Does Analysis of Competing Hypotheses (ACH) Really Mitigate Cognitive Biases? Practical Implications for Intelligence Analysts and Criminal Investigators

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Abstract

This article discusses controversies about the Analysis of Competing Hypotheses (ACH) efficacy. The technique was developed by the Central Intelligence Agency (CIA) to mitigate cognitive biases and improve critical thinking, becoming one of the most popular analytical tools in the intelligence community. Despite its pervasiveness, ACH has some limitations and does not perform well in experimental tests. The findings suggest that the technique is not an effective way of mitigating analysts' biases and does not necessarily improve their reasoning. This might happen because of multiple factors (e.g. problems in implementing the technique, theoretical flaws, and vagueness of its instructions). However, this is not necessarily a reason to abolish the use of ACH in intelligence and investigative activities. With that in mind, the paper suggests some practical improvements that might lead to better results. These suggestions must be submitted to further experimental testing, which is related to the other aim of the article: to encourage the use of randomized experiments to test analytical techniques in the intelligence and investigative contexts.

Keywords

Analysis of Competing Hypotheses (ACH); Cognitive bias; Intelligence analysis; Investigative reasoning; Structured Analytic Techniques (SATs)

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INTRODUCTION

One important attribution of intelligence analysts in developing explanations for current situations and predictions about future scenarios (Dhami et al., 2019). To do that, they must generate plausible hypotheses based on the available data and then produce reports with their inferences. Despite seeming like an objective task, hypothesis generation is a difficult process because of the complex phenomena that analysts try to explain and predict. In addition, the available information is often fragmented and of questionable reliability. There is no precise way of predicting future events such as governors' decisions, military tactics, and criminal trends, for example. And on top of that, the intelligence activity involves other actors that might be working to hinder the information gathering, thereafter harming the subsequent analysis. This is another factor that makes intelligence analysis a complex job. This myriad of challenges is well described by Viale (2021):

> The task of analysis is made difficult partly because the human mind is limited in terms of attention, perception, memory, and processing capacity, and partly because the task itself can be extremely constraining and demanding. Indeed, there may be not enough relevant data or there may be large volumes of data, the credibility of data sources may vary, the data may be formatted in different ways (e.g., structured/ unstructured, textual/ visual/ audio), it may be ambiguous, unreliable, and sometimes intentionally misleading, and there may be time pressure and high stakes involved. This is further compounded by the lack of feedback which limits learning on how to perform analytic tasks.

Hypothesis generation can be cognitively challenging. As explained by Passmore et al. (2015), this is not a linear process and the analysts must revisit earlier inferences to change or discard them and generate new ones based on further discoveries. It is also important to notice that hypothesis generation and evidence-gathering feedback into each other. The inferences will guide investigations and will point to what path must be followed while the acquired information will serve as a filter to decide which hypotheses are "good" and which ones are not. However, this raises some questions: What makes an inference good or bad? How to distinguish them rationally and objectively? Such problems are the foundation of Structured Analytic Techniques (SATs). The term refers to several analytic tools that were developed to deal with these and other challenges within the intelligence activity. According to Chang et al. (2017): “At their core, SATs are a set of processes for externalizing, organizing, and evaluating analytic thinking”

Theoretically, they can do that by helping users to display complex data in structured models, allowing them to manipulate, rearrange and interpret the information more efficiently. SATs can also make the process of hypothesis generation more transparent and open to scrutiny. This can be helpful to encourage group discussions about a specific line of thinking, to audit the analysis process searching for mistakes, and also to evaluate analysts’ performance. In conclusion, the purpose of the SATs is to improve users’ objectivity while making them accountable for the steps taken, which can theoretically be accomplished because of the externalization of thinking required by the tools. The use of a structured technique allows a systematic screening for reasoning errors and it makes it theoretically possible to retrace the steps taken by the analysts to see how they arrived at specific conclusions.

Currently, SATs are employed for a multitude of tasks, dealing with past, present, and future scenarios. They are used in a variety of endeavors such as criminal investigations, geopolitics, combating transnational organized crime, counterterrorism, and chemical warfare (Chang et al., 2017; Hart, 2014). One of the most known and taught SATs is the Analysis of Competing Hypotheses (ACH). Developed by the CIA, the tool is applied to mitigate cognitive bias and it is one of the most recommended SATs in the intelligence community (Coulthart, 2017; Whitesmith, 2018; Dhami et al., 2019; Jones, 2017). “Cognitive bias” refers to a series of inclinations in our reasoning that harm our objectivity and can lead to systematic errors. One of the most famous cognitive biases is confirmation bias, which is a tendency to focus on evidence that supports our existing beliefs and to give less attention to contrary information (Artner et al., 2016). This makes us more prone to see what we already believe to be true. According to the literature, analysts can present biases (Dhami et al., 2019), but this is not a well-understood phenomenon. The failure to generate hypotheses effectively and rationally discard them can damage further steps of the analytical process and lead to inaccurate conclusions, often leading to intelligence mistakes (Whitesmith, 2018). Therefore, it is necessary to understand these cognitive shortcomings to develop effective strategies for reducing bias in the intelligence reality.

ACH tries to deal with this problem with a systematic approach to inferential reasoning and users must follow an 8 step process (Jones, 2017):

(1) Identify hypotheses to be considered.
(2) List significant evidence and arguments.
(3) Use a matrix to analyze the ‘diagnosticity’ of evidence and arguments for each hypothesis.
(4) Refine the matrix, revising hypotheses or deleting non-diagnostic evidence and arguments.
(5) Draw tentative conclusions about the relative likelihoods of the hypotheses.
(6) Analyze conclusions for sensitivity to misleading or misinterpreted evidence.
(7) Report conclusions.
(8) Identify milestones for future observation.

These steps can theoretically help analysts avoid confirmation bias because the first recommendation is to identify multiple hypotheses that are consistent with the data. This could prevent them from pursuing a specific explanation of their preference. In addition, the guidelines propose a classification of hypotheses with a critical perspective, ranking them in terms of consistency. Finally, analysts must also seek ways of confronting the inferences with the reality to test which ones should remain being considered.

A central aspect of ACH is that users must seek to disprove their hypotheses rather than confirm them, a process called eliminative induction. The conjectures with fewer inconsistencies will then be rated as more plausible. Such an approach can allegedly antagonize the confirmation bias by pushing the analysts to be skeptical about their inferences. According to Mandel et al. (2018), the eliminative induction used in ACH may have been inspired by Karl Popper’s idea that hypotheses falsification is important for the scientific method.

Despite being developed and usually used in the intelligence context, we can discuss possible applications of ACH in the criminal investigations scenario. Baechler et al. (2020) argue that intelligence and forensic activities must be seen as similar processes, concluding that there are no qualitative differences between intelligence and evidence. As they state, “both are a piece of information that has to be combined and put into perspective with alternative pieces of information to understand criminal problems, solve crimes and support decision-making at various levels”. Houck (2020) describes similar challenges that both investigators and analysts must deal with: Limited or incomplete information; Unreliable, conflicting, or ambiguous information;

Denial and deception; Information in the context of volatile or unknowable social situations; Work within limited time frames; Collection of appropriate information and Identify information gaps.

Houck (2020) argues that criminal investigators can benefit from structured analytical techniques because they also face challenges regarding collecting, organizing, and communicating information. Major investigations involve several professionals from multiple areas of expertise in different agencies, so it becomes difficult to gather and transmit information effectively. The author recommends the use of ACH in criminal investigations since this line of work has so many similarities with intelligence activity.

Does ACH have scientific validation?

From an epistemological perspective, there are problems with the technique. As stated above, ACH proposes the use of eliminative induction because it allegedly mitigates confirmation bias by making users refute their explanations. However, the superiority of this approach has not been proven. There is no evidence that eliminative induction will reduce the probability of biased hypotheses being generated. According to Mandel et al. (2018), this might be the result of a misunderstanding of the falsification principle proposed by Karl Popper. This principle illustrates the impossibility of confirming a generalization such as the popular example of “all the swans are white”. One didn't examine all the swans in the world to make this statement and it takes only one black swan to refute this proposition. However, in the intelligence activity, there are rare situations when a generalization of this kind will be made and possibly refuted by a single event and/or information. In conclusion, there are several problems with trying to apply popper’s falsification principle to techniques such as ACH.

And how well does ACH perform in experimental evaluations? First, it is important to know that the number of experimental studies of ACH is small. With that in mind, we can analyze the scarce results found in scientific literature. Despite being one of the most popular analytical techniques in the intelligence community, ACH offers little evidence of its efficacy. A study conducted by Whitesmith (2018) found that the tool was not effective in reducing cognitive bias and serial position effects. Mandel et al. (2018) showed results pointing in the same direction. According to the researchers, the control group was more accurate at hypothesis development than the group using ACH. Whitesmith (2020) reported no significant differences between groups using ACH and other methods such as serial order. Chang et al. (2017) showed that the technique was not effective in reducing confirmation bias in intelligence professionals. An experiment conducted by Maegherman et al. (2020) to test ACH did not show bias mitigation. Dhami et al. (2019) showed that the group using ACH was not more successful than the control group in choosing the right hypothesis in an experiment. The authors also gathered other sources stating that ACH is not effective in improving participants' reasoning.

Despite multiple sources showing that ACH is not necessarily an effective technique, these studies have several limitations. They generally have a small number of participants and in several cases, they don't even work in the intelligence field (Dhami et al., 2019). This leads to results with questionable statistical relevance (because of small samples) and no ecological validity since they are not examining real intelligence analysts' reasoning in most cases (Dhami et al., 2019). Some studies are using real analysts (Chang et al., 2017; Mandel et al., 2018) but they are scarce and suffer from the small sample problem. However, these limitations are not a sign that ACH should be used indiscriminately. In fact, to the knowledge of the author, no systematic reviews are supporting the technique and it lacks scientific validation.

From the practical perspective, ACH does not show how it would mitigate cognitive biases. Analysts are instructed to generate as many plausible hypotheses as possible, and then evaluate which ones have fewer inconsistencies to select them. However, the technique does not provide a detailed way of doing that. Users are not instructed on how they must develop inferences in the first place, and there is not a reference system to rank them (Mandel et al., 2018). If there aren't specific instructions on how to generate and filter hypotheses, users can still follow their own beliefs and biases when using the technique. For example, ACH's first step (Identify hypotheses to be considered) does not prevent analysts from generating inferences based on what they believe to be more realistic. In addition, they can fall within the search satisficing bias, which is a tendency to stop looking for alternative explanations once a plausible hypothesis is developed (Viale, 2021). In step 3 (Use a matrix to analyze the 'diagnosticity' of evidence and arguments for each hypothesis), analysts still can judge a piece of evidence that they believe to be strong as more diagnostic than other ones.

Another problem regarding the use of ACH is that analysts sometimes have to provide statements with verbal probabilities such as “ this scenario is highly probable”. There are two main pitfalls with this practice: first, users may rank hypotheses as more probable if they can easily remember similar situations that occurred in the past (availability bias) (Viale, 2021). Second, it could be dangerous to communicate verbal probabilities without relying on actual statistical estimates. Since there isn't a consensus on terms such as “highly probable”, they can have different meanings to different analysts (Dhami et al., 2015). How it is possible to categorize some phenomenon as “highly probable” without having quantitative data to support this claim? Probabilistic estimates need a previous quantification of a frequency to be useful here. Let's take the following case as an example: In a study conducted by Chopin et al. (2019), the authors found that sexual offenders left semen at the crime scene in 73,94 % of the cases. With this information, we can estimate that it is “very likely” that investigators will find semen in similar crimes within the region of the study.

Nonetheless, it is necessary to acknowledge that in several cases it's not possible to provide percentages in intelligence analysis. The circumstances of the job are complex and sometimes unpredictable, therefore hindering statistical analysis. But on the other hand, generating and ranking hypotheses without doing that gives plenty of space for a judgment based on prior beliefs and biases. This leads to another question: how the analysts judge what is more or less consistent? There is no unified definition of what this means in the intelligence context, and giving instructions to evaluate how consistent a hypothesis is can be dangerous if some delimitations were not made. Instead of saying exactly how analysts should assess consistency, the technique allows them to use their idiosyncrasies to decide what is consistent and what is not (Mandel et al., 2018).

As we can see, there are still multiple problems with ACH, which raise doubts about its scientific basis. To sum up, the claims made in defense of the tool and their respective shortcomings, a table is available below:

Table 1: Claims in favor of ACH and their respective limitations

Claim	Limitation
ACH can mitigate cognitive biases because it recommends the generation of multiple hypotheses	The technique does not specify how to generate the hypotheses and it allows analysts to make inferences based on their preexistent beliefs. The claim that ACH reduce cognitive biases lacks experimental validation
ACH mitigates confirmation bias by encouraging users to seek evidence that may disprove their theories instead of trying to confirm them (eliminative induction)	Eliminative induction does not prevent analysts from discrediting the weight of disconfirming evidence and focusing on the confirming ones
ACH makes it possible to identify cognitive biases because ideas are being put on a table, allowing peer review	Externalization of thinking can provide some degree of clarity about the reasoning process and subsequent peer review. However, it does not precisely show the steps taken in hypothesis development and ranking, making it difficult to track cognitive biases
ACH provides an objective way of judging hypotheses by ranking them according to their consistency with the evidence	There are no specific guidelines on how to evaluate the hypotheses' consistency and there is not a clear definition of what "consistent" means. Analysts can end up unconsciously using their own beliefs and biases to judge what is consistent with their hypotheses and what is not
Analysts trained with ACH perform better at developing hypotheses than those who weren't trained with the technique	There is little empirical data to confirm that. The scarce existent data indicate that analysts trained with ACH usually have an equal or slightly worse performance than those who weren't trained with the technique

Challenges in implementing debiasing strategies

The ACH and the other Structured Analytic Techniques can also be described as "debiasing strategies". This is an umbrella term that refers to all tools that are used to mitigate cognitive bias and enhance critical thinking. They are applied in several fields of knowledge, going from medical diagnosis (Croskerry et al., 2013) to criminal investigations (Fahsing et al., 2021). However, the efficacy of such techniques is at least dubious. This might happen because it's difficult to identify and target cognitive biases since they are not explicit (Fahsing et al., 2021).

According to Croskerry et al. (2013), the implementation of debiasing strategies must walk a path full of obstacles: “from a state of lack of awareness of bias to awareness, to the ability to detect bias, to considering a change, to deciding to change, then initiating strategies to accomplish change, and finally, maintaining the change.” This lack of awareness and ability to detect one's own bias is often referred to as the “bias blind spot”, and it occurs without harming the individual's capacity to acknowledge bias in others (Viale, 2021). This represents a major challenge in debiasing strategies implementation because it's necessary to convince professionals that 1- they are susceptible to biases and 2- that they need to learn how to overcome them. Teaching them debiasing techniques might not work because there's no guarantee that users will adhere to the techniques and apply them correctly. In addition, we don't know how long the results of a technique will last, in the case of effectively reducing biases (Viale, 2021).

Debiasing strategies are often studied from a dual-thinking perspective. This approach considers that human reasoning manifests itself by 2 different processes, usually named system 1 and system 2 (Frankish, 2010). System 1 refers to a thinking process that is subconscious and intuitive, while system 2 is conscious, analytical, and goal-oriented. Since system 1 does not obey rules of logic and is a fast way of thinking that relies on intuition, it is often referred to as “the culprit” of reasoning errors because of an apparent proneness to biases.

To manage this problem, debiasing strategies try to make users more cautious about the first and spontaneous inferences that pop up in their minds since they can be a product of the “flawed” system 1. There are tools specifically developed to assess this problem (e.g. forcing techniques) that aim to make analysts “go further” in hypothesis generation, theoretically stimulating the analytical process of the system 2. This dual-thinking model has become pervasive in the scientific literature regarding cognitive bias, but there are some controversies with this approach. For instance, some scholars argue that intuitive and analytical thinking can occur simultaneously and systems 1 and 2 might not be categorically distinct. Opposing this duality, there is another view that considers a continuum with different degrees of both analytical and intuitive thinking, which undermines the idea that a reasoning process can fall under only one of these two categories (Viale, 2021).

It is also important to stress that some techniques can also generate other biases while trying to mitigate the targeted ones, causing iatrogenic effects. For example, trying to avoid overconfidence can lead analysts to be underconfident, harming their reasoning in the opposite way (Viale, 2021; Chang et al., 2017). However, the literature assessing this collateral damage is scarce and this dual aspect of biases is often under-discussed.

Future directions

The use of a visual analytic technique such as ACH is not necessarily a problem. Literature shows that analyzing and manipulating visual information can be an effective way of thinking and solving problems (Passmore et al., 2015; Sunde, 2020) and there is evidence that considering competing scenarios can be an effective way to improve reasoning in some cases (Fahsing et al., 2021). However, it is necessary to conduct more studies about their implementation in investigative and intelligence scenarios. As stated in this article, ACH has several limitations and might not be ready to be used by intelligence analysts and investigators. Nonetheless, some directions can offer possible improvements for the technique. Some of these suggestions are described below:

Serious games - Some studies show that computer games can be a powerful tool to help with debiasing if they are specifically developed for that purpose (Viale, 2021). A study conducted by Morewedge et al. (2015) showed that a single intervention with a computer game was successful in reducing biases, and the reduction lasted for at least 2 months after the study. This research also used an intervention based on a video for another group, resulting in smaller debiasing effects. One important finding of the study is that the improvements in decision-making were extended to other contexts, showing that debiasing strategies might have effects in domains not related to the intervention. The efficacy of computer games might be caused by immediate feedback through dynamic interactions, which allow users to observe the consequences of their choices instantaneously. They also can mimic real-life situations, allowing users to think and make decisions that can help them outside the virtual landscape (Poos et al., 2017).

Structured investigative models - This has practical implications for both analysts and forensic scientists because, according to the authors, they are executing essentially the same tasks (i.e. collecting and assessing information to use it for explaining events). This approach allows the use of structured models developed to aid police investigations, such as the Structured Hypothesis Development in Criminal Investigation (SHDCI), developed by Sunde (2020). The SHDCI is a step-by-step visual tool that also stimulates the consideration of opposite explanations for each inference. Users are instructed to create hypotheses and then frame them in opposite ways (e.g. considering that no crime was committed to counterbalance investigators' inclinations to think easier about criminal explanations). Nonetheless, these resources need further experimental testing as well. The SHDCI steps could theoretically be added to ACH's process, making its instructions more specific. For example, some questions developed by Sunde (2020) could guide the early stages of hypothesis generation: "What criminal offenses may have occurred based on the information in the case?"; "What other criminal offenses may have occurred?"; "What non-criminal circumstances may have occurred, based on the information in the case?"; "What could be reasons for him/her being innocent, based on the information in the case?".

Significance, reliability, independence, and patterns (SRIP) evaluation - Eck & Rossmo (2019) recommend the acronym SRIP to help analysts/ investigators to evaluate evidence more objectively. This might mitigate the lack of clear guidelines on how to judge information before using it to develop hypotheses. *"S"* stands for significance, which entails evaluating the probability of the evidence being present in that specific scenario (e.g. "what's the probability of the suspect's DNA being in the crime scene beyond he/she committing the crime? It could be there for other reasons?"). *"R"* refers to the reliability, which reminds the user of questioning how trustful the piece of evidence is. *"I"* stands for independence, or how derivative one piece of evidence is from the rest. *"P"* stands for patterns, a principle to remind users to analyze evidence by comparing it to the other pieces of information already gathered because it may be dangerous to evaluate something in a vacuum. The SRIP acronym is a more specific set of guidelines to evaluate data and can be added to the ACH to make it more clear. This tool can be particularly useful in helping analysts and investigators when they face new evidence and/or information. With this acronym, they can reason about the aspects of the facts and evaluate them in a more structured manner. Since ACH does not prevent users from disproportionately weighing new information, the SRIP tool could make this process more objective with its clear criteria for evaluation.

CONCLUSION

This paper showed some practical and conceptual limitations of the ACH and brought some suggestions for improvement. However, there must be a dialogue between researchers and intelligence professionals for the improvements to occur. In addition, this dialogue is necessary for developing more scientifically based analytical techniques, therefore making this cooperation paramount for the evolution of intelligence activity.

Despite several theoretical and practical pitfalls, some debiasing techniques are still used in intelligence analysis without systematic evaluation (Dhami et al., 2015; Coulthart, 2017; Artner et al., 2016). Intelligence professionals must be cautious about the claims of efficacy of the ACH and must develop stronger relationships with scholars to create and implement evidence-based analytical techniques. There is an alarming lack of research regarding SATs effectiveness in the intelligence context, which can potentially cause catastrophic repercussions. Since the intelligence activity deals with highly sensitive information about matters of national and international security, it is a paradox that the professionals analyze such formation using techniques that are not scientifically validated yet.

Despite some promising results, the future directions suggested in his article need more experimental evaluation. This type of research design is necessary to see what works in mitigating cognitive biases and improving critical reasoning. ACH and other SATs must be tested with experimental designs to evaluate their efficacy. Randomized controlled trials are an objective way of determining if an intervention has promising impacts because of how they use chance in their favor. They randomly separate participants into two or more groups, and then also randomly choose which group will receive the intervention and which one will not (control group). This is important to isolate the results from spurious influences, therefore showing that the differences found between the groups are probably due to the intervention (Prancan, 2002).

In addition, it is important to acknowledge that there is not a technique completely bias-free (Jones, 2017). The aim must be to gradually reduce the flaws of the tools used by analysts to optimize them *ad infinitum*. This is the core of the scientific method, which fits the intelligence activity because of the similarities between these fields. As stated by Dhami et al. (2015), intelligence analysis "involves generating and testing hypotheses and accurately characterizing the degrees of uncertainty in both the evidence and conclusions reached." This points to a need for a scientific approach to developing and testing analytical techniques in this field.

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