textbook on critical thinking is a good example of how even those who value objectivity, can engage in debate mode and the promotion of groupthink. Ruggiero certainly makes a strong case for his point of view. But his statement also serves to "talk tough," and to squelch dissenting viewpoints, by preemptively saying that those who disagree with him are no different than flat-earthers and holocaust deniers. Ruggiero is methodologically believing his point of view and methodologically doubting those who might have a different point of view, leaving no room for dialogue.

In thinking of this from the third loop, I asked myself how one might see this from a different perspective if one practiced methodological belief of dissenting viewpoints, and methodological doubting of Ruggiero's conclusions. What additional questions would this engender? Questions such as, "Are there cases where truth is subjective and can't be known with certainty?", "What assumptions are implicit in his argument, and are those assumptions accurate?", "If I believe that the truth is sometimes subjective, does that make me a Holocaust denier?", "Are those the only two choices?" And furthermore, "How would someone react to being called a Holocaust denier because they had the belief that truth is sometimes subjective?", "How would that affect their respect for academia?"

Uncertainty and Perspective

I began to reflect upon the fundamental question of whether there is always an objective truth, and whether one can be certain when one has found it. There certainly is a class of problems where one can be certain of the truth, where there is no room for subjectivity. The outcome will always be the same no matter how many times we try. Methodological doubting will never find an example where the statement is not true.

These are problems such as 3+4=7, whether the sun will rise, and whether humans need air to breathe. For this class of problems, many terms associated with critical thinking terms are synonymous. Critical thinking, rationality, reason, logic, all result in the same answer. There is an absolute truth, there is only one correct answer. Knowledge, truth, and beliefs are likewise all the same. The answer is the same from any perspective. Success is getting the right answer, and failure is getting the wrong answer. Problems like this are known as deterministic problems because the outcome can always be determined.

Deterministic problems become the exemplar for what is often thought of as critical thinking. This is the type of truth than Vincent Ruggiero is speaking of. This application of critical thinking is reinforced in our daily lives through standardized tests, quiz shows, and puzzles such as crosswords and jigsaw puzzles. We reflect this thinking when we follow recipes, listen to GPS directions, or buy the same brand of toothpaste.

This concept is reinforced so much, that it becomes easy to forget that there are other classes of problems for which it isn't true, where the correct answer can vary depending on the frame of reference it is viewed from. An example is Figure 6, outlining how the same evidence can look different from different perspectives. Depending on the angle, the same figure looks like a six or a nine. Each person can believe with certainty that their answer is correct. Only

when we practice methodological believing are we able to see it from the other's perspective. And when we step back and view the problem from the balcony, we are able to see it from another perspective that allows us to better understand why each side was certain of their answer.

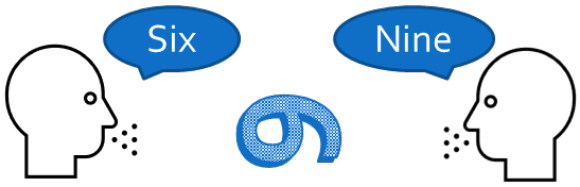

Figure 6 : How Perspective Affects Perceptions

More importantly, there is yet another large class of problems that involve some amount of randomness, so the outcome can *never* be predicted with certainty, regardless of perspective and knowledge. These are known as non-deterministic problems. For example, consider the case of a coin flip. Before the flip, there is no way of predicting the outcome. Even the smartest mathematician in the world will be no better than a fortune teller. If one views the coin showing "heads" after the flip, the result is as certain as a deterministic problem. And to an objective observer with no knowledge about the randomness of coin flips, the mathematician who predicted "tails" looks as foolish and irrational as someone who answered that 3+4=9. And the fortune teller who predicted heads seems prescient. In this case, truth is indeed personal.

Stepping back, we can see how the same logic that worked well for deterministic problems can lead us into false conclusions when applied to non-deterministic problems. If we approached the problem with the assumption that it is deterministic, once we observe that the fortune teller was correct, we go back and change our prediction methodology to trust the fortune teller over the scientist. Unless we are conscious of the fact that the two classes of problems

require different approaches, we may end up using the wrong tools. Not unlike a carpenter, who having known tools to successfully connect wood boards (hammer and nail), would be choosing the wrong tools if they tried to join two pieces of metal with hammer and nail. Different tools are needed for different problems, but we have to first recognize that the problems are different.

I have been surprised at how often this fundamental concept is underappreciated and even misunderstood by those who are focused on absolute truths. The search for absolute truth has become so ingrained in the scientific community, that we often minimize the importance of the large class of problems to which there actually are no absolute truths.

This is an example of the danger of debate where we are only seeing two sides and are so caught up in advocating our side, and advocating against another side (e.g., those that believe there are no absolute truths), that we miss that there are more than two perspectives to be considered. When we practice methodological doubting, a core principle of scientific inquiry, we can also make errors of logic if we stop there and don't also take the time for methodological believing ─ taking the time to understand under what circumstances a reasonable person might have adopted a different conclusion.

I do appreciate that Ruggiero's focus is a reaction to those who say that truth is *always* relative, that there are no absolute truths, and he is trying to counter that position. And I recognize that this belief in the absence of any absolute truths is often used as an excuse by some who propagate misinformation, so Ruggiero is making an important point that there are indeed absolute truths, and about the value of the scientific method.

Nevertheless, his statements leave us in debate mode, with each side talking tough and not listening to the other; and it doesn't change the fact that in many situations, truth is indeed subjective and non-deterministic. And not recognizing that fact can itself lead to the propagation

of a different kind of misinformation. An important role of critical thinking is therefore to identify the type of problem, and then to apply the appropriate tools. And for real-world problems outside of a scientific laboratory, the majority of social problems are complex, having no single objective solution and having non-deterministic components. Complex problems are a combination of interrelated problems, with each potential solution having both pros and cons with differing impacts on those affected. The variables affecting the solutions are not independent. Solutions look different based on perspectives and priorities, and like the coin flip example, evidence may sometimes be misleading. In these cases, definitions of rationality, reason, and logic can diverge. In the **Appendix,** I have attempted to classify problems based on the certainty of outcome for those readers who are interested in a further exploration of these issues.

More on Uncertainty

Certainty is more efficient than uncertainty because one has fewer outcomes to consider. Treating solutions as certain allows us to make quick decisions and move on to other tasks. This results in some interesting paradoxes. If 100 people each flip a coin, roughly half will see heads and half will see tails, a clear indication of uncertainty when viewed from the more objective perspective of the second loop, akin to seeing things from the balcony. But, without the balcony view, each individual will see it from the micro level of the first loop, and only see their own coin flip. From that perspective, each will be certain of the result of the specific coin flip they witnessed. Kahneman identified how humans are adept at finding patterns (p. 115). So, based on an individual's observations, a person with no other knowledge of coin flips, who sees a coin flip comes up heads twice in a row may see no reason to test further, and may assume that coins always come up heads. That gets filed away as truth. Later, if they see someone else's coin

come up different than their belief, the first assumption is likely to be that "they must have done it wrong" because our individual observations are prioritized. This is a form of cognitive bias. We are giving our own experience more weight than the experience of others.

Elbow's methodological doubting alone can lead us to see these as errors in thinking. We know the ideal solution, we see how a person drew a different conclusion, and we begin to systematically identify all of the other similar errors that cause a person to draw incorrect conclusions. And if we can do that, then it seems logical, that we would all be better thinkers.

But if we also practice methodological believing, we might ask the question as to why would evolution have permitted these flaws in thinking to thrive? If there are better ways to think, wouldn't evolution have favored those methods? Wouldn't those who made better decisions have a better chance of survival? Given that, perhaps there are also benefits to cognitive biases?

From that perspective, one can begin to identify times when cognitive biases might be helpful. Perhaps the ability to make quick choices is sometimes more important than making the perfect choice? E.g., in a fight or flight decision, flight doesn't work well if it takes too long to flee. In that case, by the time one decides the best option is to run away from a lion, it may be too late. Even if only half got it right by making a quick decision, half of the population would survive. Whereas if it took too long, 100% of those who got it right would still likely be dead. So, over time, our System 1 thinking might evolve to favor those who have a quick reaction to lions. It might also mean that some people also run away from housecats, but the impact of a false positive (e.g., running away from a housecat) is much less serious than the result of a false negative (e.g., trying to pet a lion).

Statistics

Statistics is the mathematical field that helps us deal with uncertainty by recognizing correlations and patterns in data and assigning probabilities. Statistics allows us to observe a smaller sample and infer a property about a much larger population. This is especially useful for non-deterministic problems where individual results might lead one to an incorrect conclusion. While the aggregate of the samples can infer a global property, any individual sample can be misleading. So, for example, a sample of random people might give one a reasonably accurate view of the average height of humans, but if one happened to take that sample at an NBA tryout, one would likely draw a misleading conclusion.

Tversky and Kahneman (1974) have documented numerous situations where humans drew incorrect conclusions from the samples they observed. And they demonstrated how statisticians were able to anticipate those errors, implying that humans are not very good at statistical thinking. This is an example of scientific inquiry, based on methodological doubting, at work. Tversky and Kahneman were able to identify specifically a class of problems where cognitive biases resulted in humans jumping to incorrect conclusions. And from that, concluded that human thinking would improve if we corrected these biases. But, as Elbow observed, doubt is half of the equation. What is missing are other questions that Tversky and Kahneman did not address. Questions that would come from a methodological believing approach to the problem. For example, how many situations were there where the people did people get it right? How many times did they draw conclusions quickly that statisticians would have needed significantly more time to reach the same conclusion? What values did the people involved place on accuracy vs. efficiency in reaching an answer?

In addition, as someone trained in statistics, I think it is especially important to note that given a limited set of information, given only the data that the individuals were working on, a trained statistician/scientist might make no better inferences on the outcome than the untrained individual. The difference is that statisticians/scientists understand that the data is insufficient and don't stop at the initial conclusion, but rather continue the experiment, setting control groups, pulling samples from other places, and aggregating samples observed by others. They actively look for other potential explanations.

In doing so, each person is making a choice of priorities. For the non-statistician, their priority may be to make a quick decision that is good enough for their purposes, so they can move their cognitive attention to other activities. Perhaps that entails earning a wage, cooking dinner, or changing a diaper. For the scientist in that situation, however, the priority is greater accuracy.

Because research is part of a scientist's job, it also means that they have more time and expertise than the average person to focus on this research. But it should be noted, that even then they are making prioritization choices about what to research and how precise they need to be, since they can't give every decision the same scrupulous attention. Each scientist still must make decisions about balancing other commitments, where to focus their research, when to dig deeper, and when to move on to other areas of research. Just because they have more time to focus, doesn't mean that they have unlimited time.

The point I am making here is the importance of time and priorities. To someone who has significantly more knowledge of a subject, it may appear that another person is making irrational decisions when uncertainty is involved. But for that other, there is little reason to

complicate things if they perceive the current solution as sufficient. Learning more, getting a more correct answer, may simply not be as important to them as other things on their minds.

Prioritization

As previously mentioned, we use heuristics to help us prioritize what gets our attention, and how we decide which sources to believe. Kahneman calls this innate ability "intensity matching" (p. 93). We are very good at comparing things to each other, a form of pattern matching. Not only do we compare like things, such as which weighs more, but also disparate things, such as what do we like more, a new shirt or a candy bar.

A number of cognitive biases affect our prioritization. For example, what is labeled "confirmation bias" means that we give greater weight to information that confirms our beliefs. Steven Pinker describes confirmation bias as "the bad habit of seeking evidence that ratifies a belief and being incurious about evidence that might falsify it" (p. 13). This is a good example of how heuristics are often judged negatively by well-meaning thinkers. But if this is a heuristic that we all share, and helps us make difficult decisions efficiently, why should we label it a "bad habit" because sometimes it produces an imperfect solution? If it is such a bad habit, wouldn't it be likely that evolution would have eliminated it? I believe that the reason this "bad habit" has survived is twofold: First, confirmation bias is actually efficient and effective, and when viewed across a wide sample of situations, will be more beneficial than harmful. We don't have time to investigate everything in the world, so it makes sense that we should set a higher standard for those things that run counter to things that we've already investigated. Secondly, it helps us deal with non-deterministic problems. As we discussed, non-deterministic problems mean that we **will** find examples where the results counter our beliefs. Should we go back and challenge our

beliefs every time we see a specific example that yields a different result? E.g., we know that slot machines favor the casino, so should we question that belief each time we witness someone who hits a big payoff?

Another influence on prioritization is called "priming" (Kahneman, 2013). We are more likely to prioritize something if it is associated with something we have recently seen or experienced. This explains why, for example, we might pay more attention to climate change on a hot summer day than on a more temperate one.

Ironically, in some cases, eliminating cognitive biases can actually result in less logical thinking, not more. For example, should an individual doctor doubt all of the evidence for the efficacy of vaccinations because one of their vaccinated patients contracts the disease? We certainly have examples of that happening, and spreading misinformation based on a small sample of evidence.

This is the importance of thinking from the third loop. It is not enough to find examples where cognitive bias results in incorrect conclusions, but rather one must step back and also look at assumptions and context. I would suggest that if we were able to put all of the examples on a scale of where cognitive bias resulted in an incorrect conclusion vs. a correct one, the scale would tip largely towards the value of cognitive biases.

The Role of Outliers

Although Pinker points out that confirmation bias is incurious about evidence that might falsify it, sometimes being curious can also lead us down the wrong path. Here is an example: In a coin flip, we think of outcomes as either heads or tails. But there is another possibility ─ the coin can land on its side. It is so rare, that it doesn't affect any statistics on coin flips. It is what is known

in statistics as an outlier, an anomaly that is statistically insignificant. The probability of a coin landing on edge is 1 in 6000 (Murray and Teare, 1993). I have never personally witnessed it, so don't even think of it as a possibility. On the other hand, a person who witnesses it happening will undoubtedly have a skewed view of its likelihood. Even if they flip a coin 100 times, their personal observations will tell them the chance are 1 in 100, overestimating the likelihood by a factor of 60. And because anomalies are interesting, and interesting things get passed on, their importance gets magnified, especially in the world of social media. I would be very unlikely to send my friends a video of my coin flip landing heads, but if it landed on edge, I would be more likely to post that. And it is more likely that others would forward that video to their friends. The upshot is that those who see the video will likely overestimate the probability of a coin landing on edge because that image becomes part of their individual sample. When an event is shared, that same event gets included in other people's samples, making it seem more likely than it is. This is what happens when a lottery winner is shown on the news. We all see that person, but we aren't seeing stories on the other 200 million people who didn't win, so our perceptions will be influenced.

Prosocial factors

Humans are prosocial in that we have responsibilities not only to ourselves, but also to the groups we belong to (Hare, 2017). Individual and group goals are not always the same. In the classroom of traditional schooling, individual goals are emphasized. It is considered cheating to ask a fellow student for help on a test or to help another student. In other situations, that same behavior may be seen as cooperation.

Evolutionarily, it is important that individuals survive in order for the species to survive. This often means prioritizing one's own survival. The classic example is the oxygen mask in an airplane. We need to put ours on first, to make sure we are able to help others. We then focus on those nearest to us. It isn't that we don't care about others, just that pragmatically, survival of a society and thus the species, depends on individuals surviving. And in general, individuals are in the best position to evaluate what is best for them. That is an important reason why organizations that delegate decision making generally do better than those where decision making is centralized (Hubbard, 2016).

So, it should be no surprise that our heuristics prioritize attention based on proximity to ourselves. Not only in physical location but in proximity of time. This can explain why people focus more on their own family's nutrition than those of the homeless or people in other countries, and why we prioritize the temperature of our living room over concerns of climate change in the future. It doesn't mean we don't care about them, it simply means that we don't weight them as highly. And this can be frustrating when we think of issues like global warming that need our attention. But I believe that unless we understand human heuristics, and factor them into our solutions, the likelihood is that we will simply get more frustrated.

Also, sometimes we play different roles in life, and make different decisions personally from what we would do on behalf of a group. We my answer a question differently if we are representing, or at least considering, both individual and group interests. For example, when we vote in elections, we are often representing both interests. So, a person may vote to increase funding for public schools and still choose to send their children to private schools. A scientist can believe in evolution and be a devout believer in the biblical story of creation. Each approach achieves a different goal.

The important point here is that even critical thinkers may come up with differing solutions depending on whether they are prioritizing their individual or group goals. And this can seem hypocritical when we see people being, for example, both pro-life and in favor of the death penalty.

When we are practicing methodological believing, it is important to look at priorities from the perspective of other people to ensure that we are seeing it from their eyes. I find it useful to think of Pinker's definition of rational thinking as "using knowledge to achieve goals" (2021, p. 36). Because while a specialist like Pinker uses rational thinking with the goal of finding absolute truths, the goal of rational thinking for an individual human is often to find an answer that is simply "good enough" so they can move on to other problems. Absolute truth is a luxury many humans can't afford.

The Role of Fear and Anger

Our thinking processes change when we are stressed or threatened. Hormones like adrenaline change our focus from long term to short term. Our ability to reason is affected because we are putting our energy into heightened senses (Swink, 2010). This is an important evolutionary feature that helps humans survive dangerous situations. Anger causes similar responses. When we are in debate mode, and are talking tough, we are chemically less able to think critically.

We also tend to choose sides when threatened. There is power in numbers, so we tend to migrate to others who think like us. When we are threatened, the world becomes more binary. The goal is survival. Proximity plays an even larger role. We side with those who are on our side, and we vilify those on the other side. Sometimes we question why people on one side of an

issue could possibly team up with people that have values opposite to theirs with respect to other issues. The simple answer is that when threatened, the natural instincts are to accept those who are on the same side of the battle. In battle, there are usually only two sides, so one has to pick one of the other.

Sometimes we may feel that the fear is unjustified. That may be the case, but it doesn't obviate the fact that our biology works that way. And it only matters that the threat is perceived, it doesn't need to be real. A coal miner may feel that their way of life is threatened by environmental laws, and their reactions will be motivated by fear.

The Role of Equity and Fairness

For a prosocial system to work, there must be some form of equity. Equity is a fundamental tenet of a modern democratic society. There is evidence that a sense of fairness is also part of our evolutionary wiring. De Waal (2012) has demonstrated through experiments that primates will work cooperatively but will get angry when they perceive they are being treated unfairly, such as when they are given a lesser reward for performing the same task as their neighbor. An important aspect of this is that the perception of fairness is relative in that it is judged compared to something else. In de Waal's experiment, the subjects only became upset when their neighbor got a different reward. A good analogy for relative judgments is a balance scale. The scale only measures whether the two sides are equal, not how much is actually on the scale. If both sides are equally reduced or increased, the scale is still in balance. So, if each side gets an extra 2 candy bars, or 2 less candy bars, the scale remains in balance. Fairness is maintained. But if we add 2 candy bars to one side, and 3 candy bars to the other, the scale will

be out of balance, and that will be perceived as unfair, even though both sides have benefited by the addition.

I believe that many disputes can boil down to different perceptions of fairness. And in a complex world, with complex problems, deciding on measures of fairness is difficult. Depending on what is put on the scale, what we individually value, the answers will be different. If one person has 3 apples and 5 candy bars, and another has 5 apples and 3 candy bars, perceptions of who has more will depend on whether we put apples or candy bars on the scale.

The Role of Time

Time is an important factor in how we filter information and set priorities. There is only so much information we can process in any given amount of time. We can't manufacture more time. For each issue we spend time thinking about, there is less time available for thinking about something else. Days are only 24 hours, we only live so long, and we need to sleep and attend to work and family duties as well as personal maintenance. System 2 thinking has a "natural speed" and can't be made to go faster without eliminating information. When we take shortcuts in thinking, when we don't research further, often we are not being lazy, but rather making prioritizations that help us manage our limited time. Judging what is important requires making trade-offs.

Time has different value to different people. Critical thinking takes time and energy. Not everyone has the same amount of free time. When we judge others for not giving something enough thought, or not considering data that we think is important, often we are imposing our prioritizations and valuations of time upon them.

In all my education on logic and problem-solving methodologies, time was seldom discussed as a factor. A teacher assigns homework, and we are expected to complete it and answer each question thoroughly. Implicit in this is that we have enough time to do so, and if not, we need to prioritize to make enough time. This is much more difficult when problems are non-deterministic. I know when my arithmetic homework is complete, so there is no value in spending more time on it. I don't have a similar metric for knowing when this paper is finished. There is always more that could be done to improve it. Managing time is an important skill to be able to function in this world. We have to make determinations of what is good enough given the time we have to allocate to it.

Some tasks take longer than others, depending on the person. One of the wonderful aspects of a society is that we can specialize. We can focus on an area of expertise, and someone else can focus on another. Doing so allows us to reach synergies. Specialized farmers, supported by others who build roads and farm equipment, can produce more crops than if we all had to grow our own food and grade our roads. It is sometimes easy for those of us in academia to forget that we are specializing in critical thought. In class, we practice laying out our views logically and expressing them cogently. Others may not have the same level of comfort and experience, and their doing so would take significantly more time. This is an important aspect of "seeing behind the mask," recognizing that someone who expresses a thought that we see as illogical, might not have the expertise to identify the flaw in logic, or might not have the time to figure that out, or might not have the right words to see the logic in their thinking.

Reflection, Summary, and Conclusions

When I first entered the CCT program, my goal was to better understand the causes of political polarization in the United States. My expectation was that I would learn more about cognitive biases and fallacies with the goal of helping people overcome their biases and become better at identifying and overriding misinformation. This is an approach that is suggested by many well respected thinkers in the field of cognitive psychology such as Steven Pinker. However, as my research progressed, I thought further about the assumptions inherent in that approach. I kept coming back to the fundamental question: if cognitive biases are so bad for decision making, why did they survive the evolutionary process?

I set out to answer that question through tools I had learned through the CCT curriculum. Thinking in terms of Scharmer's four fields of conversation was an important first step. This paper described how many of our conventional approaches are based on the debate field, where each side acts as an advocate for their position. Scharmer points out the benefit of reflective dialogue, where instead of focusing on debate, our focus turns to understanding and respecting other points of view. I tried to mirror that approach in my research into the way human's process information. Using the SCAMPER method of repurposing tools, the triple loop model of learning was adapted to serve as a framework for more objective understanding of problems and proved better suited to model the fields of dialogue than the traditional grid model. In each loop, one takes a step back and changes perspectives. The first loop of the triple loop model of learning is the foundation. We act as sponges. We observe, we listen, and we absorb knowledge. We believe our experiences and we believe others. In conversation, we are polite, we are on the same page, we support other, and we help each other gain knowledge and building blocks that is necessary for any future thinking.

In the second loop, we bring in our System 2 thinking and the tools of science. We question assumptions, and we look for proof. This loop models debate. We use rationality to construct and support our viewpoints. We believe and trust in those viewpoints and find evidence to support them. We also practice doubt, the heart of scientific inquiry. We challenge other points of view and search for flaws in logic. In conversation, we use the debate model to construct logical cases that would appeal to an objective judge. In doing so, we challenge and help others develop strong arguments to counter our own. If both sides keep an open mind, debate can lead us to great new discoveries that improve each other's thought processes. However, this can also lead us to seeing thinking as a contest between sides as opposed to a collaborative effort to find truth and solutions that take all sides into account. During debate, we act as advocates, believing in our own positions, and doubting opposing positions.

In the third loop, we change our focus. We step back and look at our own selves from an outside point of view. We wonder not only about the best answer to the question, but question whether we are asking the right questions. We try to understand the context as well as the assumptions. In this loop, we reverse our perspectives. We try to believe opposing points of view and doubt our own. In conversation, we listen to others with empathy and try to see our positions through their perspectives. Elbow's approach to methodological believing helps ensure that we take deliberate steps to fully take other perspectives into account.

Sometimes, instead of seeing the loops of thinking as part of an overall process, we may see them as competing processes, treating one loop as more important than the others. I know that upon reading Scharmer for the first time, that was my takeaway: that somehow we should replace politeness and debate by reflective dialogue. Over time I have come to recognize that all the loops are necessary components of an effective dialogue process. We shouldn't think of one

as superior to another. Polite conversation is a key component of conversation, as is debate. Just because we have identified potential flaws with each does not mean we should throw them out, it simply means recognizing that there is more to the process. We don't want to be stuck where one field is the only model we have for conversation. An ideal conversation should easily slip back and forth between the three fields. Treating all loops as important allows us to take a "yes, and…." approach to problem solving. Similar to the "plus-delta" feedback tool (Taylor & Szteiter, 2019) that we often used in our CCT curriculum to allow for a more holistic, less binary view of problem solving, "yes, and…" helps us see the pros and cons of all sides. Methodological believing does not only mean believing what others say, but also understanding the context of why they are saying it. This shifts us away from being critics and doubters, and more to being collaborators.

By using this triple loop approach, this paper was able to step back and look at research into cognitive psychology from different perspectives. Instead of focusing on the flaws of cognitive biases, it focused situations where cognitive biases could be helpful. The following section summarizes the findings.

Humans are Human

Humans have capabilities for deep thought, but we are not machines. Our thinking has evolved over hundreds of thousands of years, has allowed us to adapt to a wide variety of situations. Humans make errors. In some situations, what appear to be flaws may actually be "features" that allow us to cope with other situations and solve other complex problems. The act of finding these flaws through scientific thinking processes such as methodological doubting,

should be balanced with methodological believing which allows us to a deeper understanding of why the "flaws" exist in the first place.

By doing so, we become better and more objective thinkers. Even if we ultimately reject the result of the methodological believing, we gain a better and more universal understanding of the problem.

Knowledge Comes from Sources

Humans rely heavily on sources and observation for our information. The reliance on sources is an innate function, embedded in our System 1 thinking, and not easy to override. This helps explain why well-reasoned logical arguments are not always accepted by others who believe other sources over us, even if the sources are spouting misinformation. For example, this can help explain why so many believe that the 2020 Presidential election was fraudulent, despite the fact that no one has produced any evidence to support that claim. The sources they believe, whether their newspaper, their neighbor, or Donald Trump, are treated by their heuristics as if they had personally seen the evidence.

And this also helps explain why changing a person's mind is much more difficult than imparting new information. If you had personally observed an event, imagine how likely you would be to reconsider your recollection if someone else told you that your observation was incorrect. And how even less likely you would believe them if they were outside your trusted circle and came from someone that a trusted source told you was non-credible?

Prioritization of Thought

Thinking logically and rationally has a cost. One has to devote significant time and mental focus to a problem to apply the tools of rational thinking. We cannot devote this amount of attention to every problem in our lives, so we need to prioritize what we think about. Instead of thinking of others as not being rational, I find it is useful to think of them as not having gotten there yet, not having had the time to prioritize these issues the same way we have.

There are many influences on what and how we prioritize our cognitive attention. In most human decision making, we are making some tradeoffs between efficiency and accuracy. If we don't recognize this, we may expect others to share our priorities. And if we try to impose those priorities on others, that may spur a defense reaction that causes others to focus their cognitive thought on fighting us, as opposed to addressing the core issue

Non-Deterministic Problems Need Different Approaches

The scientific community tends to treat non-deterministic problems the same way we treat deterministic problems. Solutions to deterministic problems can be shown to work in all cases. However, in the real world, many problems are non-deterministic. The nature of non-deterministic problems means that there will be instances where all sides can provide an example of an instance where the other side's point of view did not work. For example, many of the people we might label "science-deniers" can point to specific examples of where scientists were wrong. These exceptions take on greater weight as sources spread this information, making exceptions seem more common than they occur in reality.

Final Thoughts and Next Steps

One of the most important lessons I have received from my CCT education is the importance of recognizing that projects such as this are a work in progress, as opposed to a completed work. While I had initially hoped to be able to offer solutions to political polarization, this paper only dealt with the first "problem-finding" step. A major focus became repurposing tools to develop a triple loop framework to better understand the complexities inherent in political polarization. This framework helped me consider differing perspectives, and allowed for the equivalent of reflective dialogue, even when others are not able to represent themselves. I believe that the ability to do this as an individual is increasingly important in a world where it is difficult to engage disparate viewpoints in constructive, respectful conversation. In addition, understanding human brain architecture and our cognitive limitations, understanding the role of time, prioritization, and sources in human thinking, helps us better understand why others may reach different conclusions based on the same data.

I believe this modified triple loop model can be useful for addressing other complex problems facing our world. I look forward to continuing this work in process, through additional research and by engaging in reflective dialogue with others to hear their perspectives on the issues raised in this paper. Unlike debate, there is no winner, no final resolution.

REFERENCES

Anson, I. (2018). Partisanship, Political Knowledge, and the Dunning-Kruger Effect.. *Political Psychology*, 39(5), 1173–1192.

Cherry, K. (2020, July 19). What is Cognitive Bias? *VeryWell Mind*. Retrieved from https://www.verywellmind.com/what-is-a-cognitive-bias-2794963

Davis, G. (2004). *Creativity is Forever.* Fifth Edition. Kendall-Hunt Publishing.

de Waal, F. (2012). Moral Behavior in Animals. *TedTalks.* Retrieved From: https://www.ted.com/talks/frans_de_waal_moral_behavior_in_animals?language=en

Doherty, C. & Kiley, J. (2019). Americans have become much less positive about tech companies' impact on the U.S. *Pew Research Center.* Retrieved from: https://www.pewresearch.org/fact-tank/2019/07/29/americans-have-become-much-less-positive-about-tech-companies-impact-on-the-u-s

Elbow, P. (1986). Methodological Doubting and Believing: Contraries in Inquiry. *Embracing Contraries: Explorations in Learning and Teaching*. Oxford University Press.

Fisher, R. and Ury, W. (1991). *Getting to Yes*. Penguin Books. Second Edition.

Fuller, B. (1982) *Critical Path*. St. Martins Griffin.

Goldstein, D. & Gigerenzer, G. (2002). Models of ecological rationality: The recognition heuristic. *Psychological Review*, 109(1), 75–90

Hare, B. (2017). Survival of the Friendliest: Homo sapiens Evolved via Selection for Prosociality. *Annual Review of Psychology*, 68(1), 155–186.

Hubbard. (2016). Research: Delegating More Can Increase Your Earnings. *Harvard Business Review,* August 12, 2016. https://hbr.org/2016/08/research-delegating-more-can-increase-your-earnings

Isaacs, W. (1999). *Dialogue and the Art of Thinking Together*. Doubleday.

Johnson. M., Hashtroudi, S., & Lindsay, D. (1993). Source Monitoring. *Psychological Bulletin*, 114(1), 3–28.

Kahneman, D. (2013). *Thinking, Fast and Slow.* Farrar, Straus and Giroux. Paperback edition.

Kalyuga, S. (2011). Informing: A Cognitive Load Perspective. *Informing Science*, 14, 33–45.

Machete, P., & Turpin, M. (2020, April). The use of critical thinking to identify fake news: A systematic literature review. *Conference on e-Business, e-Services and e-Society* (235-246).

Marmion, J. (2018). *The Psychology of Stupidity*, Penguin Books.

Mill, J.S., & Rapaport, E. (1978*). On Liberty*. Hackett Publishing.

Murray, D, & Teare, S. (1993) Probability of a Tossed Coin Landing on Edge, *Physical Review E*, 48, 4, 2547-2552.

Nussbaum, M. (2018) *The Monarchy of Fear*. Simon and Schuster.

Paas, F., Sweller, J. (2012) An Evolutionary Upgrade of Cognitive Load Theory: Using the Human Motor System and Collaboration to Support the Learning of Complex Cognitive Tasks. *Educational Psychology Review* 24, 27–45.

Pinker, S. (2021). *Rationality*. Penguin Random House.

Reynolds, M. (2014). Equity-focused developmental evaluation using critical systems thinking. *Evaluation*, 20(1), 75–95.

Ruggiero, V. (2009). *Becoming a Critical Thinker: A Master Student Text.* Wadsworth. Sixth edition.

Salvador, R., & Sadri, G. (2018). The biology of decision-making. *Industrial Management,* 60(1), 12.

Scharmer, C.O. (2016). *Theory U*. Berrett-Koehler Publishers. Second Edition.

Schilling, D. R. (2013, April 19). Knowledge Doubling Every 12 Months, soon to be Every 12 Hours. *Industry Tap.* Retrieved From: https://www.industrytap.com/knowledge-doubling-every-12-months-soon-to-be-every-12-hours/3950

Shermer, M. (2002). *Why People Believe Weird Things.* Henry Holt & Company.

Sweller, J. (2003). Evolution of human cognitive architecture. *The psychology of learning and motivation* (Vol. 43, pp. 215–266).

Sweller J., Ayres, P., & Kalyuga, S. (2011). *Cognitive Load Theory*. Springer New York. First Edition.

Swink, D. (January 31, 2010). Adrenaline Rushes: Can They Help Us Deal With a Real Crisis? *Psychology Today*. Retrieved From: https://www.psychologytoday.com/us/blog/threat-management/201001/adrenaline-rushes-can-they-help-us-deal-real-crisis

Tannen, D. (2021). Three decades in the field of gender and language: a personal perspective. *Gender and Language*, 15(2).

Taylor, P. & Szteiter, J. (2019) *Taking Yourself Seriously*. The Pumping Station. Arlington, MA.

Texas (2021). TX HB1359, 2021-2022 | 87th Legislature. Retrieved From: https://legiscan.com/TX/text/HB1359/id/2261566

Tuckman B,, & Jensen, M. (2010). Stages of Small-Group Development Revisited. *Group Facilitation*, 10, 43–.

Tversky, A. & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases: Biases in judgments reveal some heuristics of thinking under uncertainty. *Science (American Association for the Advancement of Science)*, 185(4157), 1124–1131.

UTEC. (2022, Feb 14*). Mission and Values*. https://utecinc.org/who-we-are/mission/

APPENDIX: CLASSES OF PROBLEMS

As discussed in the body of this paper, some problems have single solutions, and others can have multiple solutions depending on perspective. This appendix provides additional information on the various types of problems, and how they may need to be approached differently, especially when communicating with others.

This understanding is not essential to this paper, but it is helpful information for addressing complex problems. For that reason, this information is included here as an appendix. The information here is based on fundamental mathematical principles, and my educational and work experience.

Classes of Problems: Single Solution Deterministic Problems

Deterministic problems are those that have a definitive answer. In most cases this means there is a single correct answer. Examples are crossword puzzles, jigsaw puzzles, or the question "what is 3+4?". Answers to these questions are often called **absolute truth** or **objective truth**. A key goal of science and philosophy is the search for absolute truths.

A core aspect of a deterministic solution is that it can be proven to be correct. For some science and mathematical questions, the answer can be proven through mathematical logic. An example is the calculation for the volume of a cylinder. Proving this mathematically requires specialized training and knowledge but one can verify it empirically by trying it out. The Oxford language dictionary defines "empirical" as "based on, concerned with, or verifiable by observation or experience rather than theory or pure logic."

For many real-world deterministic problems, proof comes through such empirical repetition and observation. This is something humans do naturally, often without conscious thought. The more examples where we verify that the solution works, the more confident we are. The "proof" comes from the fact that there is no case where it doesn't hold true. Mathematical/scientific proofs can often be verified empirically by individuals with no training in mathematical logic. E.g. In the case of the volume of a cylinder, a person can fill a cylinder with water, measure it, then measure the volume of water in a measuring cup.

This type of single answer problem is prevalent in our society and our education. In early mathematics we are taught techniques to find the single correct answer to equations. Standardized and multiple-choice tests are based on there being a single correct answer to questions. Crossword puzzles and jigsaw puzzles similarly have one answer. Since we are exposed to these types of questions so often, it is only natural that this is the type of problem that often comes to mind when we use the word "problem." And this is reinforced in our language and social systems as the model. For example, in common English usage we use the phrase "question and answer"; we seldom use the phrase "question and answers." However, these types of problems are not representative of many real-world problems.

Classes of Problems: Multiple Solution Deterministic Problems

There is a second class of deterministic problems where there is more than one correct solution. In all other respects, they mirror single answer problems. Each answer is true in all cases, so they can be proven to be correct. Likewise, wrong answers can be proven to be wrong. An example of this in mathematics are fractions. If we want to describe something representing 50%, we can use the fractions of 1/2, 2/4, 7/14, etc. to represent the exact same percentage.

There are an infinite number of correct fractions. There even more incorrect answers. E.g. 2/7 is incorrect.

We can still use empirical methods to find correct and incorrect answers, but finding more answers requires more work. In most cases, we only need to know one correct answer to solve the problem, so we select one move on. When we have choices of multiple correct answers, we often use a metric to determine which one to use. So, for example, in mathematics, the concept of lowest common denominator is used as the metric.

Such problems are also common in the real world, but our training to expect single answers can often get in the way of us seeing them. Our single answers often assume a metric, even though that metric may not be explicitly stated, or even consciously thought about. A question such as "what route should I take to the grocery store?" is an example. There are multiple "correct" routes that will get us there and back, and many more incorrect routes that will get us lost. But when we answer, we typically subconsciously choose a metric such as "shortest path" or "fastest route," or "most scenic" or even "the one I usually take."

In our minds, language, and culture, we often think of these as if they are single correct answer question. A television chef, or one's grandmother, may tell you the *proper* way to make dumplings, or a spouse may tell you "that's not the way to get there" if you take a different path. Repetition makes us give greater weight to the most common correct answer and treat that answer as somehow better than other equally valid answers.

The reason I think this is so important is because this reinforcement causes our subconscious definitions to equate "truth" with "single correct answer" and that will influence our problem-solving capabilities and objectivity. A good real-life example of this is in terms of gender. For many of my generation, the assumption was that there were only two genders, male

or female. The non-binary LGBTQ movement opened my eyes to the fact that there were additional choices, and that gender is used in many different contexts. But even now, there are many who resist this concept and insist that only one context is "correct," that there is one "absolute truth" single answer.

Classes of Problems: Perspective Based Deterministic Problems

Some problems have different correct answers depending on the perspective of the observer. Again, here is a case where "scientific objective truth" does not provide a single correct answer.

Perspective-based problems differ subtly, but importantly, from multiple answer problems because for each perspective there is only a single correct answer; but someone looking at it from a different perspective would have a different answer. Each will feel that their answer is objective truth in that it will always be empirically true. In order to see the full picture, one has to step back from a neutral point of view.

Let us consider the case of a video camera sitting in the grandstand of an automobile racetrack, and another attached to the driver's window of one of the racecars. The camera in the grandstand will show that the cars are moving at 150 mph, so fast that they may only appear as a blur, the cars barely recognizable. The trees in the infield and fellow spectators will be clearly recognizable. From the camera in the racecar, other nearby racecars appear so sharp one can see the faces of the other drivers, they don't appear to be moving much at all. The trees and the people in the grandstand are a blur. From that perspective, the trees and the spectators appear to be moving at 150 mph.

This is a case where empirical evidence can lead us astray. Empirical evidence is based on observation, and from a specific observation point, all of the data supports a single correct answer. This isn't an optical illusion, this is all supported by science.

And to complicate things further, is the scientific fact that the earth is rotating around its axis, one revolution each day. That means that each of us, the racecars and those in the grandstand are all moving at over 1000 mph. (The earth's circumference is approximately 24,900 miles, rotating once every 24 hours). The only reason we don't notice it is because everything else in our frame of reference is also moving at the same speed. And taking it a step further, our Milky Way Galaxy, including the sun is spinning at over 400,000 mph[2].

I believe that this is a valuable lesson when discussing attitudes toward social problems by recognizing that two different perspectives can each appear to be perfectly rational from each point of view. It is popular in some circles to disparagingly label this as "moral relativism," and counter to science and objective truth. To my mind, that approach is a dangerous misconception in that it clouds the scientific fact that some things in the real world *are* indeed relative and dependent on the observer, and that many scientific truths include unstated assumptions. And that is the objective truth!

Of course, not everything is relative and dependent on perspective, but some things are. This is why it is important to classify problems and not think of a single meaning. Just as I believe it is incorrect to think that everything is relative (some things aren't), it is also incorrect to deny that many things are relative, and in such cases the only way to know is to step back and observe it from other points of view.

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[2] Fraknoi, A. How Fast are You Moving When You are Sitting Still. *The Universe in the Classroom,* 71. Astronomical Society of the Pacific.

Classes of Problems: Non- Deterministic Problems

There is another class of problems that are among the most common in the real world. These are problems that involve uncertainty and randomness. These problems are especially difficult since the best answer is only correct some of the time. No answer is correct all of the time.

And I believe these are the most often misunderstood and difficult problems, because applying the same techniques we use for deterministic problems can lead us astray at times. It is my experience that even scientists and mathematicians often apply deterministic logic in addressing these problems.

An example of a non-deterministic problem is a coin flip or a roll of the dice. The greatest mathematician in the world is no better at predicting the result of the next coin flip than a fortune-teller. However, a mathematician can tell you how much more likely it is for a roll of two dice to result in a 7 than a 12. In that case, mathematicians can assume that the coin or die are "perfectly random," i.e., that each option has a known probability of occurring. But in the real world, where human behavior is involved, there is no perfect randomness so even that can only be estimated. So, while a mathematician can tell you that the chance of the next coin flip resulting in heads is 50%, there is no similar mathematical calculation for predicting whether a person will choose heads or tails.

The field of mathematics that deals with uncertainty and randomness is called statistics. Statistics is based on the concept of taking a sample from a larger pool of data, and making predictions about the larger pool based on distributions. Statistics doesn't deal with absolute

truths, but rather is an estimate of how likely something is to be true, or how likely one event is caused by another **(correlation**).

Where distributions are fairly uniform without significant variability, statistics can make quite accurate decisions from relatively small sample sizes. In such cases, human decision making is quite accurate as well. For example, a child who observes an average family gathering can make quite accurate conclusions about average human heights or the friendliness of dogs.

The biggest problem comes when a sample contains outliers. Outliers are instances that are exceptions to the norm such that a given sample is not representative of the whole. For example, if the child is at a gathering of professional basketball players, their conception of human heights will be skewed. Statisticians solve this by averaging multiple samples from various places, but humans aren't always able to do so. Humans are at the added disadvantage in that our wiring and our culture tends to emphasize outliers. To a statistician, an 8-foot-tall person is just one data point out of many, and that person will only occur in one sample.

But there would be a problem if that same person were included in multiple samples, since that would skew the results. And, to most humans, an 8-foot-tall person is newsworthy, so knowledge of that person is likely to be shared via the news, social media, and conversations. So, in essence, that same 8-foot-tall person might get added to lots of people's samples, and they would overestimate how common it is for a person to be that tall.

We see similar situations occur often in our media and conversations. Lottery winners are shown on television and become water-cooler talk, but we seldom focus on lottery losers. Can you imagine the television news show that interviewed all of the people who bought losing lottery tickets? The upshot is that our subconscious overestimates the likelihood of winning the lottery. Which helps explain why so many people buy lottery tickets.

This focus on exceptions isn't a human flaw, it is actually a useful feature gifted us by evolution. Our heuristics are always looking for deviations from "normal." They allow us to quickly identify the fox in the henhouse. The problem is that also may skew our sense of reality and cause us to make decisions based on the emphasis of those outliers. E.g., if there are very few foxes, we may have incorrectly estimated the number of foxes because that one happened to frequent our henhouse. Unless we pool our sample with many neighbors, our decisions will be imprecise.

I bring this up because often when discussion issues like attitudes toward climate change or vaccines, we tend to focus on the most extreme arguments of the opposite side. Those are the people who get the most attention, who are seen on television in interviews, whose tweets are retweeted, and whose quotes get forwarded. And that skews our samples and our understanding of others. We don't see them as outliers, we see them as representative of the norm. We may attribute their extreme rhetoric with others who may have come to similar conclusions based on a completely different rationale.

Classes of Problems: Complex Problems

In the real world, many of the most difficult problems are complex, involving multiple interrelated questions and dependent variables. Seldom are questions able to be answered the way they are on standardized tests. Identifying correlations is much more difficult when we can't identify all of the variables, much less be able to control them. There are seldom ideal solutions, but rather, all solutions have pros and cons, and the best is not easily apparent. Solutions may create unintended consequences that weren't factored into the decision-making process.

In a democratic process, the most popular answer gets chosen, not necessarily the best one. That is difficult enough, but when the solution requires the buy-in of those outside the group, success depends as much on marketing the solution to others. Other than bragging rights, it is of little practical use to identify a great solution if no one adopts that solution.