

# The Effects of Display Type on Operator Decisions and Confidence

Mike Oliver

16.422

# Summary

- Introduction
- Motivation for research
- Research method
- Experimental results
- Conclusions and questions

# Introduction

- How does the display of information affect
  - Decisions
  - Confidence
- Military context
  - Radar displays
  - Command and control centers

# Motivation for Research

- System Complexity
- F/A-18 Contact ID
  - Often wrong
  - No display of sensor confidence
- Combat Information Center (CIC)
  - Scattered input sources

# F/A-18E/F Cockpit

See image at

<http://www.globalsecurity.org/military/systems/aircraft/images/fa-18-ef-cockpit.jpg>.

# Combat Information Center

(Gaston, 2003)

031125-N-0119G-002 Arabian Gulf (Nov. 25, 2003)  
-- Operations Specialist 1st Class Derrick L. Johnston from Meadville, Pa., (left) tracks interceptions of aircraft and reports them to the Tactical Actions Officer (TAO), Lt. Cmdr. Michael J. Yager from Troy, N.Y., (right) in the Combat Direction Center (CDC). CDC is the nerve center of the nuclear powered aircraft carrier, USS Enterprise (CVN 65). This is where information is collected, processed, displayed, evaluated, and disseminated from sources outside and inside the ship. U.S. Navy photo by Photographer's Mate Rob Gaston. (RELEASED)



(Pendergrass, 2003)

030305-N-3235P-522 At sea aboard USS San Jacinto (CG 56) Mar. 5, 2003 -- Fire Controlman Joshua L. Tillman along with three other Fire Controlmen, man the ship's launch control watch station in the Combat Information Center (CIC) aboard the guided missile cruiser during a Tomahawk Land Attack Missile (TLAM) training exercise. San Jacinto is deployed in support of Operation Enduring Freedom. U.S. Navy photo by Photographer's Mate 1st Class Michael W. Pendergrass. (RELEASED)



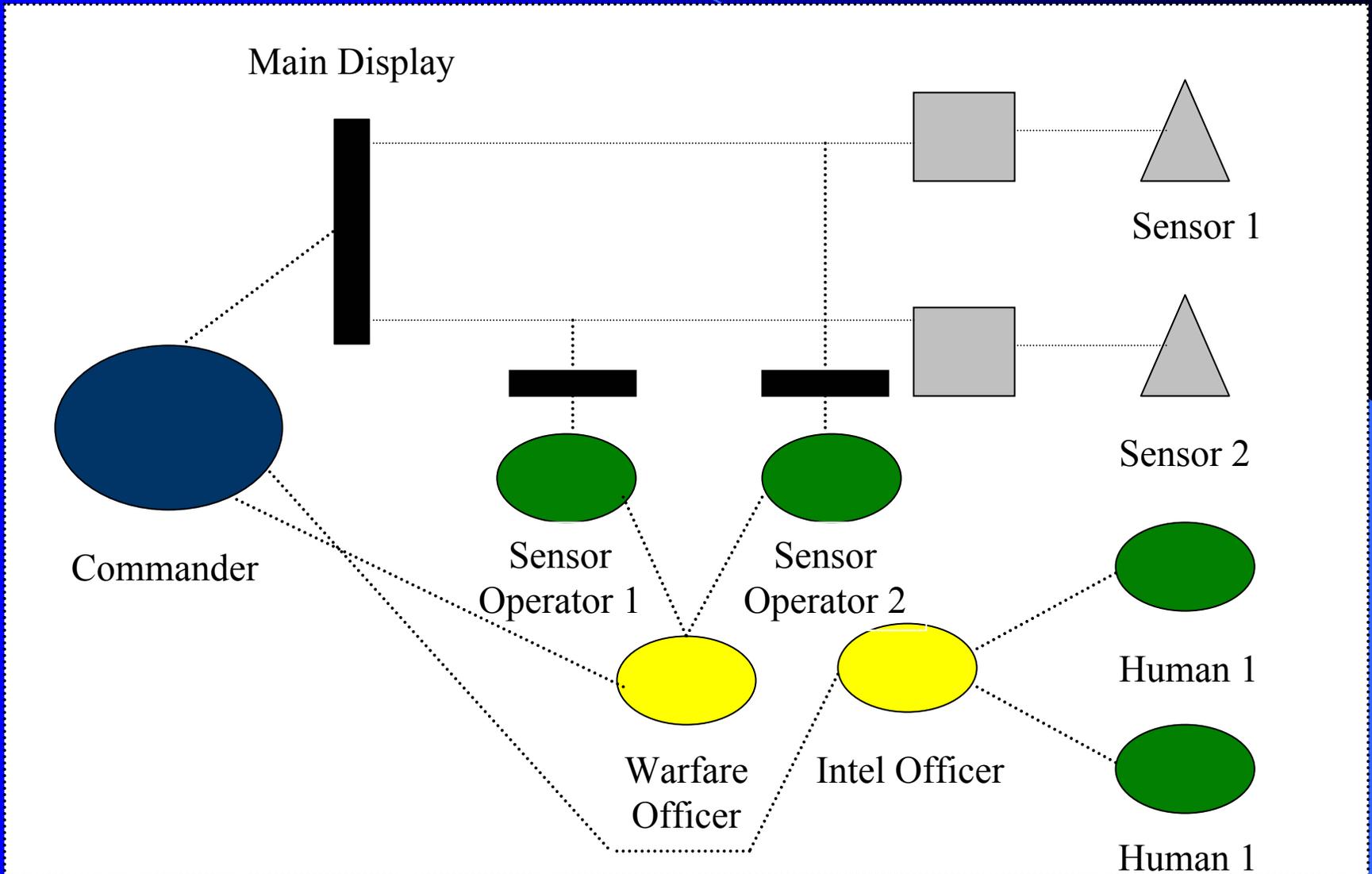
# What Information is Important?

- What is the contact?
  - Friendly
  - Hostile
- How likely is that correct?
  - Confidence

# Single Display

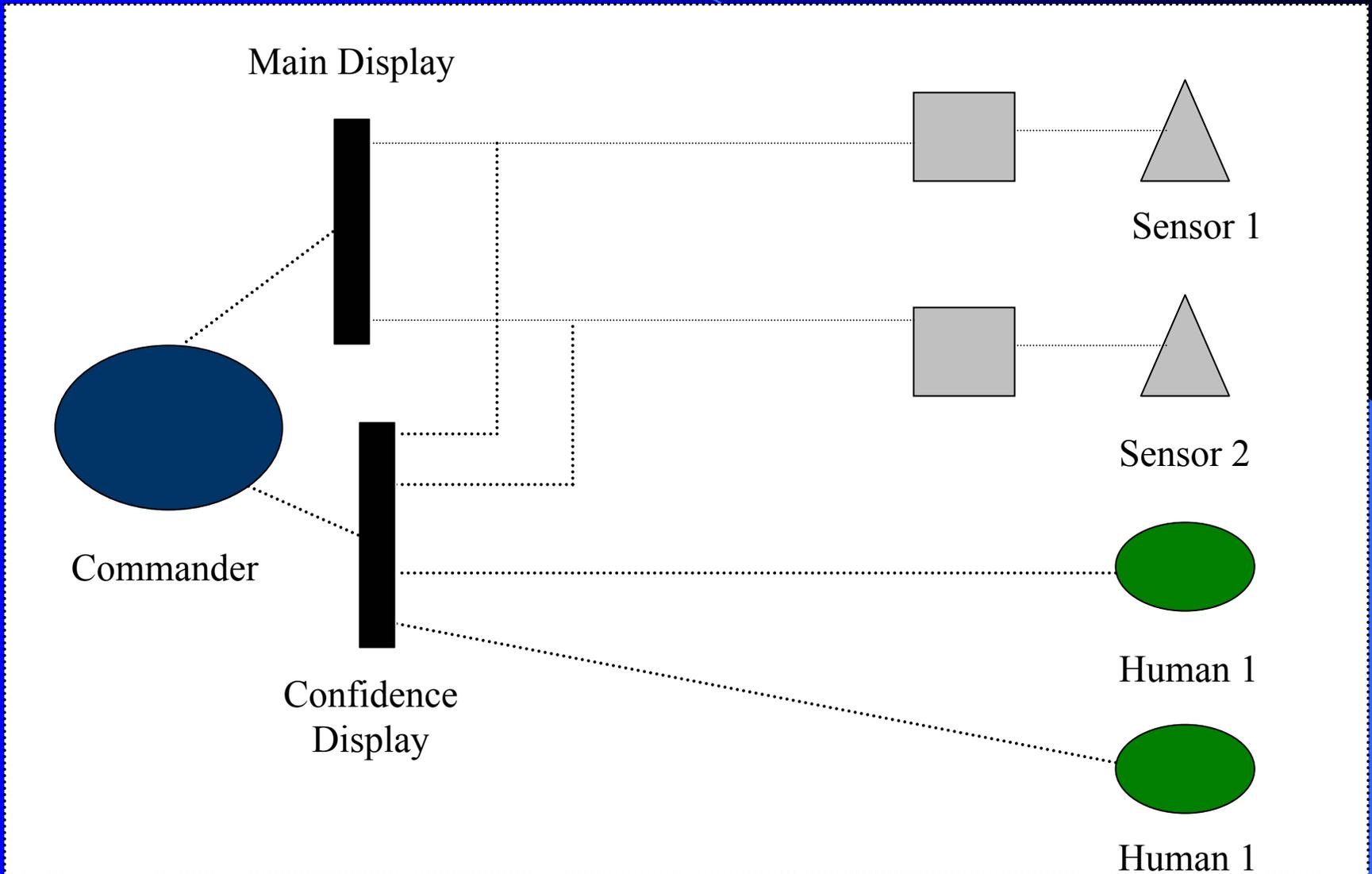
- Include all sources of information
- Display each source's confidence
  - Hostile confidence
  - Friendly confidence
  - Combine display

# Semi-Structured Model



(Hansman, 2000?)

# Semi-Structured Model



(Hansman, 2000?)

# Concept of Research

- Improve decision accuracy
  - Information restriction (Tabatabaei, 2002)
    - Steer operator towards a preferred decision
- Change decision maker confidence
  - Improve
  - Reduce

# Research Method

- Create conceptual display
  - 2 human inputs
  - 2 sensor inputs
- Devise different scenarios
  - Vary confidence
    - Friendly
    - Hostile
    - Ambiguous

# Research Method (cont'd)

- 45 different scenarios
- 22 subjects
  - 14 officers
  - 5 ROTC Midshipmen
  - 3 civilians
- Classify contact
- Provide confidence level

# Research Matrix

Scenario	Friendly	Combine	Hostile
Friendly	2	2	2
Probably Friendly	2	2	2
Ambiguous	5	5	5
Probably Hostile	4	4	4
Hostile	2	2	2

# Sample Displays

Hostile

Combine

Friendly



Human #1



Human #1



Human #1



Human #2



Human #2



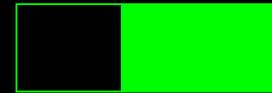
Human #2



Sensor #1



Sensor #1



Sensor #1



Sensor #2



Sensor #2

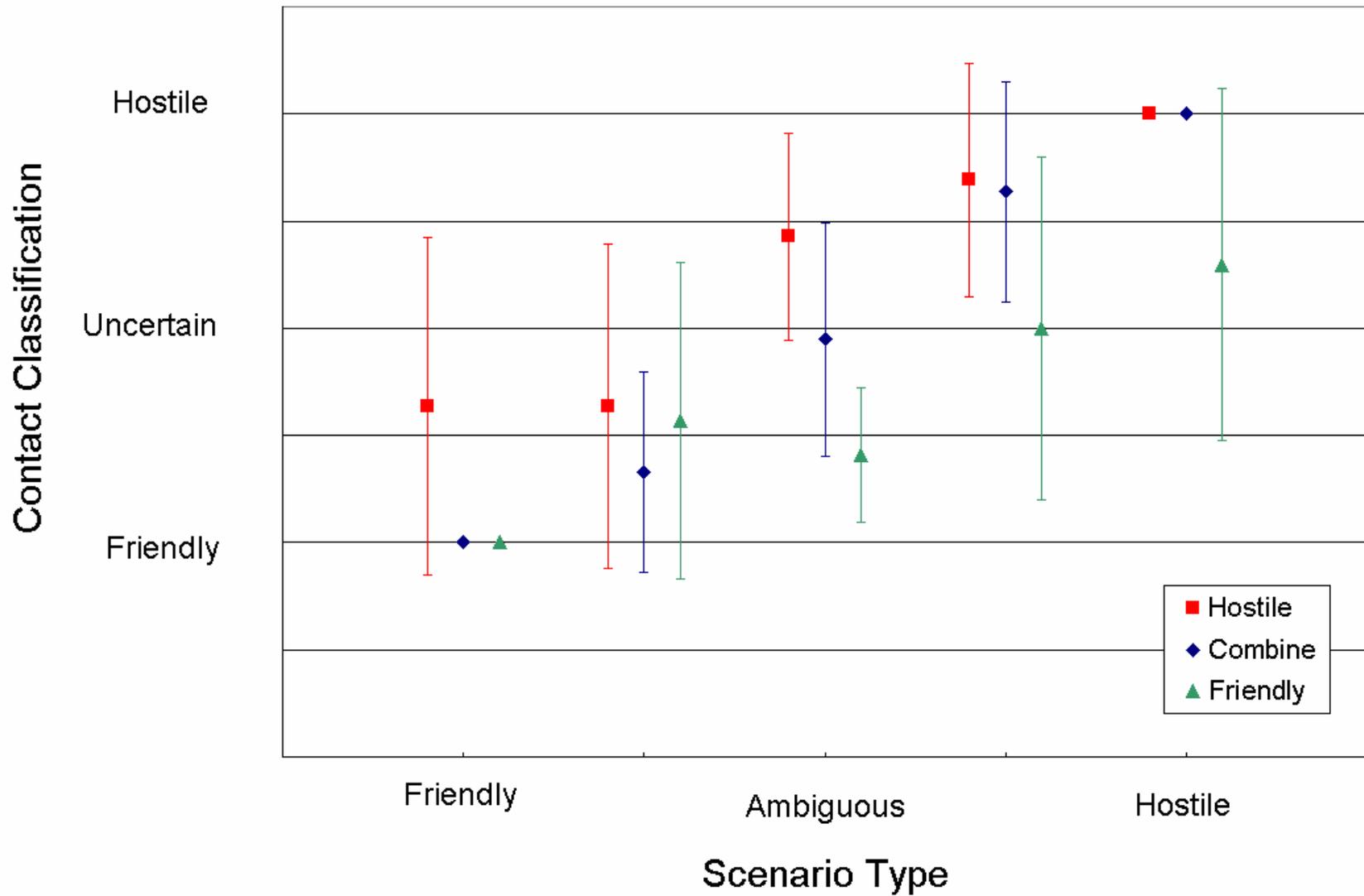


Sensor #2

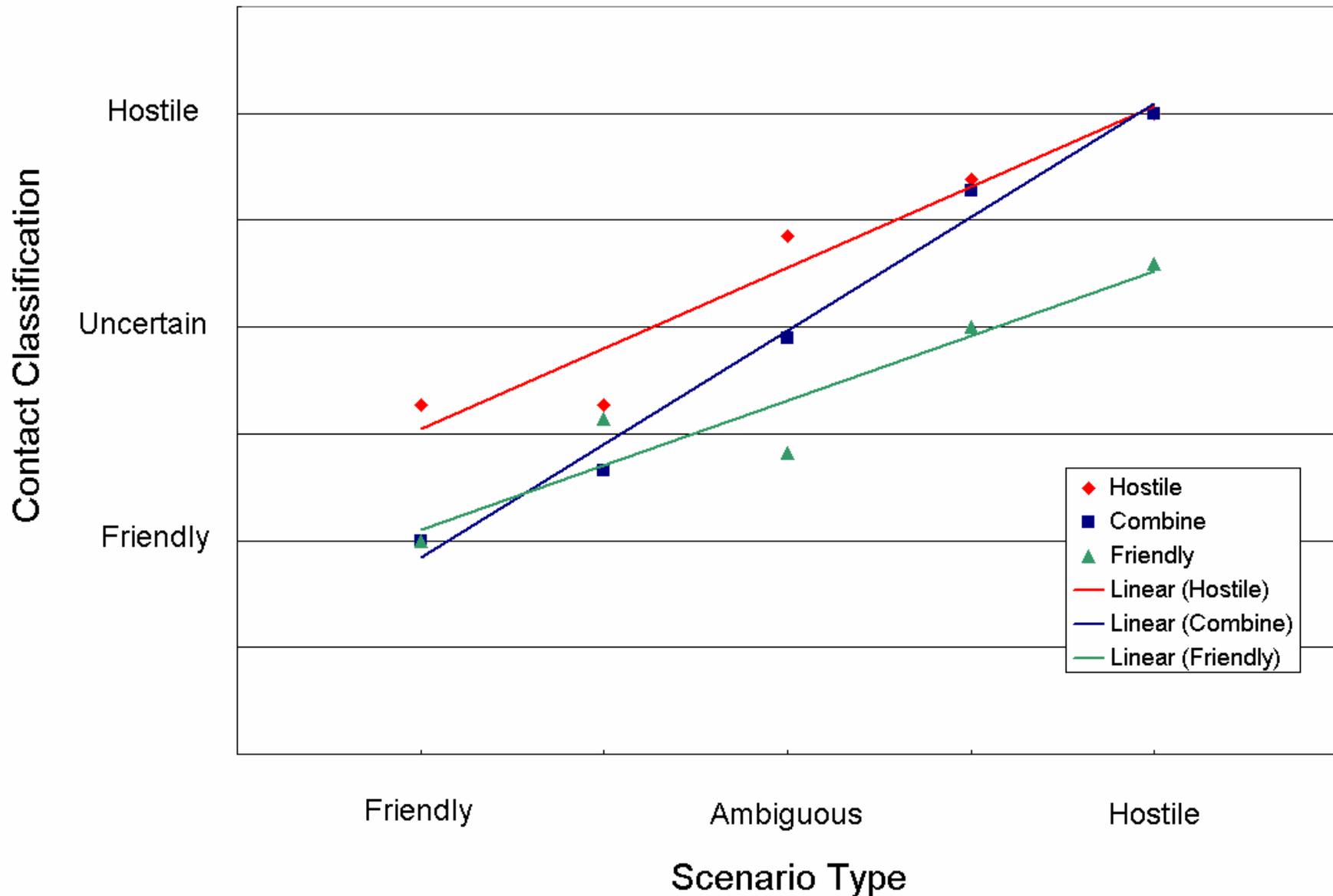
# Questionnaire

- Which display setup did you prefer when making your decision? Why?
- What additional information did you feel would have been beneficial if included in the display?
- Did you tend to favor the human or sensor inputs?

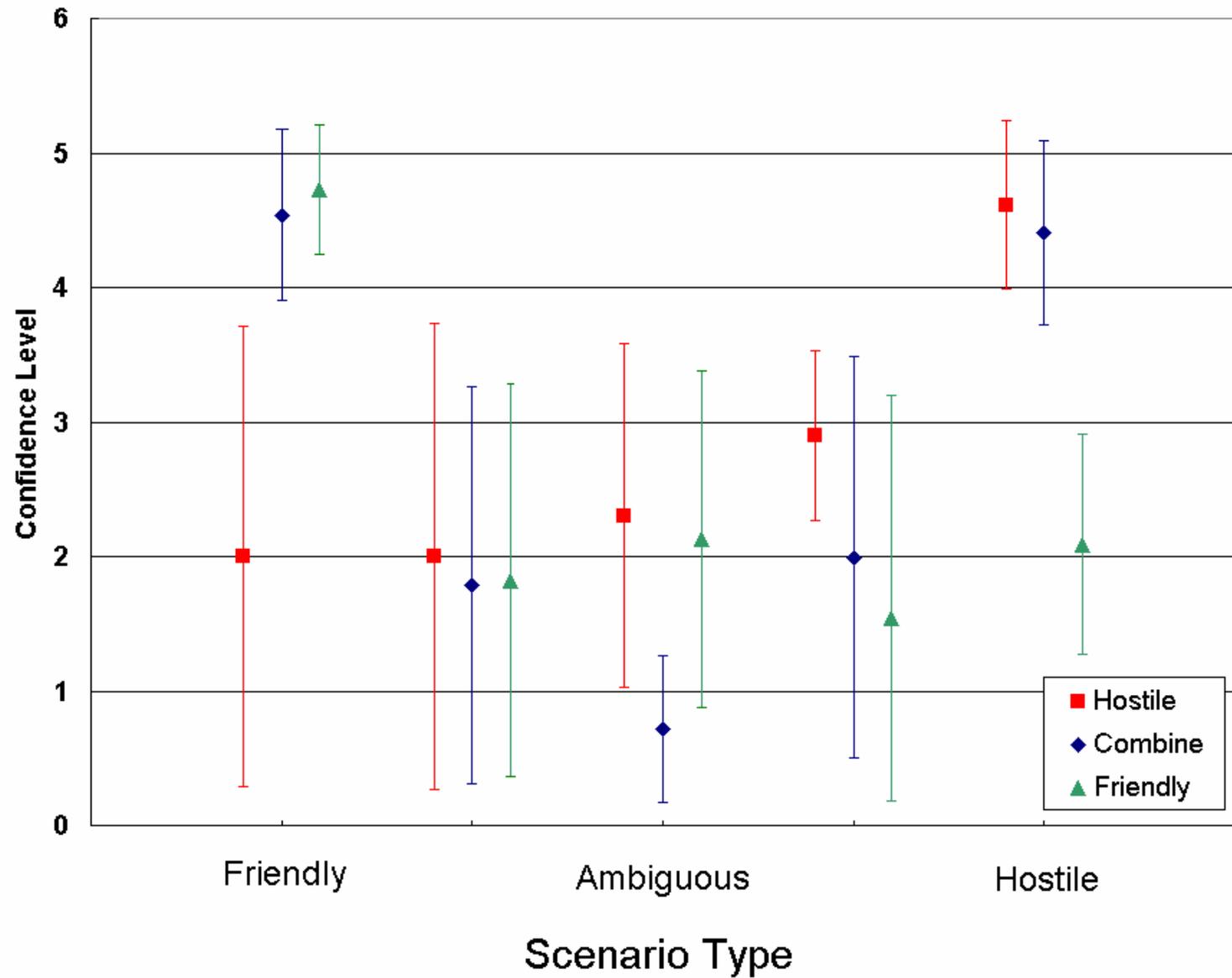
# Operator Decisions



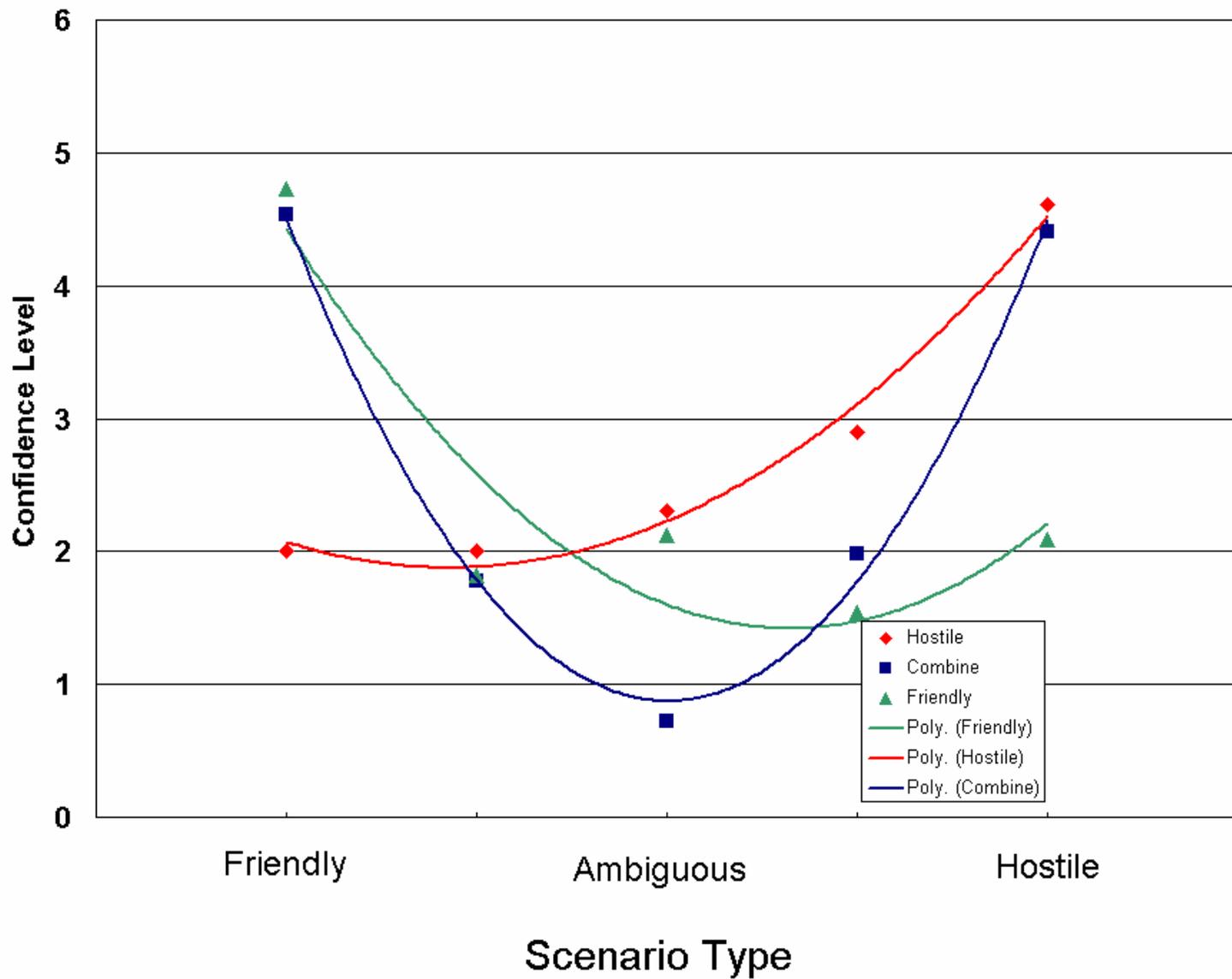
# Operator Decisions



# Confidence



# Confidence



# Analysis

- ANOVA
  - Decision
    - Well below 0.01
  - Confidence
    - 0.035 for display type
    - $<0.01$  for scenario type

# Questionnaire Response

- All but 1 subject preferred combine display
  - All available information
- Additional information
  - Numeric percentage
  - Timeliness of info
- Human vs. Sensor
  - Split equally

# Conclusions

- Display type matters
  - 30% bias
- Combine display
  - Accuracy
  - Confidence

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# References

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