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Are Structured Analytic Techniques (SATs) the Missing Component in Cognitive Warfare? The Future of ISR Military Operations

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ABSTRACT

Intelligence, Surveillance, and Reconnaissance (ISR) operators collect critical information with respect to our adversaries ground movement patterns, weapon capabilities, and strategic framework to support future military direction and enhance Joint All-Domain Command and Control (JADC2) situational awareness. However, the ability for ISR operators to (1) detect and identify essential elements of information (EEI) within vague or ill-defined content and (2) fuse and disseminate collected information across the JADC2 enterprise is extremely challenging. To combat these issues, ISR tools have been developed in an effort to augment and enhance decision-making efficacy. Previous research has discovered that implementing structured analytic techniques (SATs) when providing vague content has been shown to improve decision-making performance. Therefore, the objective of this study was to add to the body of knowledge by evaluating the effectiveness of Sphinx, an ISR decision-support tool focused on SAT methodology, when providing vague/ill-defined content.

Keywords: Structured analytic technique (SAT), Essential elements of information (EEI), Intelligence, surveillance, and reconnaissance (ISR), Joint all-domain command and control (JADC2)

INTRODUCTION

Intelligence, Surveillance, and Reconnaissance (ISR) operators are continually tasked to process, exploit, and disseminate (PED) collected intelligence on our adversaries ground movement patterns, weapon capabilities, and troop formations in near-real time to support the strat-to-task framework for future military direction (see Figure 1). Intelligence data can be collected from a multitude of sources such as human intelligence (HUMINT), signals intelligence (SIGINT), imagery intelligence (IMINT), geospatial intelligence (GEOINT), measurement and signature intelligence (SIGINT), and open-source intelligence (OSINT) (Kamiński, 2019). Nevertheless, regardless of the collection methodology, all the intelligence has a single commonality – essential elements of information (EEI). EEIs are embedded, mission-relevant information that provides underlying evidence to support a high-level question or Priority Intelligence Requirement (PIR) based on commanders' intent (Frame et al., 2023). If EEIs are correctly identified, they can provide reasoning and justification to inform strategic planners and military leadership

on future planning guidance (Nelson et al., 2023). However the question still remains, is there an optimal methodology to augment and enhance the understanding and interpretation of vague collected intelligence resulting in higher efficacy for EEI detection.

Figure 1: Processing, exploitation, and dissemination (PED) phase of the intelligence cycle across INTs and multi-INTs with a focus on how to detect subtle essential elements of information (EEI) (Nelson et al., 2023).

Within the literature, Structured Analytic Techniques (SATs) has been shown to augment and enhance critical thinking and logical reasoning when confronted with vague textual content by reducing pre-existing cognitive biases resulting in improved performance (Whitesmith, 2019). Moreover, SATs has had a positive influence on performance outcomes when processing, exploiting, and disseminating information from multiple users also known as crowdsourcing (Estellés-Arolas, 2012). With a capability gap identified with the processing and exploitation of collected ISR intelligence, SATs could be the missing component. As a result, ISR subject matter experts (SMEs) from Wright-Patterson AFB developed Sphinx. Sphinx is an ISR collaborative workspace tool focusing on structured analytic techniques to systematically support the breakdown of high-level PIRs into detectable EEIs in an effort to enhance future prediction and recommendation accuracy. Therefore, the objective is study was to evaluate the effectiveness of Sphinx on military operators performance when providing an ambiguous narrative in complete or incremental sections.

METHODS AND MATERIALS

Study Participants

The study was approved by the Air Force Research Laboratory Institutional Review Board (AFRL IRB) on human participants to evaluate the efficacy of Sphinx, an ISR decision-support tool focused on SAT methodology, when providing an ambiguous narrative. Four groups of 10 active-duty military operators ($N = 40$) were randomly assigned to one of two analytic techniques (Sphinx or Control) and provided textual content in either incremental or

complete sections. The operators objective was to correctly identify embedded EEIs within the content and provide a single solution for the problem statement.

TASK

Before evaluating the effectiveness of Sphinx in a real-world ISR environment that could have significant impact on our military posture, our objective was to evaluate the analytic approach and performance outcomes with an unclassified scenario. Therefore, a task was adapted from an online mystery-solving game 'The Haunted Portrait' (5minutemystery.com). The task provides an opportunity for the active-duty military personnel to decipher subtle EEIs embedded within the content. The detection of the EEIs can provide underlying reasoning and justification for their assessment. Within the content, there are 4 embedded EEIs that when detected, can provide valuable information leading to the correct solution. The task was selected and supported by ISR subject matter experts (SMEs) as being similar to real-world ISR mission environments that require processing, exploiting, and disseminated (PED) critical intelligence regarding problem solving and future decision-making recommendations.

PROCEDURES

The active-duty military operators were randomly assigned to either Sphinx or a Control group and provided the same content. If an operator was assigned to Sphinx, they were required to read through the content and develop the high-level question (PIR), identify the subtle clues within the text (EEIs), and provide justification and reasoning (Indicators and Observables). Following the implementation of their inputs into Sphinx, the operators would provide a single solution. If an operator was assigned to Control, they were required to read through the content and provide a single solution with justification and reasoning.

Moreover, each SAT was coupled within a workflow methodology (i.e., all at once or incremental sections). If the operators were provided all the content at once, they would read through the information and follow the structured approach assigned. If the operators were provided incremental sections, they would read through the first section provided and follow the structured analytic approach. This process was repeated for each of the five sections. The purpose of the experimental design was to determine if providing Sphinx, an ISR SAT capability, with incremental or complete sections of information would enhance the detection of EEIs resulting in enhanced situational awareness and improved solution accuracy (see Figure 2).

RESULTS

As shown in Table 1, there was a statistically significant main effect between SAT and information workflow methodology for EEI detection ($F_{3,156}=11.05$, $p<0.01$). As a result, an ANOVA was conducted comparing each SAT and information workflow methodology for EEI detection. As shown in Table 2, there was a statistically significant difference between

$Control_{All}$ and $Sphinx_{All}$ ($F_{1,78}$=15.24, p<0.01) and $Control_{All}$ and $Sphinx_{Inc}$ ($F_{1,78}$=22.56, p<0.01). As well, there was a statistically significant difference between $Control_{Inc}$ and $Sphinx_{All}$ ($F_{1,78}$=10.65, p<0.01) and $Control_{Inc}$ and $Sphinx_{Inc}$ ($F_{1,78}$=17.19, p<0.01). $Sphinx_{Inc}$ correctly detected 30 of the 40 EEIs (75%), $Sphinx_{All}$ correctly detected 27 of the 40 EEIs (68%), $Control_{Inc}$ correctly detected 13 of the 40 EEIs (33%), and $Control_{All}$ correctly detected 11 of the 40 EEIs (28%) as shown in Figure 3.

Figure 2: Textual content provided to the participants and how that information can be processed, exploited, and disseminated (PED) based on the experimental condition to enhance detection of EEIs and performance accuracy.

Table 1. Analysis of variance (ANOVA) depicting the main effect of structured analytic techniques (SATs) and information workflow methodology for EEI detection.

Metric	Source	df	SS	MS	F	p
EEI Detection	Between-Conditions	3	6.97	2.32	11.05	<0.01
	Within-Conditions	156	33.02			
	Total	159				

Statistical Significance at alpha level of 0.05

Table 2. Analysis of variance (ANOVA) comparing each structured analytic techniques (SATs) and information workflow methodology for EEI detection.

Approach	Source	df	SS	MS	F	p
$Control_{All}$ vs $Control_{Inc}$	Between-Conditions	1	0.05	0.05	0.24	0.63
	Within-Conditions	78	16.75	0.21		
	Total	79	16.80			
$Control_{All}$ vs $Sphinx_{All}$	Between-Conditions	1	3.20	3.20	15.24	<0.01
	Within-Conditions	78	16.75	0.21		
	Total	79	19.95			
$Control_{All}$ vs $Sphinx_{Inc}$	Between-Conditions	1	4.51	4.51	22.56	<0.01
	Within-Conditions	78	15.48	0.20		
	Total	79	19.99			

(Continued)

Table 2. Continued

Approach	Source	df	SS	MS	F	p
$Control_{Inc}$	Between-Conditions	1	2.45	2.45	10.65	<0.01
vs	Within-Conditions	78	17.55	0.23		
$Sphinx_{All}$	Total	79	20.00			
$Control_{Inc}$	Between-Conditions	1	3.61	3.61	17.19	<0.01
vs	Within-Conditions	78	16.28	0.21		
$Sphinx_{Inc}$	Total	79	19.89			
$Sphinx_{All}$	Between-Conditions	1	0.11	0.11	0.52	0.46
vs	Within-Conditions	78	16.28	0.21		
$Sphinx_{Inc}$	Total	79	16.39			

Statistical Significance at alpha level of 0.05

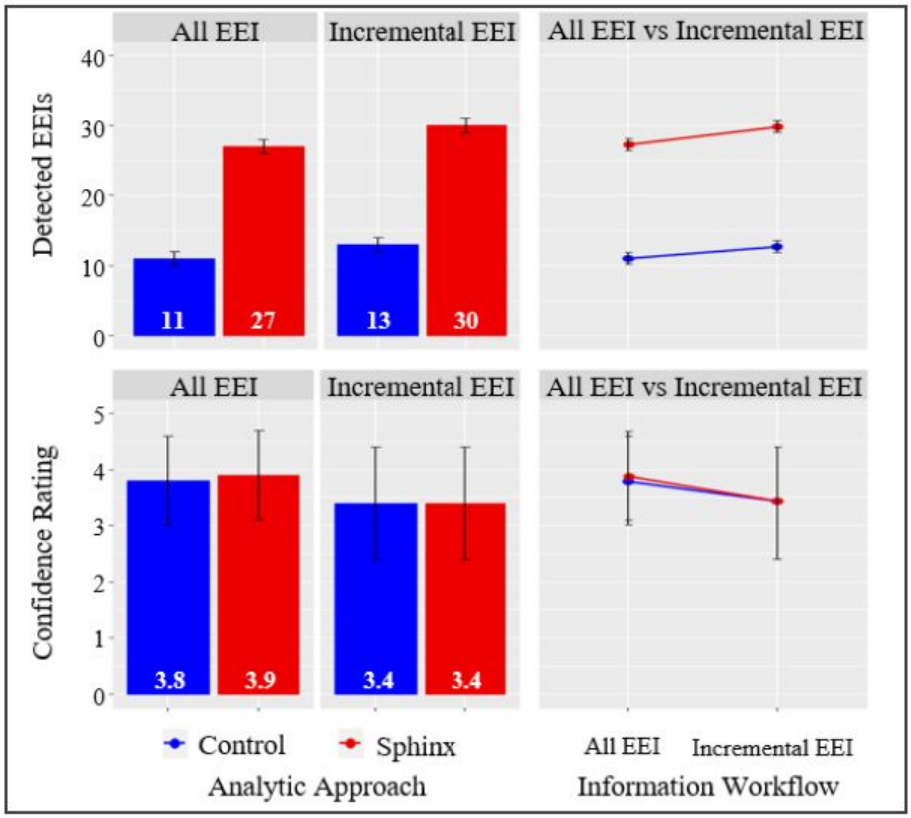

Figure 3: Essential elements of information (EEI) correctly detected by structured analytic technique (SAT) and information workflow methodology.

With respect to solution accuracy, there was not a statistically significant difference between SAT and information workflow methodology. However, $Sphinx_{Inc}$ provided the highest solution accuracy compared to all other conditions (i.e., 6 out of 10 operators identified the correct solution – 60%).

CONCLUSION

ISR operators have a daunting task of processing, exploiting, and disseminating (PED) collected intelligence in near-real time in order to provide an optimal recommendation regarding future military direction. The findings from this study have shown that incorporating Sphinx, an ISR SAT capability, can enhance the detection of critical information resulting in better performance accuracy. Future research needs to be conducted to determine how effective Sphinx may be pertaining to real-world military intel. However, we are progressing in the right direction and developing appropriate tools based upon structured analytic techniques (SATs) that will support our warfighters and ensure we maintain military superiority.

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