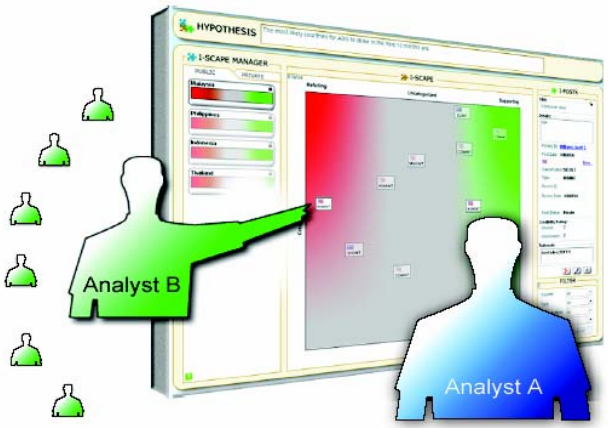
Networked Collaborative Intelligence Assessment:

Joint Intelligence Graphical Situation Awareness Web (JIGSAW)



Matthew R. Risser, PhD

Harvey S. Smallman, PhD

Pacific Science & Engineering Group

San Diego, CA

13th ICCRTS 2008, Seattle, WA. 17-19 June

Office of Naval Research: PHASE II SBIR N04-116

Introduction

- The 9/11 Commission (2004) made it clear that coordinated intelligence gathering, sharing and analysis is a national priority
- There is a recognized need to improve the exchange of information among the intelligence community; however, there are barriers to effective sharing

Barrier 1: Cognitive Challenges

- Analysts rely on familiar cadre and miss critical information
- Contributors may not know what originator needs and engage in an error-prone dialogue and information transaction (Moreland, 1999)
- Difficulty associated with integrating information and making unbiased assessments (Patterson, et al., 2001; Hutchins, et al., 2004; Smallman, 2008).
- Reluctance to entertain disconfirming evidence and reliance on simple heuristics (e.g. anchoring and confirmation biases) (Kahneman, Slovic, & Tversky, 1982; Hogarth, 1987)

© Pacific Science & Engineering 2008

Introduction

Barrier 2: Collaborative Tools and CONOPs

- A second barrier is the lack of dedicated collaborative intelligence assessment tools and concepts of operation for their usage.
- Currently, stove-piped tools and inefficient business processes (intel cycle) inhibit the shared understanding among distributed analyst teams (e.g., Warner, Letsky & Cowen, 2005; St. John, et al., 2005)

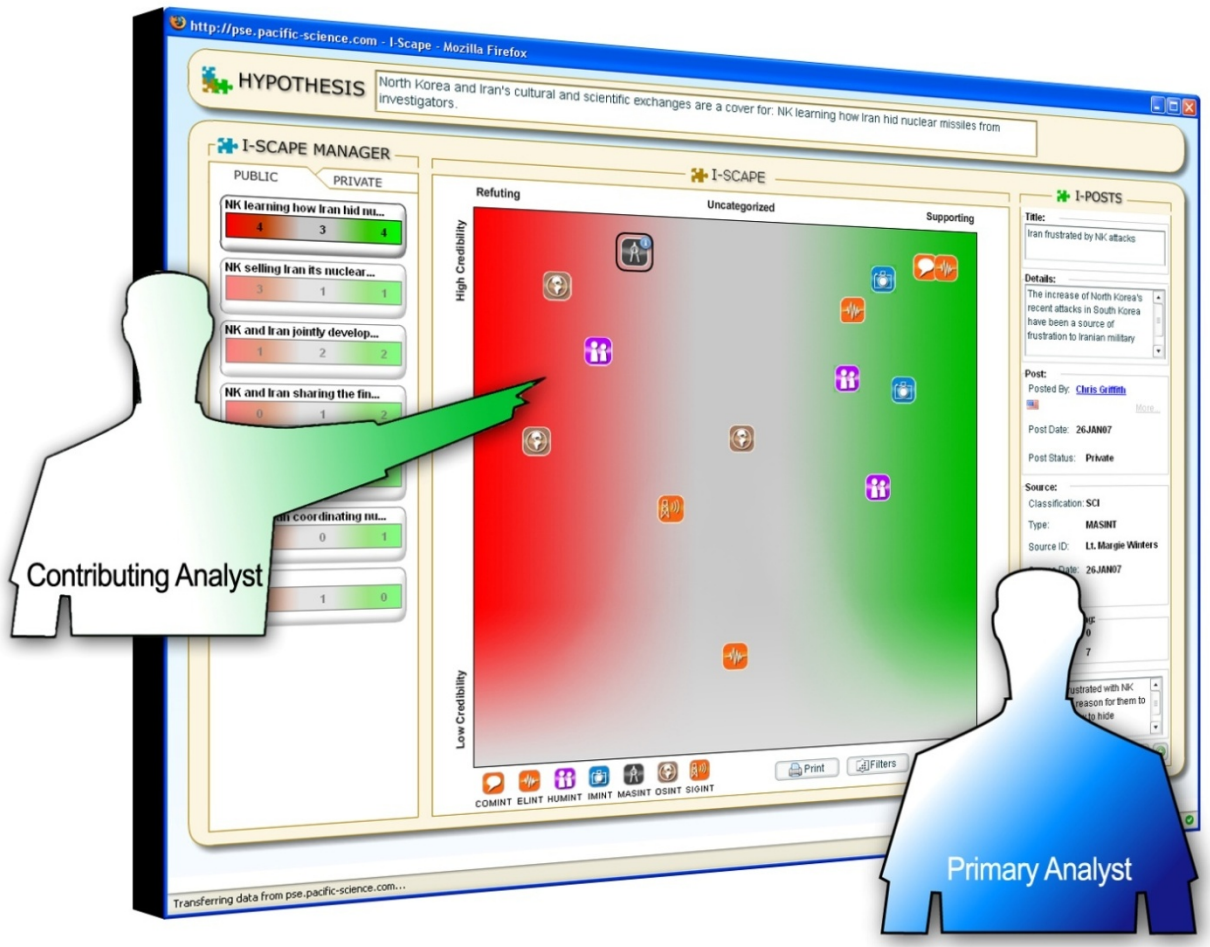
Our Response to these Barriers

- JIGSAW is web-based system intended to facilitate the exchange of information and reduce biases among disparate and unfamiliar intelligence analysts (Smallman, 2008)
- The collaborative nature of JIGSAW is facilitated through two design features that were evaluated to address both barriers:
  - a *shared visual workspace* or intelligence landscape (I-Scape)
  - a *discussion mechanism* whereby analysts can share and evaluate information from unknown but knowledgeable sources

© Pacific Science & Engineering 2008

JIGSAW Solutions

JIGSAW is a shared graphical workspace where collaborating analysts post intelligence in a coordinating representation intended to reduce biases and facilitate intelligence integration and evaluation



CONOPs

- Primary analyst (owner)
- Contributing analysts

I-Scape

- visually represents evidence (I-Posts) on two dimensions: *credibility* and *support*
- Makes conflicting evidence salient through a shared graphical layout

Discussion

- How should discussion be supported?

© Pacific Science & Engineering 2008

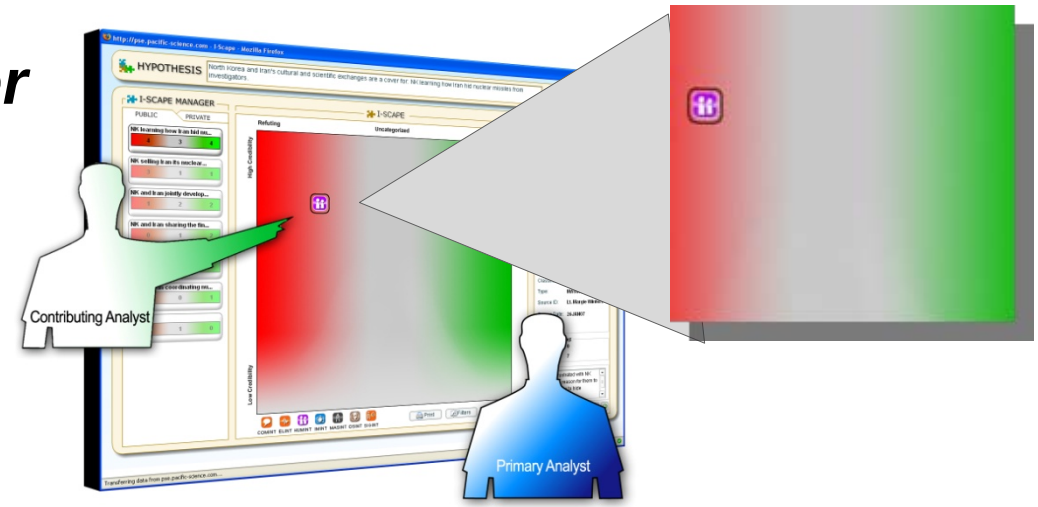
Experiment Purpose

- Evaluate two collaborative design features
  1. shared visual workspace, or intelligence landscape ("I-Scape")
  2. discussion forum
- First, to examine how the shared visual workspace might help structure collaboration
  - The I-Scape will present as two arrangements: the presence of others I-Posts and the absence of others I-Posts (to see others I-Posts or not)
- Second, to examine the effectiveness of a discussion-based design feature to facilitate collaboration
  - The discussions will progress within two communication architectures: centralized and decentralized
- To validate the CONOPS for how JIGSAW might be used over an extended period of time

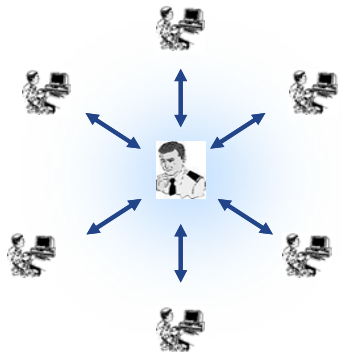
© Pacific Science & Engineering 2008

Assessment…Today and Tomorrow

Proxy for Today

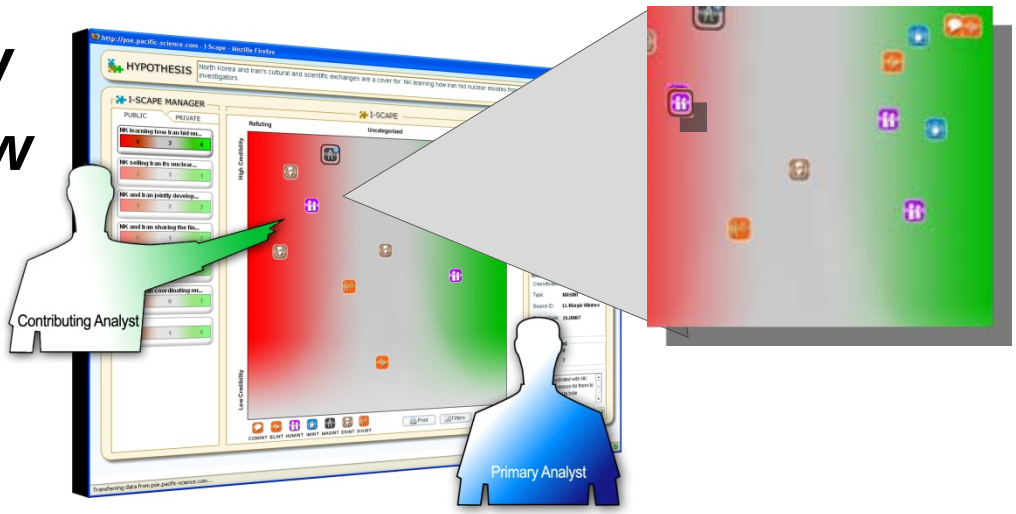


Absence

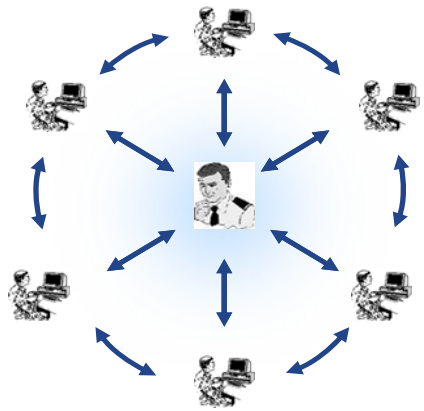


Centralized

JIGSAW Tomorrow



Presence



Decentralized

Method

Overview

- 4-week experiment that required collaborative analysis
  - 20 participants work 10 hypotheses over 4 weeks (15 min/day ~ 5 hours total)
- Worked as 2 online teams using the same hypotheses
  - 10 in decentralized and 10 in centralized
- Participants role-played both the primary analyst and the contributor
  - Owner of 1 and contributed to all 10 hypotheses
- Both I-Post and discussion activities could be performed asynchronously among team members
- Design: Discussion Architecture (2) x I-Scape Arrangement (2) x Time (2)

Participants (N=20)

- 19 students (military officers) and 1 instructor from a Decision Support Systems class at the Naval Postgraduate School
- Representing Navy, USMC, and USCG
- 25% with intelligence experience
- Mean age = 37 years
- Mean years of military experience = 13 years

© Pacific Science & Engineering 2008

Stimuli

Stimuli

- A web-based experimental version of JIGSAW was created for this study
- 10 Hypotheses
  - Unclassified and open source from news websites
  - different topics of general interest
  - may be referenced by multiple, open sources
  - with implications for government response (e.g. military or non-combatant)
  - binary (true/false)
  - balanced (likely equal evidence pro and con)
- Evidence gathered was from the web

Example hypotheses (3 of 10)

1. Turkey will be admitted into the European Union starting with the next budget cycle in 2014.
2. By the end of 2008, the U.S. will be prepared to effectively respond to any Avian flu outbreak
3. There will be another significant natural disaster in the U.S., on the same scale of devastation as Hurricane Katrina, within the next 5 years

© Pacific Science & Engineering 2008

Hypothesis Manager

JIGSAW Experiment 2 - Hypothesis Manager - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites

Address http://danielmanes/JIGSAWExp2/ManagerPage.aspx Go Links

JIGSAW Experiment 2	
Phase 1	Collect and Post Intelligence
Logged In:	Participant 12
Links:	Log In Log Out Hypothesis Manager

Hypothesis Manager

#	Subject	Own I-Post Complete	Own Reassess-ments	Final Reassess-ment Complete	Own Discussion Entries	New/ Modified I-Posts	New Discussion Entries	Hypothesis Owner	I-Posts Viewable	Discussions Viewable
1	Turkey - Euro Union	No	0	No	0	0	0	Participant 1	Own	Own
2	Iran - nuclear	No	0	No	0	0	0	Participant 3	Own	Own
3	US - Avian flu	No	0	No	0	0	0	Participant 5	Own	Own
4	US - troops in Iraq	No	0	No	0	0	0	Participant 7	Own	Own
5	US - terrorist attack	No	0	No	0	0	0	Participant 9	Own	Own
6	Osama - captured	No	0	No	0	0	0	<Participant 12>	All	All
7	US - natural disaster	No	0	No	0	0	0	Participant 14	All	Own
8	Russia - Al-Qaeda attack	No	0	No	0	0	0	Participant 16	All	Own
9	Korea - armed conflict	No	0	No	0	0	0	Participant 18	All	Own
10	Thailand - Abu-Sayef attack	No	0	No	0	0	0	Participant 20	All	Own

Please click a link to view or post to a hypothesis.

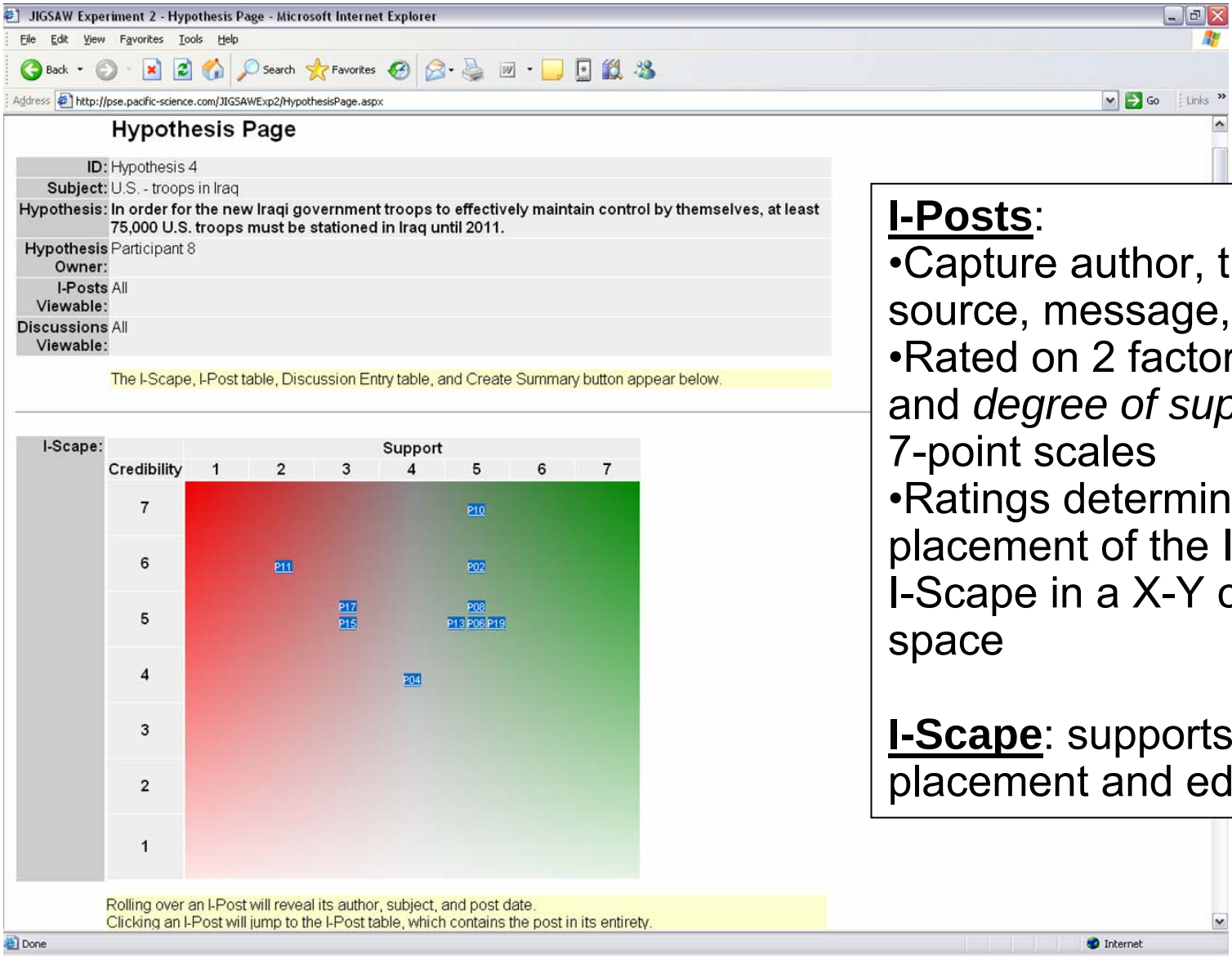
Done Local intranet

Hypothesis Manager

- stripped-down version of JIGSAW
- Keeps record of all hypothesis activity

© Pacific Science & Engineering 2008

I-Scape and I-Posts



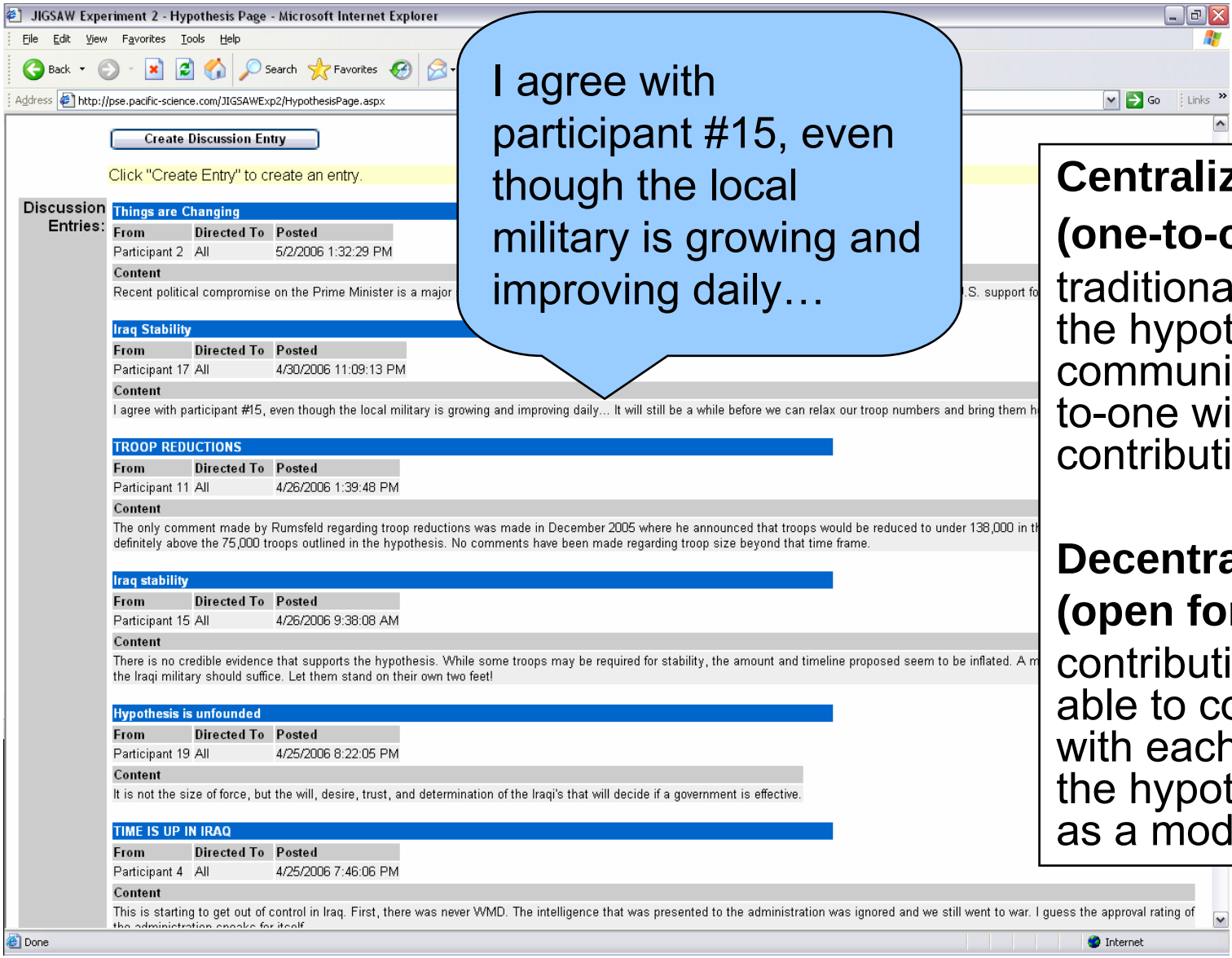
<u>I-Posts</u>:

- Capture author, time, date, source, message, and ratings
- Rated on 2 factors: *credibility* and *degree of support* on two 7-point scales
- Ratings determine the placement of the I-Post on the I-Scape in a X-Y coordinate space

<u>I-Scape</u>: supports I-Post placement and editing

© Pacific Science & Engineering 2008

Discussion Forum



I agree with participant #15, even though the local military is growing and improving daily…

Centralized (one-to-one)

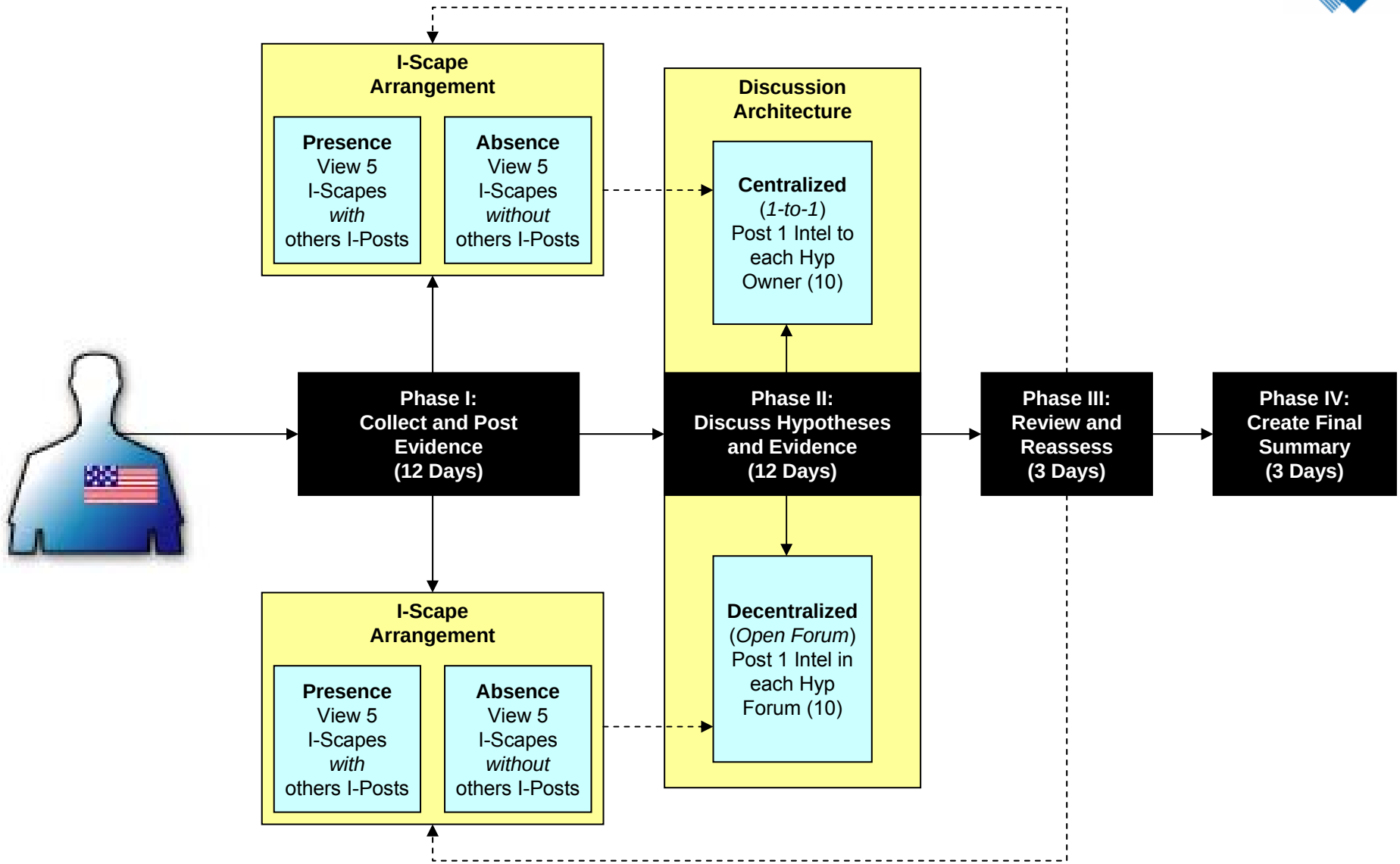
traditional flow with the hypothesis owner communicating one-to-one with contributing analysts

Decentralized (open forum)

contributing analysts able to communicate with each other with the hypothesis owner as a moderator

© Pacific Science & Engineering 2008

Procedure



© Pacific Science & Engineering 2008

Metrics

- Cartesian dispersion of I-Posts on I-Scape
  - new measurement of group cohesion (collaborative assessment)
  - combines both support and credibility axes on a single dimension
  - However, does not account for the direction of the relationship

$$\sqrt{x_\sigma^2 + y_\sigma^2}$$

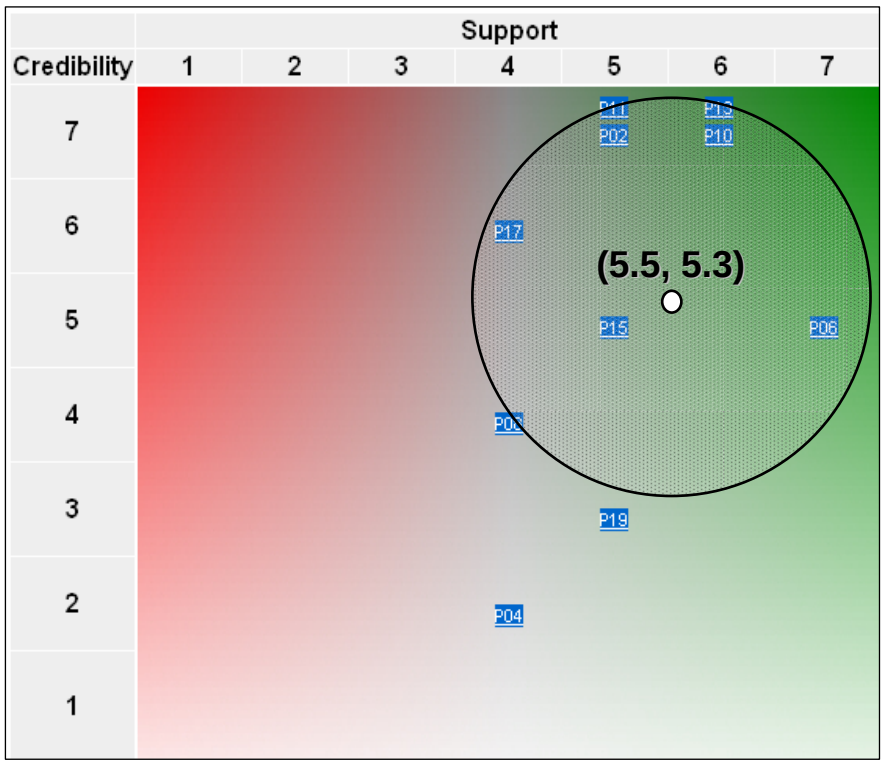
- Degree of Support
  - (1 to 7 rating on x-axis of I-Scape)
- Source Credibility
  - (1 to 7 rating on y-axis of I-Scape)
- Frequency of I-Post Movements
- Total I-Post Distance
- Number of Discussion Entries

© Pacific Science & Engineering 2008

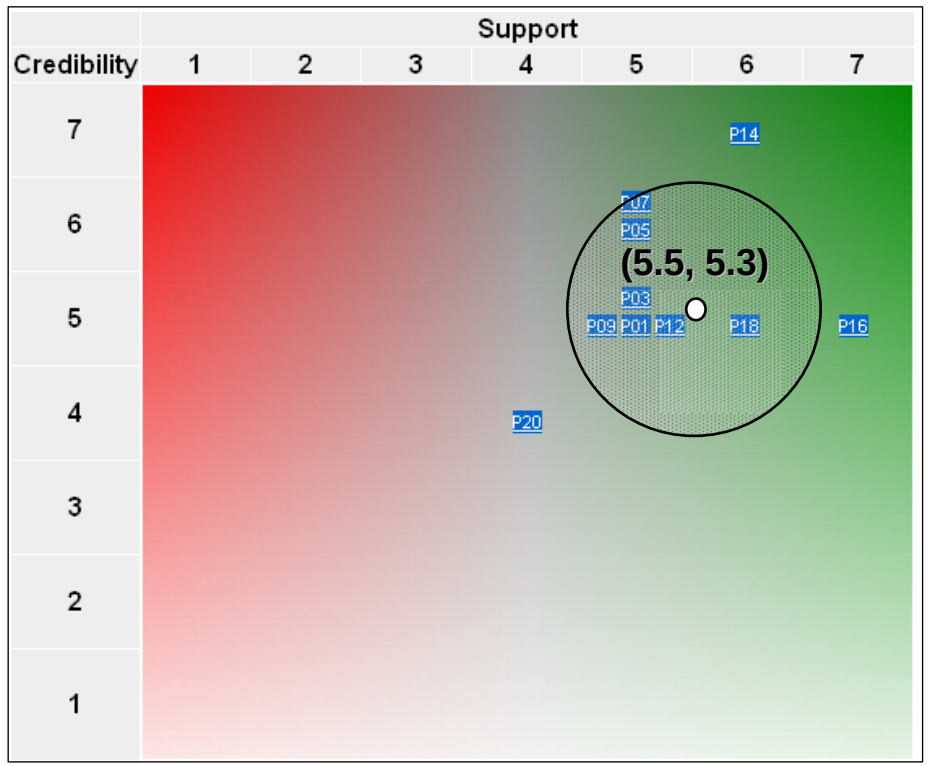
Dispersion Metric $\sqrt{x_\sigma^2 + y_\sigma^2}$

Hypothesis 7: *There will be another significant natural disaster in the U.S., on the same scale of devastation as Hurricane Katrina, within the next 5 years.*

dispersion = 1.90



dispersion = 1.27



© Pacific Science & Engineering 2008

Experimental Predictions

1. There will be greater “clumping” of I-Post positions for those using the decentralized (open forum) as compared to the centralized architecture due to greater opportunity for social comparison
2. Reach consensus faster within a decentralized discussion architecture because more time will allow for the exchange of information towards a consensus
3. There will be a greater change in absolute I-Post position and increased frequency of movement in the presence as compared to the absence I-Scape arrangement
4. The frequency of I-Post movement would be positively correlated with discussion frequency

Participants completed the minimum requirements for discussion and I-Post assessments, thus discussion frequency and I-Post assessment frequency were similar among conditions

© Pacific Science & Engineering 2008

Results and Discussion

Time

- As measured by mean I-Post position, ratings at both initial and final assessments were supportive (i.e., > 4)
- *Support* ratings grew even more supportive over time ($\eta p^2 = .34$)
  - Initial = 4.4 vs. Final = 4.8
- Collectively, results are suggestive of confirmation bias
- *Credibility* was high and did not change over time

I-Scape Arrangement

- Unexpectedly, there was no main effect of I-Scape arrangement (i.e., the presence or absence of others' I-Posts had no effect on I-Post placement)
  - Near-minimum requirements completed
  - Discussion and information content had a greater impact on assessment than display arrangement

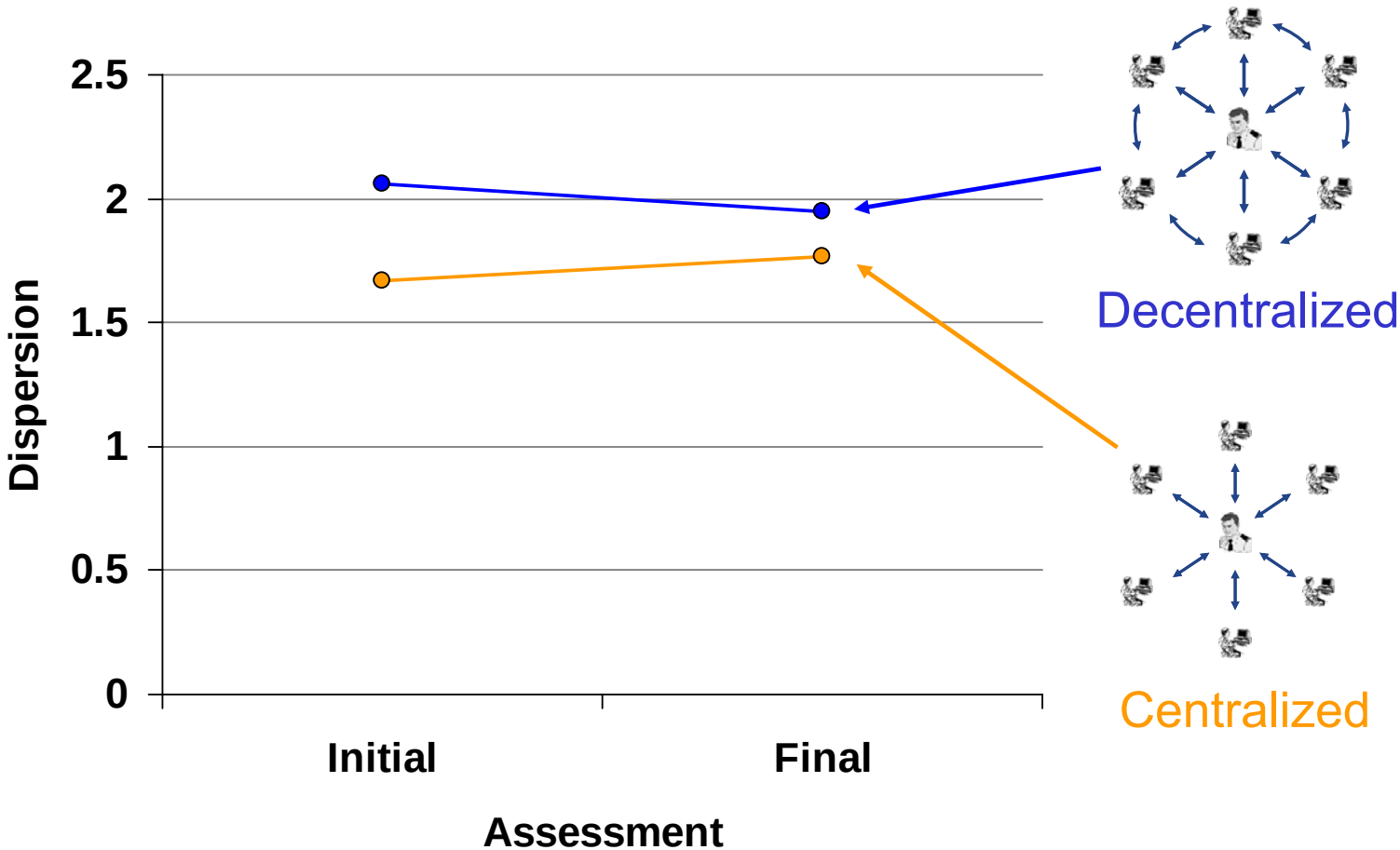
Time x Architecture

- Dispersion *decreased* within *decentralized* and *increased* in *centralized* over time ($\eta p^2 = .24$)

© Pacific Science & Engineering 2008

Results: Time x Architecture

As predicted, *decentralized* discussions began to consolidate I-Post positions over time – a result of social comparison and discussion content



© Pacific Science & Engineering 2008

Results and Discussion

Hypothesis Response Agreement (n hypotheses=9)

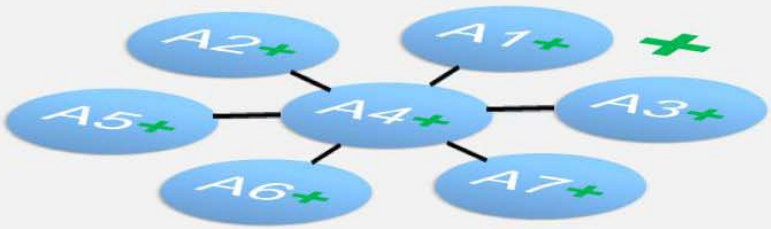
- When hypothesis responses (supporting or refuting) were compared between discussion architectures, 45% of were in disagreement
  - *e.g. centralized hypothesis owner supported hypothesis #1 while decentralized hypothesis owner refuted hypothesis #1*
  - 75% of the disagreements: *centralized* (one-to-many) supported whereas *decentralized* (open forum) refuted
  - Possible confirmation bias with centralized architecture
- 67% of hypotheses were *refuted* by at least 1 owner even though there were positive support and credibility ratings
  - Owner refuted when contributors ratings/I-Posts were supportive
- Results suggest:
  - evidence of confirmation biases
  - discussion content may have had more impact on final decision-making than initially anticipated

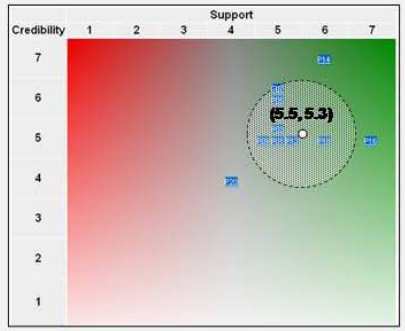
© Pacific Science & Engineering 2008

Mirroring the Pervasive Confirmation Bias

Representation of the relationship of the pervasive confirmation biases observed at both the individual (bottom) and team (top) levels

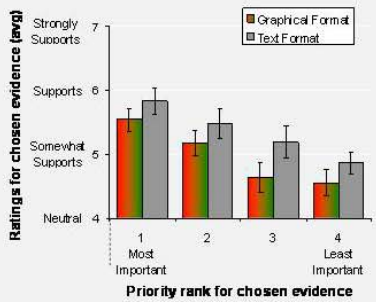
Macro / Team-bias





Present Study

Micro / Individual-bias



Cook & Smallman (2007)

© Pacific Science & Engineering 2008

Metric Applications: Temporal Trends

Application and use of the dispersion metric in an I-Scape temporal trend visualization

© Pacific Science & Engineering 2008

Study Implications

Project Achievements

- JIGSAW was used realistically over 4 weeks
  - Participants endorsed new JIGSAW CONOPS
- Applied research study integrated into design process

New Science

- Novel metrics for collaborative assessment
- Discussion architectures function differently over time
- Collaborating analysts are still prone to confirmation biases

Design Implications

- Enable controls to configure the type and extent of collaboration depending on the type of RFI
  - Collaborating analysts will reach consensus faster with decentralized discussion
- Mitigate confirmation bias by temporarily masking information content from new JIGSAW users

© Pacific Science & Engineering 2008

Contacts

Matthew Risser, PhD

risser@pacific-science.com

Harvey Smallman, PhD

smallman@pacific-science.com

Pacific Science & Engineering Group

9180 Brown Deer Road, San Diego, CA 92121

858-535-1661

© Pacific Science & Engineering 2008