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# **DATAWorks 2024: Meta-Analysis of the Effectiveness of the SALIANT Procedure for Assessing Team Situation Awareness**

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**DATAWorks 2024: Meta-Analysis of the Effectiveness of the SALIANT  
Procedure for Assessing Team Situation Awareness**

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## Executive Summary

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Many Department of Defense systems aim to increase or maintain situation awareness (SA) at the individual or team level. However, SA is difficult to measure accurately and reliably because SA metrics must be tailored to the specific situation: the type of mission, whether the mission is completed individually or in teams, etc. Accordingly, during test and evaluation, SA is examined inconsistently or not measured at all.

The Situational Awareness Linked Indicators Adapted to Novel Tasks (SALIENT) technique is an empirically based methodology meant to measure SA at the team level. While initial research using the SALIENT model suggests that it effectively quantifies team SA, no study has examined the effectiveness of SALIENT across the entirety of the existing empirical research.

The aim of the current work is to conduct a meta-analysis of previous research to examine the overall reliability of SALIENT as an SA measurement tool. This meta-analysis will assess when and how SALIENT can serve as a reliable indicator of performance at testing.



# **DATAWorks 2024: Meta-Analysis of the Effectiveness of the SALIANT Procedure for Assessing Team Situation Awareness**

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March 2024

**Institute for Defense Analyses**

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## Purpose and scope of the current study

- Many Department of Defense (DoD) systems aim to increase or maintain Situation Awareness (SA)
- SA frequently goes unmeasured or is measured sub-optimally
  - There are many methods for measuring SA!
- Situational Awareness Linked Indicators Adapted to Novel Tasks (SALIENT)

## Slide 2

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**AME3**    used "situation" in all cases except for SALIANT; addressed in the voiceover  
Armstrong, Miriam E, 4/15/2024

## Team SA is critical for many DoD missions



Command and Control



Air Missions



Cyber Operations

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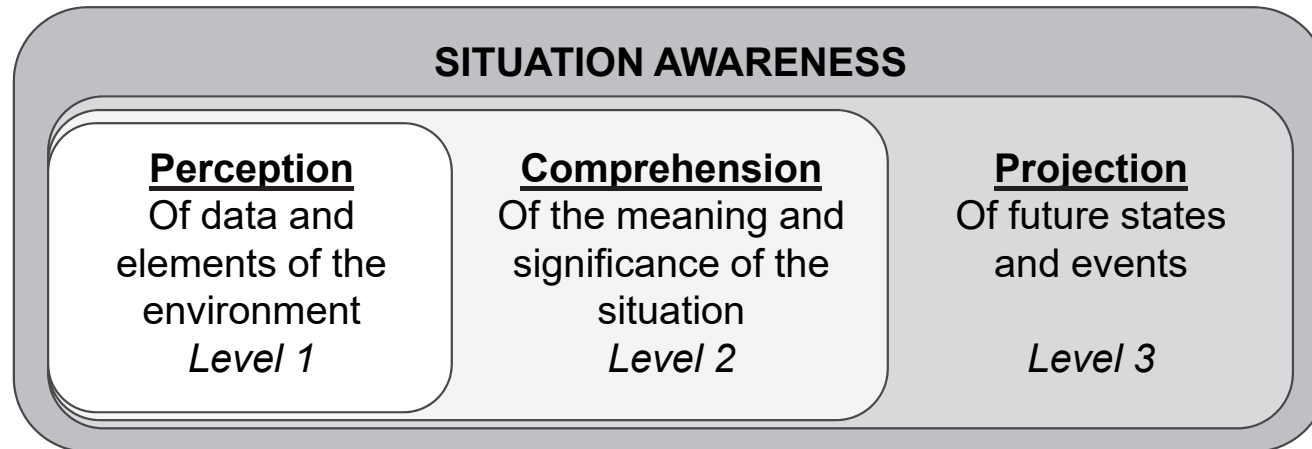


## Slide 3

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**AME4** Added DVIDS disclaimer  
Armstrong, Miriam E, 4/15/2024

# What is Situation Awareness?

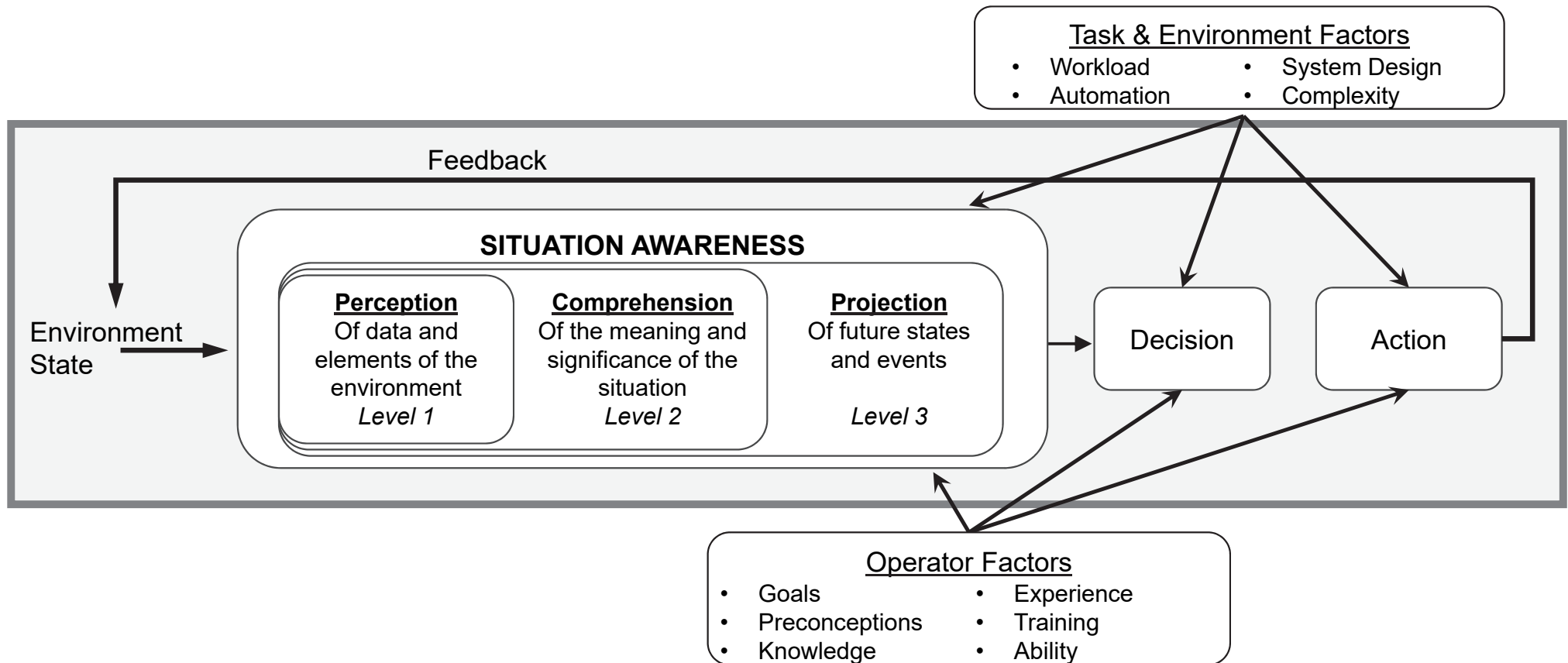


## Slide 4

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**AME5** removed Sage images  
Armstrong, Miriam E, 4/15/2024

## What does Situation Awareness involve?

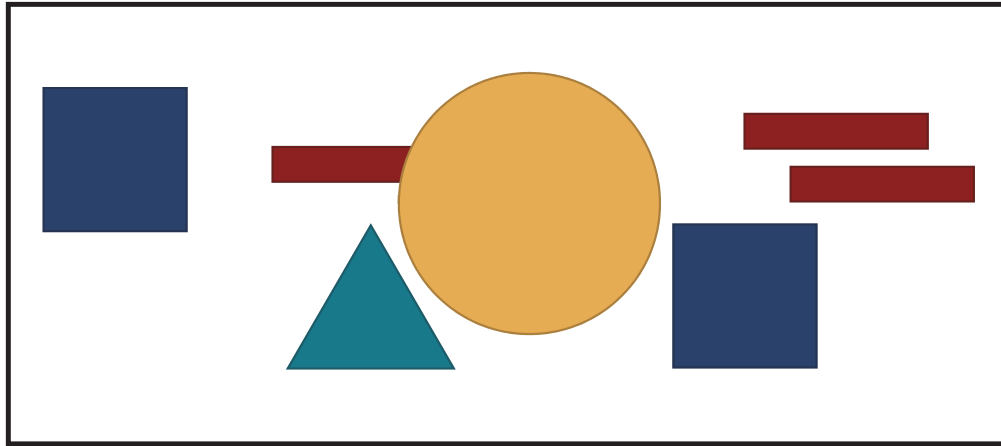


## Slide 5

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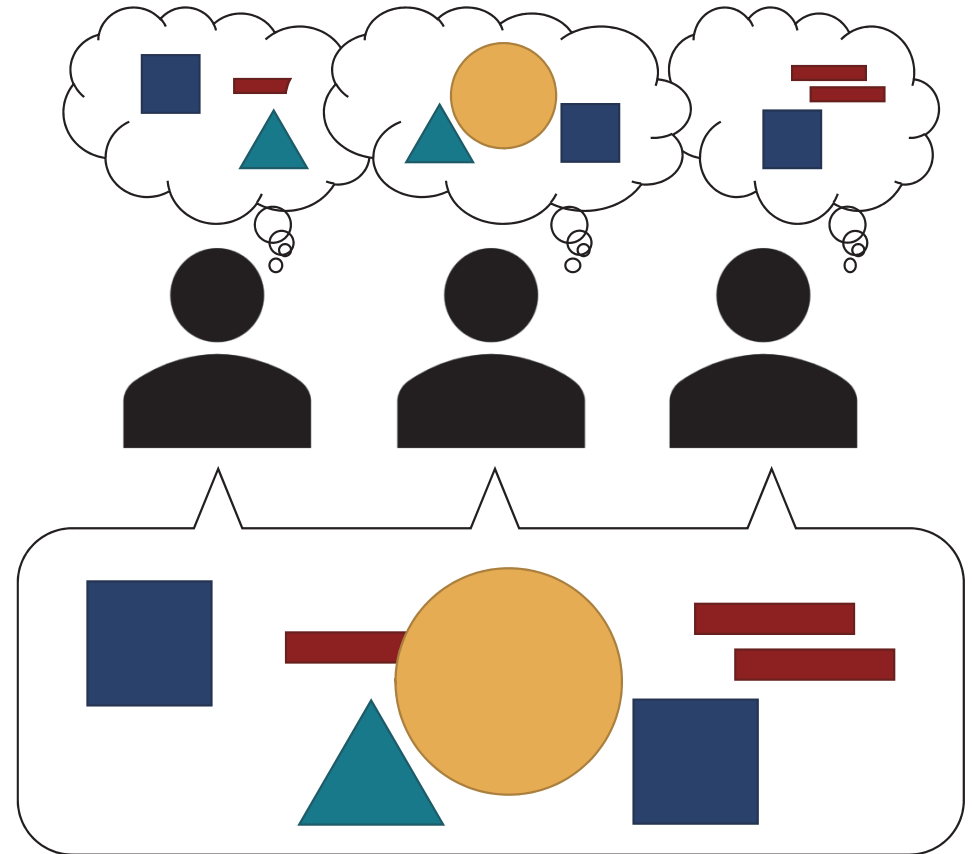
**AME6** removed Sage images  
Armstrong, Miriam E, 4/15/2024

## Team-level Situation Awareness



Team SA is a product of both:

- Individual SA
- Interactions between team members



## Why should we try to measure team Situation Awareness?

- It is important to measure team SA during testing because SA cannot be inferred from overall mission performance or individual SA
- It is impossible to accurately assess the true performance of a system without distinguishing usability and system functionality from SA effects
- Understanding impacts to SA can help improve system performance and mission outcomes

## How is Situation Awareness measured?

Survey	Behavioral	Query
<b>C-SA</b> (Cranfield Situation Awareness Scale)	Accuracy/Reaction Time	<b>SAGAT</b> (Situation Awareness Global Assessment Technique)
<b>MARS</b> (Mission Awareness Rating Scale)	Eye Movement	<b>SPAM</b> (Situation Present Assessment Method)
<b>SABARS</b> (Situation Awareness Behaviorally Anchored Rating Scale)	Imaging (e.g., Electroencephalography)	
<b>SART</b> (Situation Awareness Rating Technique)	<b>SALIENT</b> (Situation Awareness Linked Indicators Adapted to Novel Tasks)	



## NAVAIR researchers developed the Situation Awareness Linked Indicators Adapted to Novel Tasks (SALIENT) technique to measure team SA



Identify specific,  
observable  
behaviors that  
indicate team SA

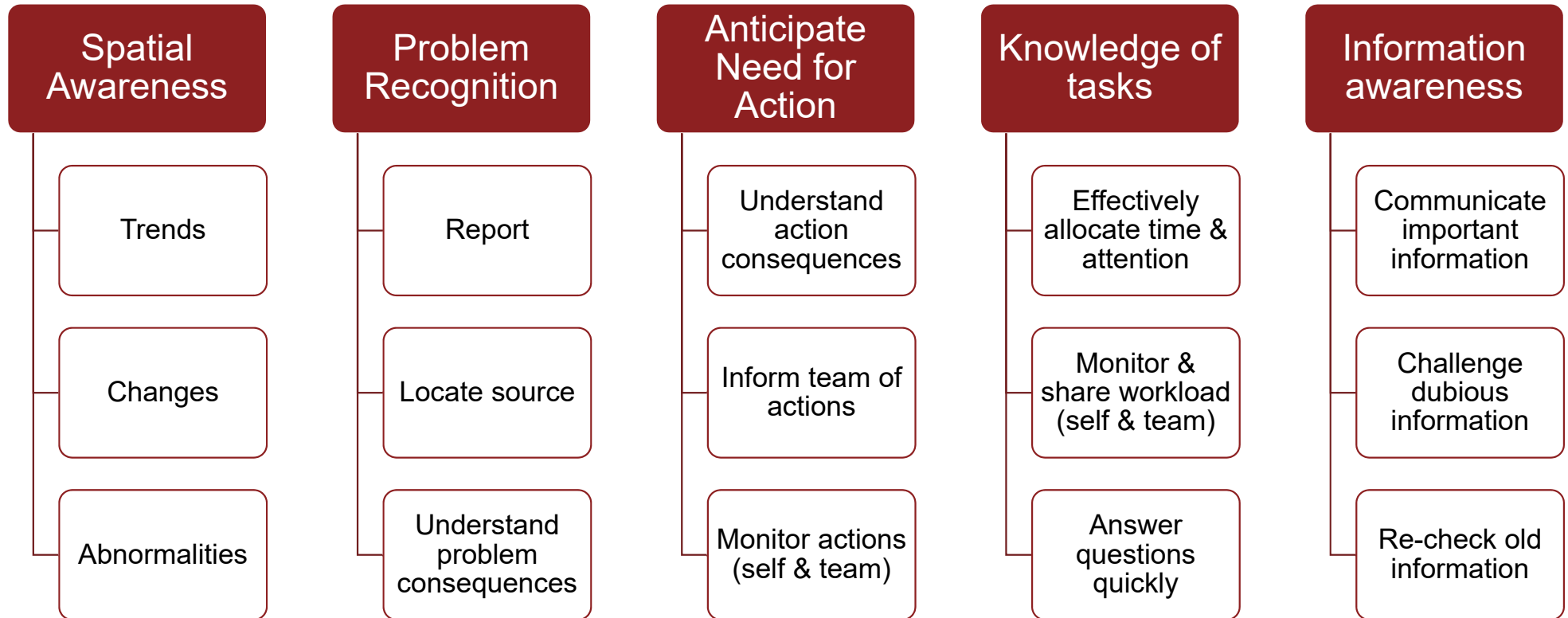


Develop a  
simulated event  
that requires team  
coordination

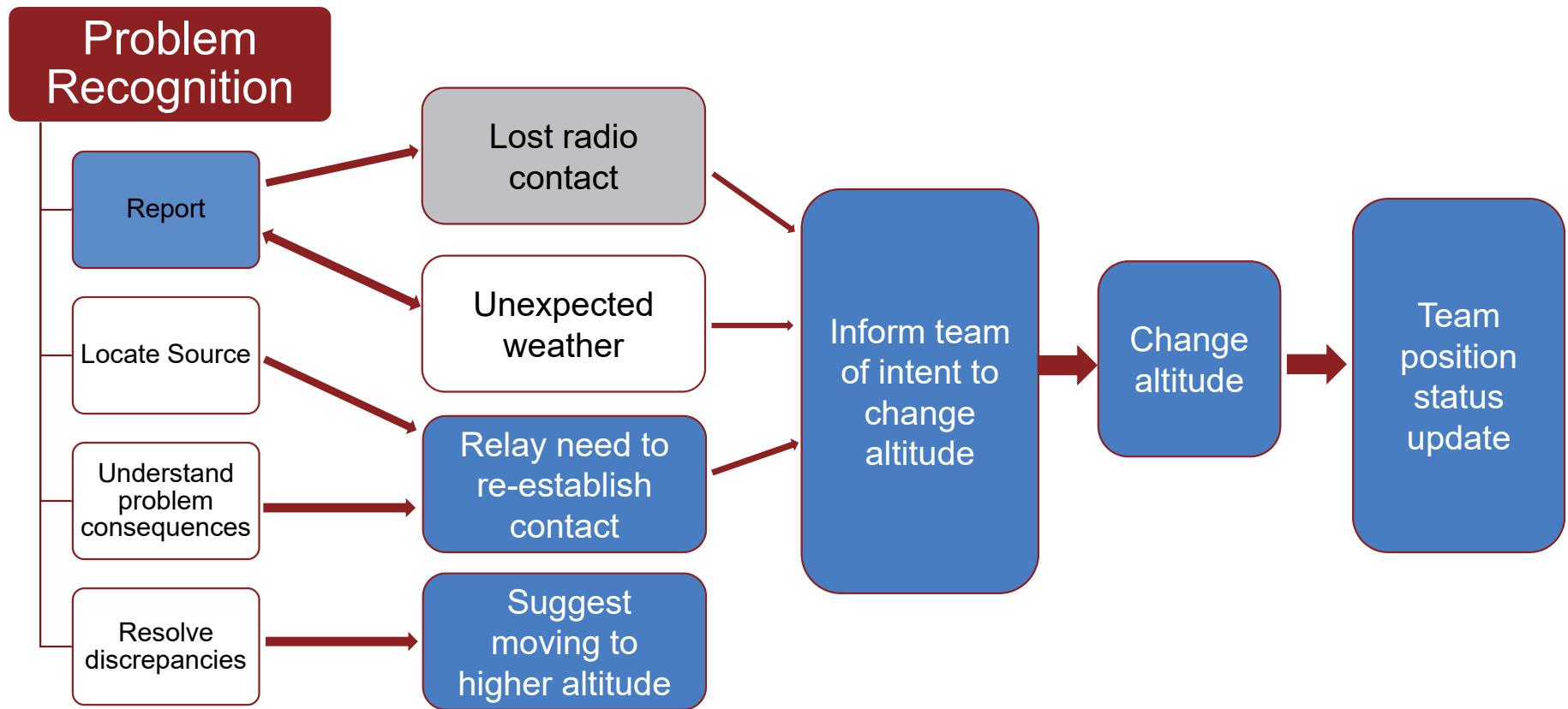


Observers record  
whether team  
demonstrated SA

# SALIENT indicator dimensions



## SALIENT: Problem recognition



## Should testers use SALIANT?

- SALIANT was developed over 25 years ago
- Does the literature indicate that this is a good measure to use (in OT)?

## We conducted a meta-analysis to investigate the merits of the SALIANT procedure

### **Is SALIANT reliable?**

Does SALIANT exhibit strong psychometric properties like internal consistency?

### **Is SALIANT sensitive?**

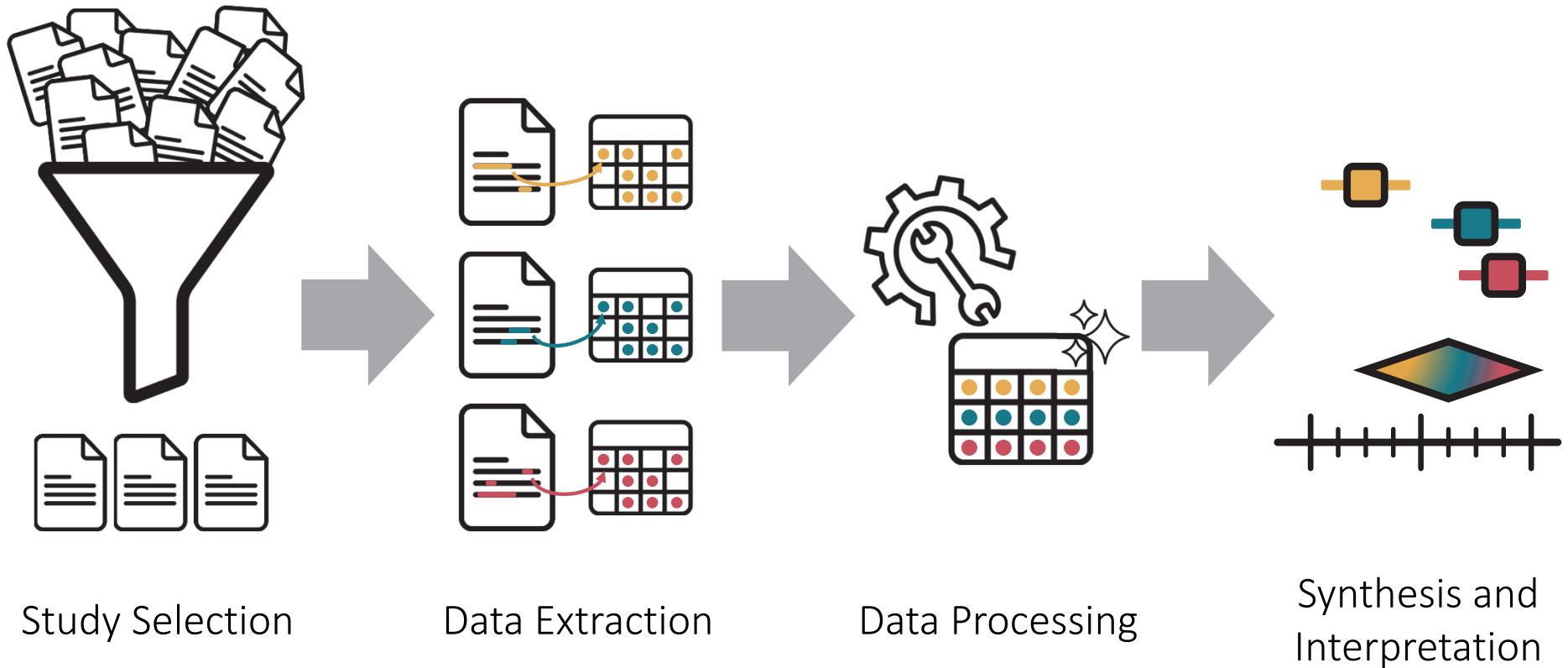
Are SALIANT scores affected by factors hypothesized to affect SA (e.g., operator training)?

### **Is SALIANT consistent with other SA measures?**

Are SALIANT scores correlated to SA measures derived from other procedures?

# Methods

**We conducted a meta-analysis to aggregate previous SALIANT findings**



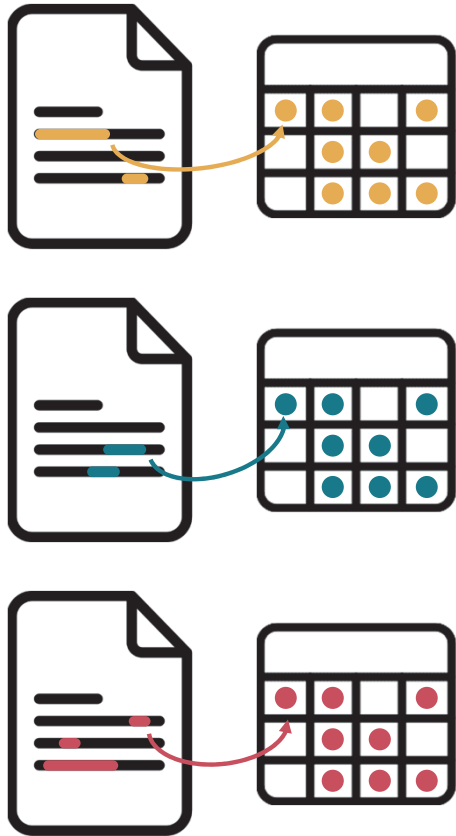
## Our sample was studies that measured team SA using SALIANT



- Searched:
  - Databases using terms “SALIENT,” “experiment,” and “measurement”
  - Papers citing originating SALIENT articles
  - Papers cited by an already included paper
- Included:
  - Published journal articles, conference proceedings, technical reports, dissertations
  - Used SALIENT to measure team SA
  - Reported relevant statistics

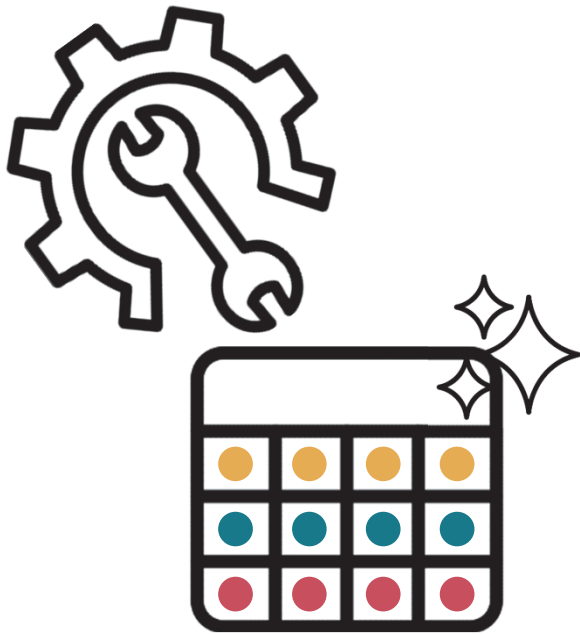


## We extracted study results relevant to SALIANT's reliability, sensitivity, and consistency with other SA measures



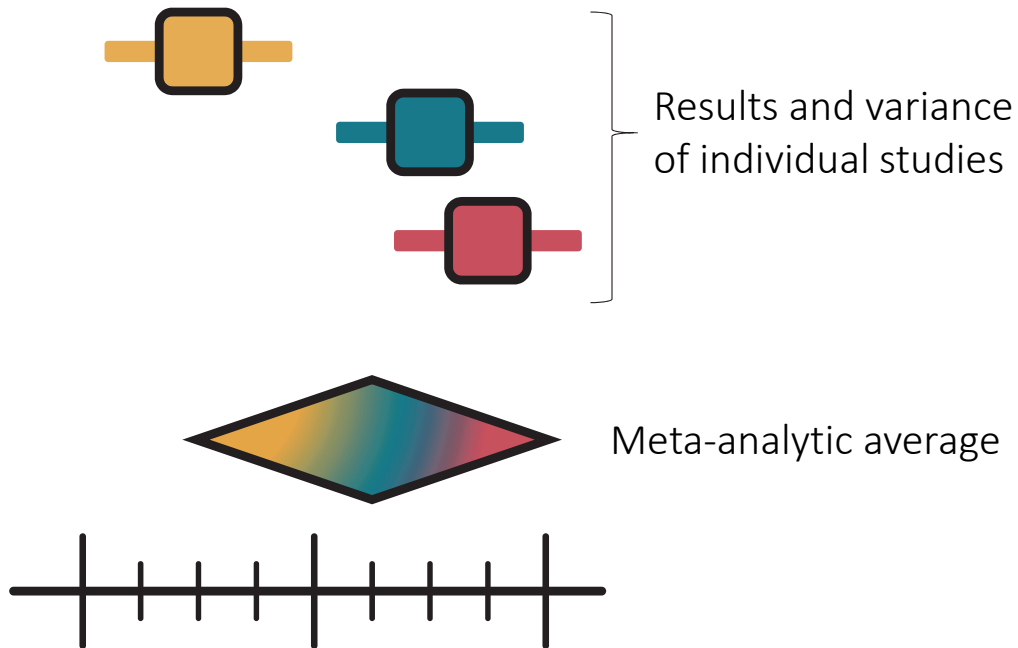
- Is SALIANT reliable?
  - Cronbach's alpha (internal reliability measure)
- Is SALIANT sensitive?
  - Effect sizes of operator or environmental factors
- Is SALIANT consistent with other SA measures?
  - Correlation between SALIANT and other SA measures

## We cleaned messy data



- Some studies conducted multiple tests relevant to our research questions
  - E.g., investigated effect of multiple types of operator experience on SALIANT
  - Averaged related results to obtain up to one statistic per study

## We aggregated results of individual studies to find a meta-analytic average



- Random effects model
  - Assumes variance both within and between individual studies
  - Appropriate when there is heterogeneity among included studies

# Results

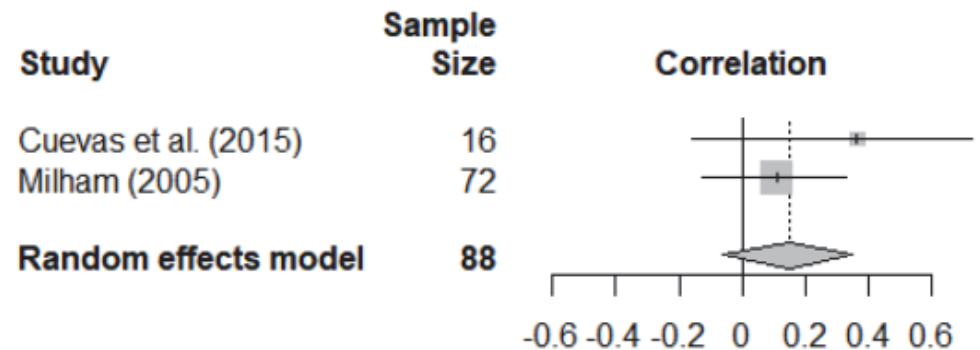
## Fewer studies than expected met our inclusion criteria

- Six studies measured SA using SALIANT and reported results
- Due to low number of studies, we have low statistical confidence in our findings

Study	Internal reliability	Effects of factors	Correlation with other SA measures
Bowers et al. (1998)	-	-	$r = .007$
Cuevas et al. (2015)	-	$r = .366$	-
Fink (2000)	$\alpha = .97$	-	$r = -.004$
Milham (2005)	-	$r = .110$	-
Milham et al. (2000)	-	-	$r = .720$
Muniz, Bowers, et al. (1998)	-	-	$r = .740$
<b>Number of studies in meta-analysis</b>	<b>NA</b>	<b>2</b>	<b>4</b>

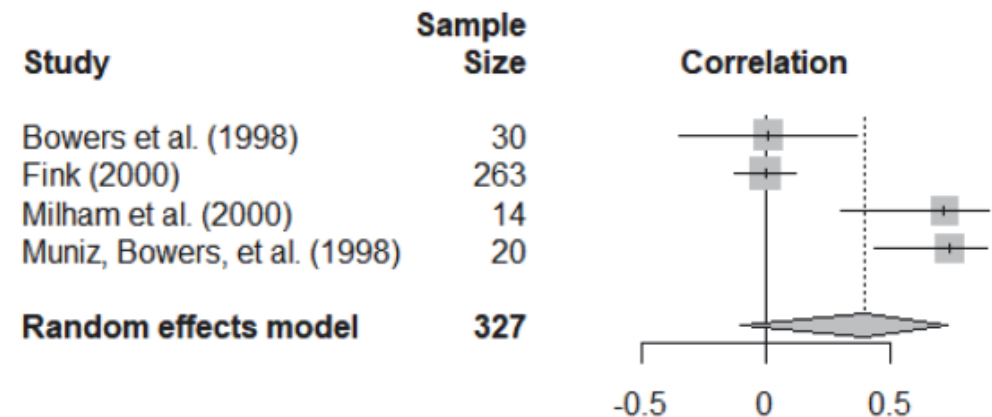
## No evidence that SALIANT is sensitive to factors that affect SA

- Two studies investigated effects of factors likely to affect SA
  - Cuevas et al. (2015): operator experience
  - Milham (2005): display design
- Meta-analytic findings non-significant
  - $r = .152$ , 95% CI [-0.063, 0.354]
  - Difficult to draw conclusions because of small number of studies, heterogeneity between studies
  - At present, no compelling evidence that SALIANT is sensitive to factors that impact SA



## No evidence that SALIANT is consistent with other SA measures

- Four studies compared results from SALIANT to other measures of SA
  - Bowers et al. (1998): query measure
  - Fink (2000): query and survey measures
  - Milham et al. (2000): survey measure
  - Muniz et al. (1998): behavioral measure
- Meta-analytic findings non-significant
  - $r = 0.399$ , 95% CI [-0.101, 0.738]
  - Difficult to draw conclusions because of small number of studies, heterogeneity between studies
  - No compelling evidence that SALIANT correlates with other SA measures



# Conclusions



## At present, we have anecdotal, but no statistical, evidence for the use of SALIANT

### Is SALIANT reliable?

- Not tested (only one study reported relevant results)

### Is SALIANT sensitive?

- No evidence for this
- Small number of studies (2) prevents definitive conclusion

### Is SALIANT consistent with other SA measures?

- No evidence for this
- Small number of studies (4) prevents definitive conclusion

## Do we recommend SALIANT? SSA1



*Source: Khosrork Creatas Video+ / Getty Images Plus via Getty Images*

SALIANT – Situation Awareness Linked Indicators Adapted to Novel Tasks

## Slide 26

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**SSA1** Still image of final slide added for PDF version  
Shaffer, Sarah A, 4/15/2024

## We may gain more insight using methods other than meta-analysis

- Multiple studies used SALIANT but did not report results
  - Reasons why are a qualitative finding (e.g., low agreement between observers, difficult for observers to multitask)
- Short-term future directions:
  - Systematic qualitative review
  - Alternative quantitative aggregation methods (e.g., vote counting)
- Potential long-term direction:
  - Investigate additional measures of team SA

**Bottom line: we're continuing to investigate the best ways to measure team SA**



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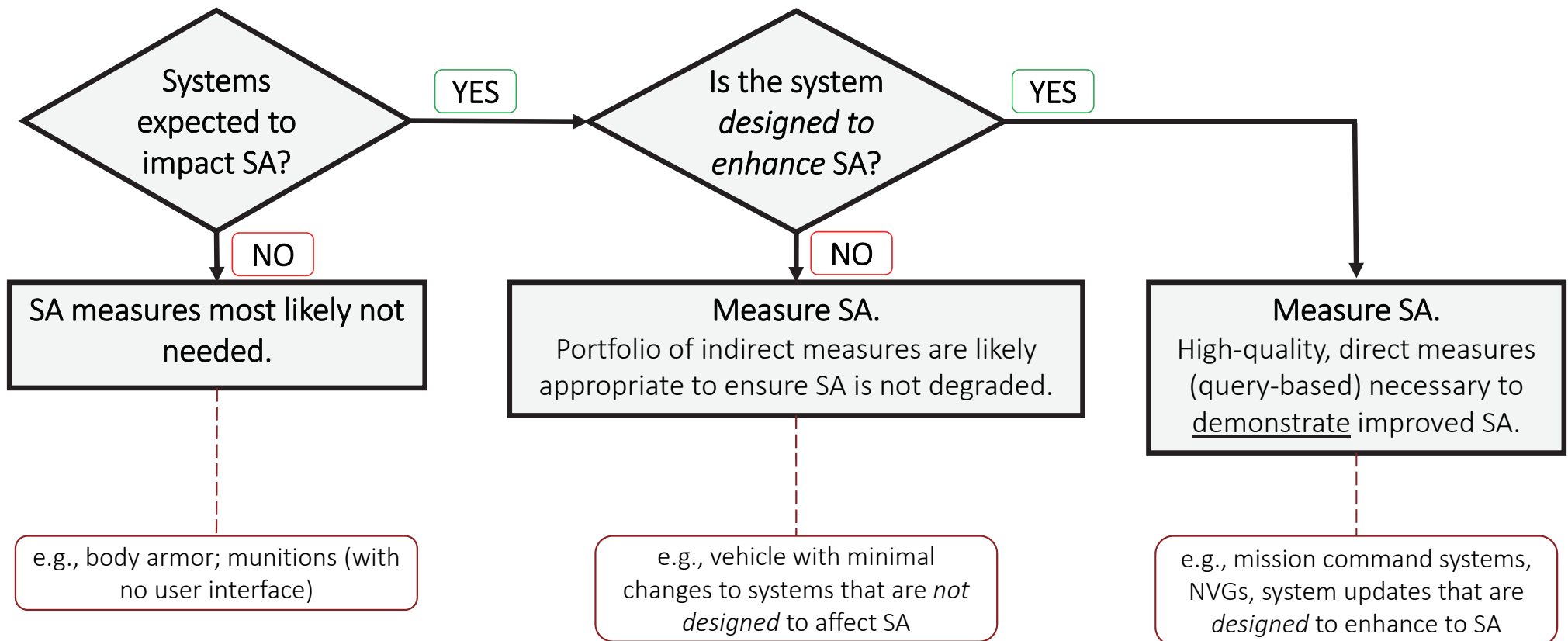
SA – Situation/al Awareness

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# Flowchart for considerations when selecting SA measurement methods





## **We conducted a meta-analysis to investigate the merits of the SALIANT procedure**

- Question 1: Does SALIANT exhibit good psychometric properties?
  - Hypothesis 1.a: SALIANT demonstrates good internal reliability
  - Hypothesis 1.b: SALIANT demonstrates good inter- and intra- rater reliability.
- Question 2: Is SALIANT sensitive to operator and environmental factors?
  - Hypothesis 2.a: SALIANT is sensitive to operator factors that influence SA (e.g., experience, operator ability, operator goals, training)
  - Hypothesis 2.b: SALIANT is sensitive to environmental factors that influence SA (e.g., automation, system design, task complexity, workload)
- Question 3: Is SALIANT consistent with other SA measures?
  - Exploratory analysis; no hypotheses made





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