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Vulnerabilities to Cognitive Biases in the OODA Loop Process

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A recent Quick Look prepared as part of a Joint Staff and Air Force (A3)-sponsored effort to examine the effectiveness of Operations in the Information Environment (OIE) examines how cognitive biases can affect the communication process (Polansky & Rieger, 2020). During review of that analysis, a discussion arose regarding how cognitive biases can affect not only communication, but also decision-making, including more structured processes such as the OODA (Observe, Orient, Decide, Act) Loop analytical framework.[1] To address those questions and concerns, in the present paper, we explore how some common types of cognitive bias can impact an OODA Loop analysis, potentially leading to a sub-optimal result.

OODA Loop process

OODA Loops were "developed to describe a tactical situation and [have] been extrapolated to explain overarching command and control systems" (Tighe et.al., n.d.). While the OODA Loop process was originally developed for aerial combat flight operations, its structure has since been adopted for other purposes requiring cognitive processing, including operations in the information environment and a wide range of adaptive, defense-related purposes. Furthermore, given its structured intent of translating information into action, it provides a useful framework for examining how information decision-making can occur within a national security setting.

The OODA loop process consists of four distinct phases:

1. Observe: Based on implicit guidance and control, observations are made regarding unfolding circumstances, outside information, and dynamic interaction with the environment (including the result of prior actions).
2. Orient: Observations from the prior stage are deconstructed into separate component pieces; then synthesized and analyzed in several contexts such as cultural traditions, genetic heritage, and previous experiences; and then combined together for the purposes of analysis and synthesis to inform the next phase.
3. Decide: In this phase, hypotheses are evaluated, and a decision is made.
4. Act: Based on the decision from the prior stage, action is taken to achieve a desired effect or result.

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The Decision phase may uncover the need for further observation or data if the decision-maker determines that more observations are needed to objectively reach a conclusion or if a hypothesis could not be confirmed (or disconfirmed). This determination in turn leads to a return to Phase One to add the required information, trigger an updated Orient phase, and if appropriate, a new Decision (Figure 2, reproduced from Boyd, 2018). Similarly, after initiating an action, "unfolding interaction with the environment" becomes an input to the next set of observations, thus triggering a new cycle (Boyd, 2018).

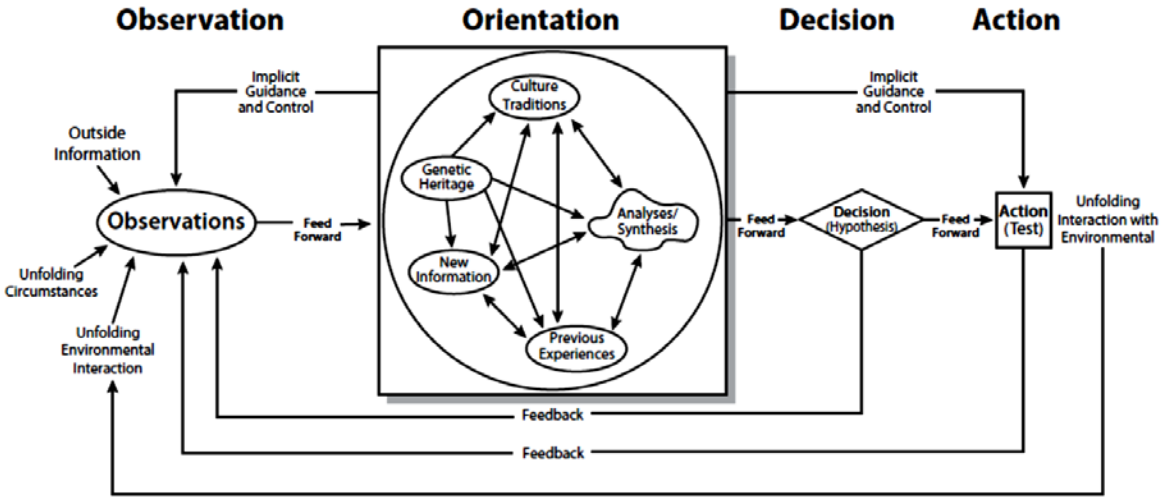

Figure 2: The OODA Loop Process

Observations that occurred in the Observe phase are subsequently presented and analyzed in the Orient phase. However, for the result to be accurate, it must be free of distortions, selective searching, or biases in interpretation. Similarly, as an analyst or decision-maker moves from Orient to Decide, and in so doing forms and evaluates hypotheses, information must be objectively weighted and analyzed. Given that these are essentially human cognitive-based activities, and that humans are subject to biases and other mental shortcuts, cognitive biases may also impact the weighting and interpretation process, potentially leading to suboptimal decisions, which in turn can lead to ineffective actions.

Examples of Biases Impacting Data Sourcing (Observe Phase) and Interpretation (Orient Phase)

There are many cognitive biases and numerous ways that they can influence how people search for information, how that information is interpreted, and how subsequent decisions are made. Information search happens mostly in the Observe Phase, while interpretation extends into the Orient Phase. In this paper, we will limit our discussion to some of the more apparent vulnerabilities to biases that may exist within and between specific stages of the OODA Loop process.[2]

[2] It is worth noting that the process outlined in Figure 1 describes communication between a sender and recipient, rather than with regard to a decision-making process. However, several concepts shown in Figure 1 (specifically, those listed as "Effect of Bias") are useful in framing the aspects of this discussion relating to information gathering and interpretation.

It all starts with information gathered during the Observe phase. The observation and interpretation of information needs to be done so in a way that is as free of bias as possible. Since the process is sequential, a distortion in an early phase can carry through to the later phases, including actions taken. Examples are provided below for three biases that have the potential to significantly influence how information is observed, deconstructed, and analyzed. Each of these biases originate from how the recipient decodes the information.

Confirmation Bias

Confirmation bias can occur when information search is centered on pre-existing beliefs, while conflicting information is either ignored, downplayed, or down-selected (Rieger, 2020). If information is chosen that only supports prior beliefs or values and/or ignores potentially valuable information that supports other conclusions, the Orient phase will appear to validate that one-sided view since no other views will be entered into the decision calculus. Thus, choosing and searching for information that relates to divergent viewpoints and perspectives is critical in avoiding this bias.

Anchoring Bias

Anchoring bias, or the anchoring and adjustment heuristic, occurs when an initial piece of data is over-emphasized and other data are viewed relative to that "anchor" rather than on their own merits (Tversky & Kahneman, 1974). Where anchoring becomes problematic is if the interpretation of information relative to the anchor is different than if the information had been viewed on its own. For example, a shirt that is priced at $100 may seem expensive. But if the buyer had first seen a sign (and established an anchor) that indicated the regular price is $200, and it is 50% off, then the same $100 would seem to be inexpensive to many, when in reality, the price had not changed . . . it is still $100. In a defense context, this may apply to initial data about a variety of outcomes or interpretations, such as degree of target audience influence, mission effectiveness, collateral damage, and so on. Ultimately, this bias can occur in evaluating any data. Biased conclusions in the Orient phase may follow from skewed interpretation based on whether a baseline "anchor" was previously established.

Framing Effects

Framing effects occur when the way data is presented influences how it is interpreted. A well-known example of this is the "Asian Disease" problem. Test subjects had to make decisions regarding a fictional scenario where all passengers on a cruise ship contracted a deadly disease. Two treatments were possible. The study showed that the choice of treatment differed dramatically depending on if the cure rate or the death rate was emphasized in how the data were presented (Tversky & Kahneman, 1981). Specifically, the majority preferred an option where 1/3 of the passengers will be saved from a particular treatment, while a majority rejected the same option when phrased as 2/3 of the passengers will die. The conclusion of that study was that different framing of the same data can result in very different and at times opposite interpretations and conclusions. In the context of the OODA Loop process, the way data is framed in sources utilized in the Observe Phase may strongly influence how it is interpreted in the Orient Phase, as well as the Decision that is implied as a result.

There are numerous other biases that could potentially impact how data are interpreted, including naïve realism, belief perseverance, and zero-sum bias, among others. It is also worth keeping in mind that some adversaries may intentionally encode messages through "fake news" or intentionally framed

messaging in order to encourage a skewed interpretation, which can in turn introduce bias into the Observe-Orient analytical process. The implication for OODA Loop processing is that simply going through the process does not guarantee that a logical, bias-free conclusion will be reached. Rather, source choice, analysis, and interpretation should be viewed critically and in a way that directly challenges assumptions and common sources of bias before the information is fully utilized in later stages of the process.[3]

Examples of Biases Impacting Consensus and Dissent (Orient Phase) and Formation of Conclusions (Decide Phase)

Once the information search is complete, the next steps are to reach a consensus and make a decision. These steps in the process can be influenced by cognitive biases relating to information weighting, information interpretation, and consideration of disparate interpretations and views. As with the prior section, a few examples of the many biases that can exert these types of influences are described below.

Examples of Information Weighting Biases

The first set of biases to consider in moving from Orient to Decide relates to how data that were collected during the Observe phase are weighted in driving to a conclusion. A few examples include negativity bias, authority bias, and illusory correlation.

Negativity Bias

When a piece of information has a negative connotation, there is a natural tendency to over-weight its importance relative to more positive news (Ito et al., 1998). This bias can be further explained by Kahneman and Tversky's classic work on Prospect Theory (1979), which showed that loss aversion (which occurs when falling short of a reference point) is significantly more powerful and influential than a similarly sized gain or increase; the magnitude of people's disappointment with a loss is generally twice their satisfaction with an equivalent gain. If negative evidence has a disproportionate weight in analysis, then the result of the Orient phase of an OODA Loop analysis could be overly skewed as a result, causing more positive news to be given less importance in driving toward a conclusion and indicated action.

Authority Bias

In Stanley Milgram's classic study on obedience (1963), he found that people have a tendency to place greater belief in the accuracy and importance of information if its source is from an authority figure or role model. This principle is often used in advertising, where famous spokespeople are used to recommend a particular brand or service. If this bias extends to the Orient phase of an OODA Loop analysis, information from authority figures could be given disproportionately high weight versus other more credible evidence or facts.

[3] A related discussion of "schemas" and their role in information acceptance and processing can be found in the recent Quick Look, Framework for Effective Communication to Inform, Influence, and Persuade (Bragg, et al., 2020).

Illusory Correlation

Illusory correlation bias occurs when an inference of causality is assumed if two variables appear to be directionally related (Chapman & Chapman, 1967). While movement in one variable may tend to predict movement in another, correlation in and of itself does not imply causality. Covariation could exist if A causes B, B causes A, or something else leads to both variables moving independently. Illusory correlation is especially concerning for OODA Loop analyses, in that a decision may be based on a faulty assumption that increases in one variable will generate a desired outcome simply because the two variables have tended to move together in the past. A deeper understanding of the data can help to provide insight into the root cause of the relationship between variables.

Examples of Biases Stemming from Dynamics within the Analytical Process

The second set of biases impacting the Orientation phase relates to interpersonal or intragroup factors or biases. Specifically, biases relating to broad assumptions made about specific types of people, especially if the process is jointly conducted by a group working together. In addition, other biases may come into play relating to assumed levels of knowledge by either the source or the analyst.

Groupthink

Groupthink occurs within a team when "strivings for unanimity override their motivation to realistically appraise alternative courses of action" (Janis, 1972). Groupthink has been associated with past examples of incorrect judgment or depressed expression of important information in cases such as the Bay of Pigs Invasion (Janis, 1972) and the Challenger disaster (Esser & Lindoerfer, 1989). In an OODA Loop Orientation, if those involved in the analysis are united in their assessment and there is pressure (subtle or otherwise) to conform to the result, alternate hypotheses and concerns may be less likely to be raised by other team members.

Attribution Error

Attribution errors occur when motivations or explanations of behavior are assumed to be based on internal factors rather than situational circumstances (Pettigrew, 1979). In other words, an actor is assumed to behave a certain way because of who they are, the group they belong to, or demographic factors, even though situational or environmental factors may have played a more significant role. Errors in determining motivation and causality can lead to assumptions about cause and effect that might be invalid if the cause is assumed to be due to internal factors when the reality could be that external or situational factors played a larger role.

Curse of Knowledge

In addition to interpersonal processes or stereotyping as noted above, some biases in moving to a decision may be triggered when a party with advanced knowledge assumes that others have the same level of knowledge, "making it difficult for people to convey their expertise to others and reducing the apparent need (from the perspective of the better-informed individual) for such a transfer of knowledge" (Camerer et al., 1989). If those who are generating data from the Observe phase have a different level of expertise versus the team doing the Orient or Decide/Act parts of the exercise, then this bias can come into play. More fundamentally, the source of data for the Observe phase may

assume levels of knowledge among recipients that are not representative of reality. In both cases, incorrect interpretation and assumptions may occur as a result. A famous example of the curse of knowledge relating to military operations is the Charge of the Light Brigade during the Crimean War, where Lord Raglan issued an order assuming the field officer had the same knowledge and context, but it was interpreted differently, leading to disaster (Pinker, 2014, as cited in Polansky & Rieger, 2020).

In summary, when conducting an OODA Loop analysis, it is important to realize that biases can impact other steps with the OODA Loop framework beyond just the Observe phase. The way that different data are weighted can be subject to a number of different biases. In addition, assumptions regarding the degree of group consensus, attributions stemming from different (or similar) backgrounds, and assumed levels of expertise can all impact how the assembled corpus of observations are synthesized and interpreted in driving toward a decision. Beyond these concerns, however, there are additional biases that can come into play, specific to the determination of a final Decision that will produce specific actions in the final phase of the OODA Loop process (Act).

Examples of Biases Impacting Decide to Act Linkages and Processes

In deciding on a final course of action, there are a few additional biases that can impact the quality of the final decision that is acted upon. Many of these biases relate to factors such as time discounting, previously invested costs, or assumptions regarding the future based on what has happened in the past, including hyperbolic discounting, sunk costs fallacies, and optimism bias.

Hyperbolic Discounting

Hyperbolic discounting, or "present bias," occurs when the time versus return trade-off places either a greater-than-expected value on near term gains or undervalues risk for longer-term horizons. In those cases, quick wins may be chosen at the expense of potentially greater gains in the future, or unnecessary longer-term risks may be adopted. In other words, the discount curve of returns over time versus risk should be exponentially shaped, but in reality, it often resembles more of a hyperbola (Laibson, 1997). Because of this type of cognitive bias, decision-makers may be tempted to go for a quick win even though a greater strategic gain could be achieved under a longer-term horizon. Or, on the other side of the curve, an unnecessary long-term risk may be taken by underestimating the potential costs of failure. As an example, a decision may be made to launch a pre-emptive strike on a target to disrupt a potential smaller threat without fully considering the longer-term impact on the broader narrative and problem set.

Sunk Cost Fallacy

The sunk cost fallacy is often referred to in the vernacular as "throwing good money after bad." In the context of the OODA Loop process, sunk cost fallacies could influence the final decision by tempting the decision-maker to continue on a current path if a significant amount of effort and resources have already been expended in that particular direction, even if that course of action is inferior to other alternatives (Arkes & Blumer, 1985). If data on a current course of action shows gradual progress, in the Orient phase, this bias may lead decision-makers to assume that the same rate of improvement will continue or even accelerate, without having evidentiary support for that conclusion. For example, it may be tempting to continue to spend additional resources on a particular information campaign if

much has already been invested, even if that campaign has reached a point of diminishing returns or has become outdated, especially if it relates to a program of record.

Optimism Bias

Optimism bias is a tendency to underestimate the probability of adverse effects occurring as a result of a particular course of action, despite evidence to the contrary (McKenna, 1993; Sharot, 2011). In the context of an OODA Loop exercise, optimism bias could lead to an underweighting of the probability of negative repercussions associated with a particular decision and subsequent action or ignoring more negative aspects of a decision entirely. When combined with other biases discussed earlier, such as confirmation bias, it can be easy for a decision-maker to find reasons to dismiss concerns that should otherwise be taken more seriously within the decision calculus. If a particular course of action has always worked in the past, it will be easy to find data to support its continued use, even if the situation on the ground has evolved to a different set of operational assumptions.

In summary, while the OODA Loop process provides a disciplined analytical structure for complex problems, given the need for human observation, analysis, and decision-making, the analysts who are attempting to source and interpret information are still vulnerable to different forms of cognitive bias, potentially impacting how information is selected and weighted, how differing opinions and interpretations are treated, and how a final decision is reached.

Table 1: Factors Increasing the Likelihood of Cognitive Biases and Their Effect on Information Processing (reproduced from Polansky & Rieger, 2020)

Factors that increase likelihood of bias	Information Search	Information Presentation	Information Weighting	Information Interpretation
Time pressure	■			
Conflicting information	■		■	■
Too much information	■			
Unknown unknowns	■	■		
Uncertainty	■	■	■	■
Distracted	■	■	■	■
Less invested in issue	■	■	■	■
Strong emotion	■	■	■	■
Limited cognitive resources	■		■	■
Preconceptions	■	■	■	■
Worldview	■	■	■	■
Mental or physical fatigue	■	■	■	■
Threat to self or group		■	■	■
Low "need for cognition" (do not enjoy thinking)	■	■	■	■

Note: Shaded cells indicate that a given factor can distort that aspect of information processing.

Triggers

Cognitive biases are, in essence, mental shortcuts that have evolved to help enable our survival but are not perfect (Kahneman, 2011). As such, they are part of human nature and therefore represent a vulnerability to the accuracy of a decision. Since the potential for falling into these traps exists in all of us, the question then becomes one of understanding the conditions under which an analyst or decision-maker may inadvertently fall prey to one of these biases.

In the prior Quick Look, Polansky and Rieger (2020) offered several potential triggers that can increase vulnerability to the biases that impact information encoding and decoding (Table 2, reproduced from Polansky & Rieger, 2020). Many of these relate to increased stress, threats, ability to process information, and personal factors such as worldview or level of fatigue. Personal investment can also lead to a temptation to fall into blindspots that lead a decision-maker to try to "sell" or "justify" their conclusion, rather than dispassionately taking a step back to evaluate whether or not it is the best path forward (Haidt, 1995; Rieger, 2020). Stress, experience level, and the specifics of the situation faced by the participants in the OODA Loop analysis are critical variables that should be considered when

reflecting upon these potential vulnerabilities. Understanding when these vulnerabilities exist, and recognizing the biases and blind spots that may occur as a result, is critical in avoiding potential introduction of these and other biases into an exercise such as an OODA Loop analysis.

Implications

While the design of an OODA Loop analysis is in many ways an attempt to provide a structured approach to decision-making, any human-led analytical process that includes data selection, orientation and analysis, followed by the formation of a conclusion, is still subject to the introduction of biases under certain circumstances. The key to limiting the potential for these biases to impact the quality of the ultimate decision and subsequent actions starts with understanding the conditions under which vulnerability to bias increases and then putting in place strategies and support tools to mitigate the likelihood of falling into some of these mental shortcuts. The Observe and Orient phases should, when possible, include information from a variety of sources and backgrounds. Alternative hypotheses and weighting schemas can be explored to ensure that the conclusions are not spurious. Other steps to minimize the risk of a distorted conclusion could be as simple as red teaming conclusions or as complex as a more structured way of "orienting" through the use of processes such as Analysis of Competing Hypotheses or through other structured analytical tools.[4] However, in the end, it becomes a question of human judgment, which, unfortunately, is by its very nature vulnerable to biases and mental shortcuts.

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[4] Refer to the Polansky and Rieger Quick Look for additional discussion of potential bias mitigation strategies.

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