Better decision making through representation and reduction of uncertainty in C^4I system

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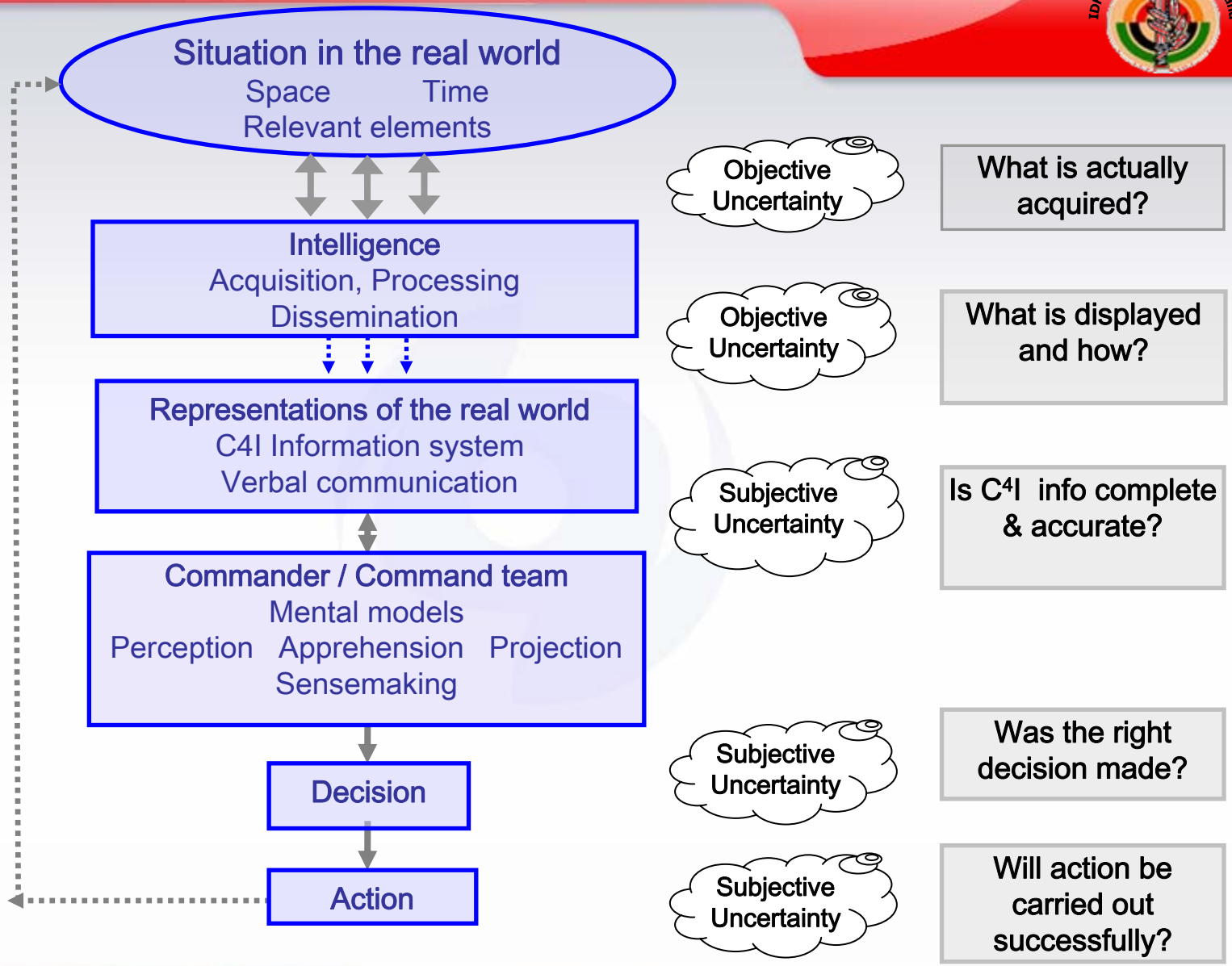
Program overview

- The program deals with ways in which representation of battlefield information and particularly information about uncertainty, may enhance Decision Making, Situation Awareness (SA) and Sensemaking in battle-space environments
- Previous research stages involved active participation in a Battle Lab experiment and a brigade-level field experiment (Brickner & Sadot-Parag, 2005a,b).
- The final stage involved a controlled experimental simulation experiment, that took place at the Israel Defense Forces Battlefield Laboratory (BatLab), on a BMS that was developed for this project.



IDF - Ground Forces Command
Pamam Designing for Users

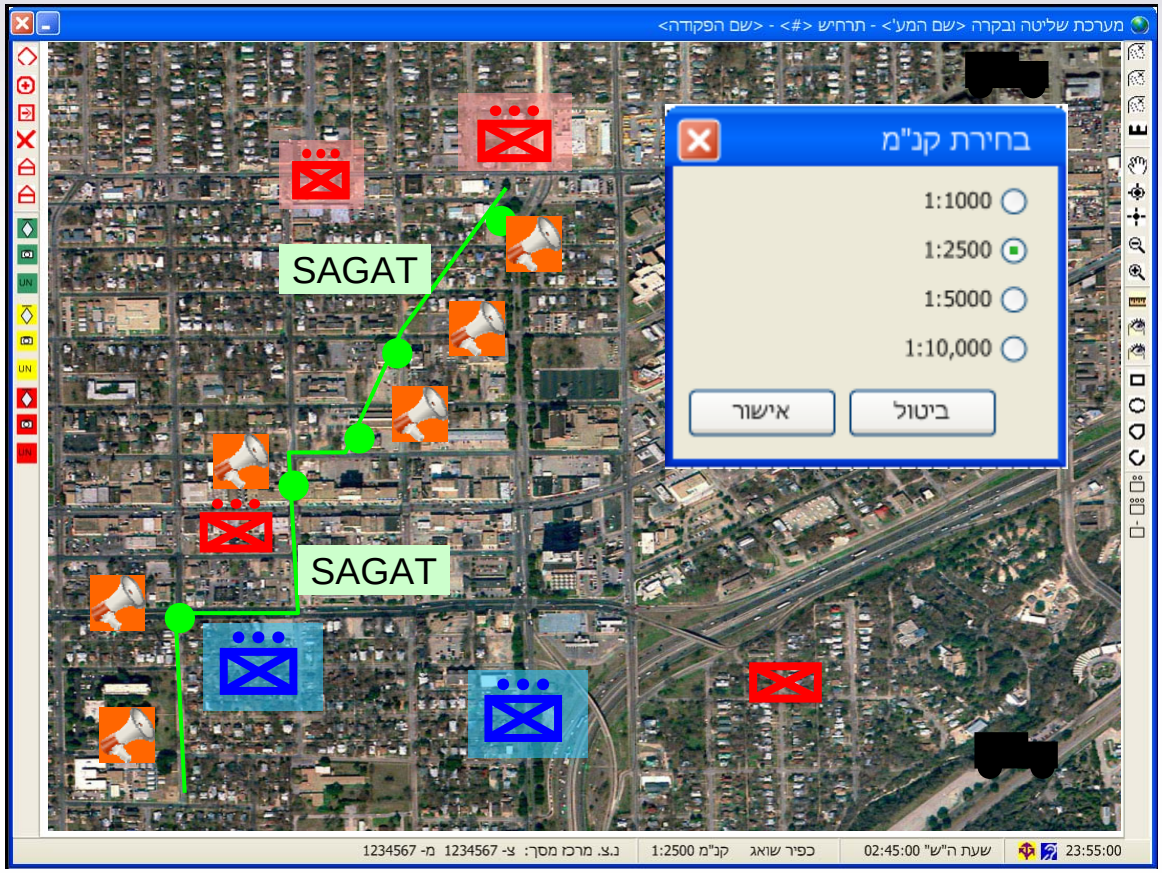
Research Objectives

- <u>Objectives</u>:
  - to investigate the effects of various methods of explicit representation of objective uncertainty on Decision Making, Situation Awareness and Sensemaking, in the command and control environment.
  - To perform controlled quantitative research in a well controlled experimental setup.
- <u>The challenge</u>:
  - How to perform a well controlled quantitative experiment while maintaining realistic, high fidelity simulation?

Experimental method

- Subjects: 16 SMEs; ranks: captain-Lt.Col; ages 26-38; all with company- brigade command experience, 12 with C^4I experience.
- Eight Operational scenarios taking place in a real urban area.
- Extended company missions. A battalion commander directs the operation, viewing a BMS and receiving messages.
- The blue force proceeded according to the mission plan.
- At selected points (5 per scenario), the commander is required to make a forced choice decision.
- Prior to the decision he may acquire more information (e.g. from UAV, balloon, ground observation point).
- The decision may have positive or negative consequences, however, after the completion of selected action, all subject continued from the same position, thereby preventing massive variability buildup.
- At “random” points SAGAT procedures were performed.

The BMS Display



Advancement line

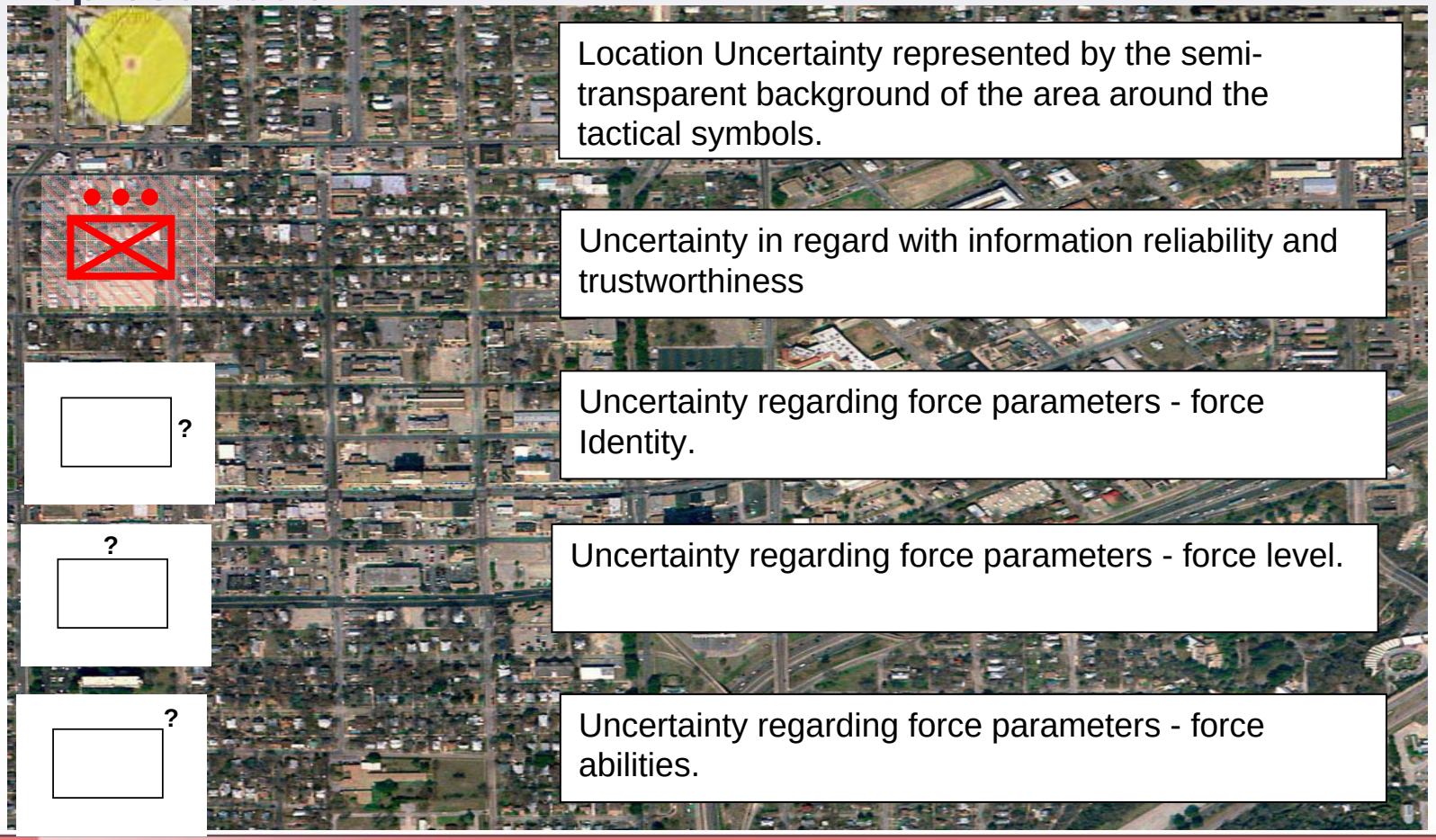
Decision point

Communication

Note: the tactical symbols and selection window are part of the display. The advancement line, decision and communication points, are for presentation only.

Experimental design

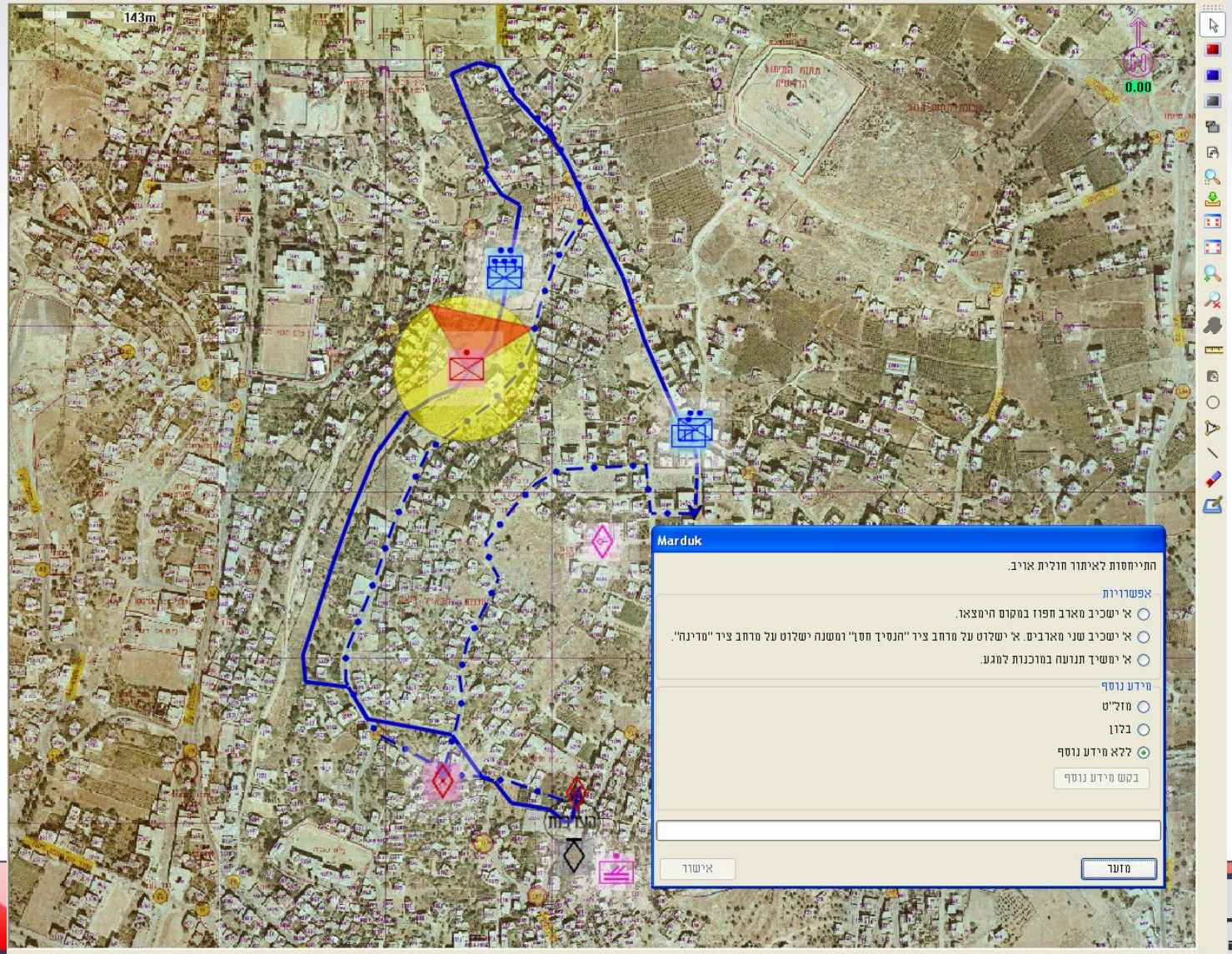
- **<u>Independent variables</u>: With or without uncertainty representation.**



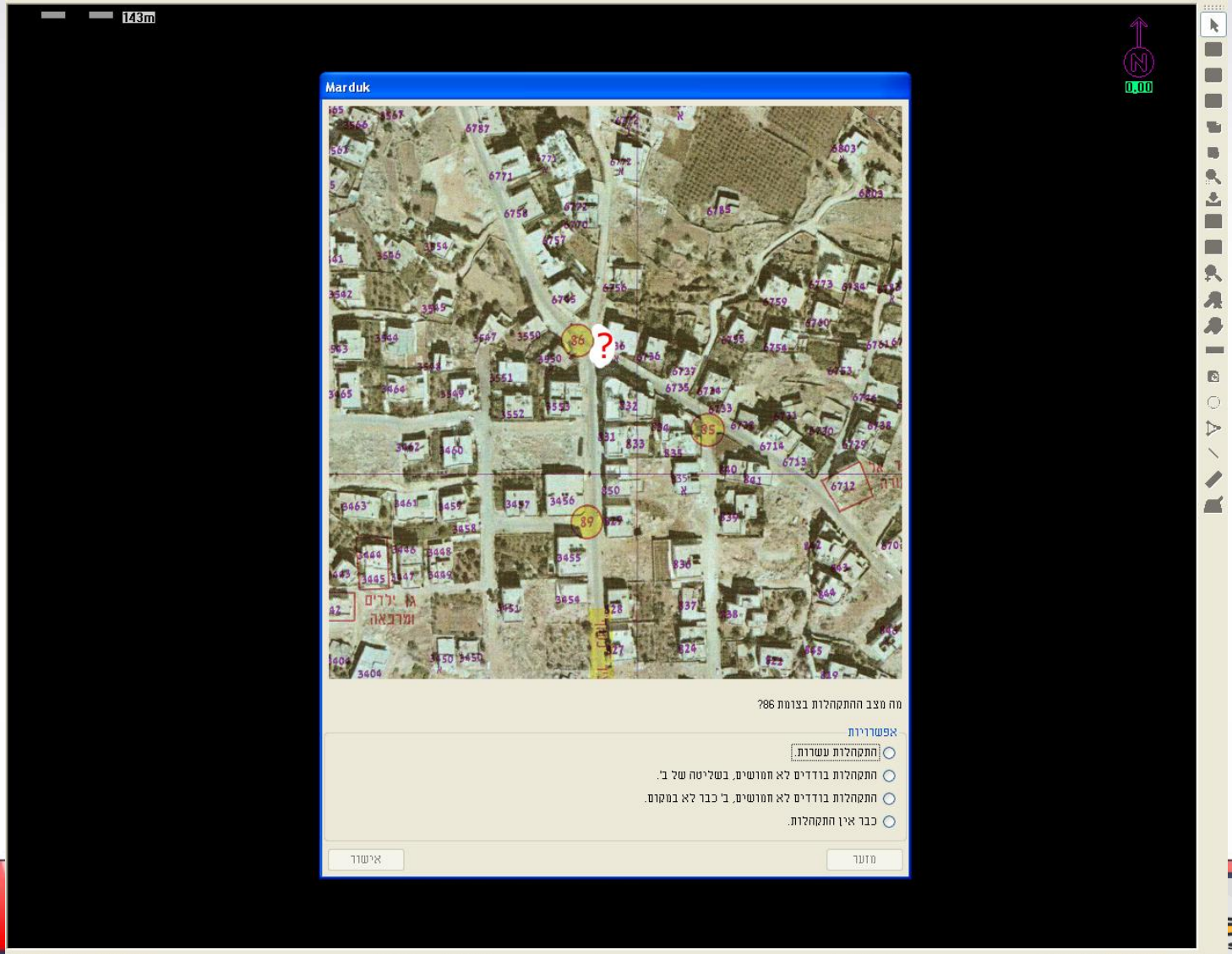
Experimental design (continued)

- <u>Experimental design</u>:
  - Between subject design.
  - Eight subjects in each group.
  - Six experimental scenarios + two for training.
  - Duration: 4-5 hours.
- <u>Dependent variables</u>:
  - Decision quality: Best, Medium, Worst. (Based on decision outcomes e.g., get to target without casualties).
  - Usage of additional information.
  - Mission completion time relative to zero hour.
  - Situation awareness (SAGAT)

Decision Points



Situation awareness (SAGAT)



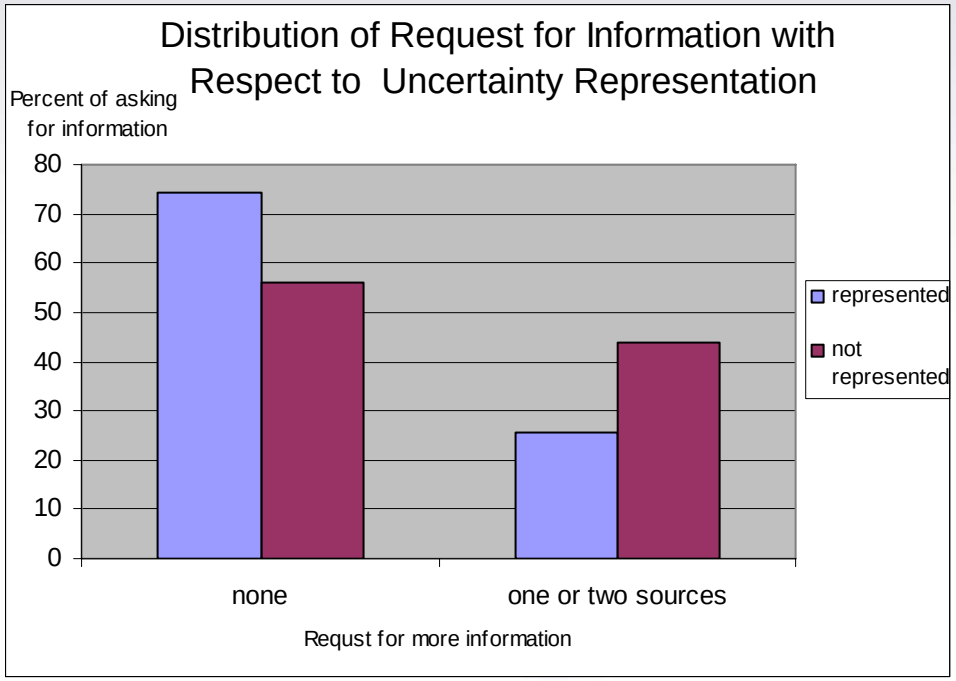
Results

- We didn't find any overall effect of uncertainty representation on decision quality and decision time.
- Positive effect of uncertainty representation in 7 out of 30 decision points.
- Use of more additional information resulted in better decisions.
- Relatively few requests for additional information were made.

Asking for information			
None	1 source	2 sources	Total
334 69.6%	124 25.8%	22 4.6%	480

Results (continued)

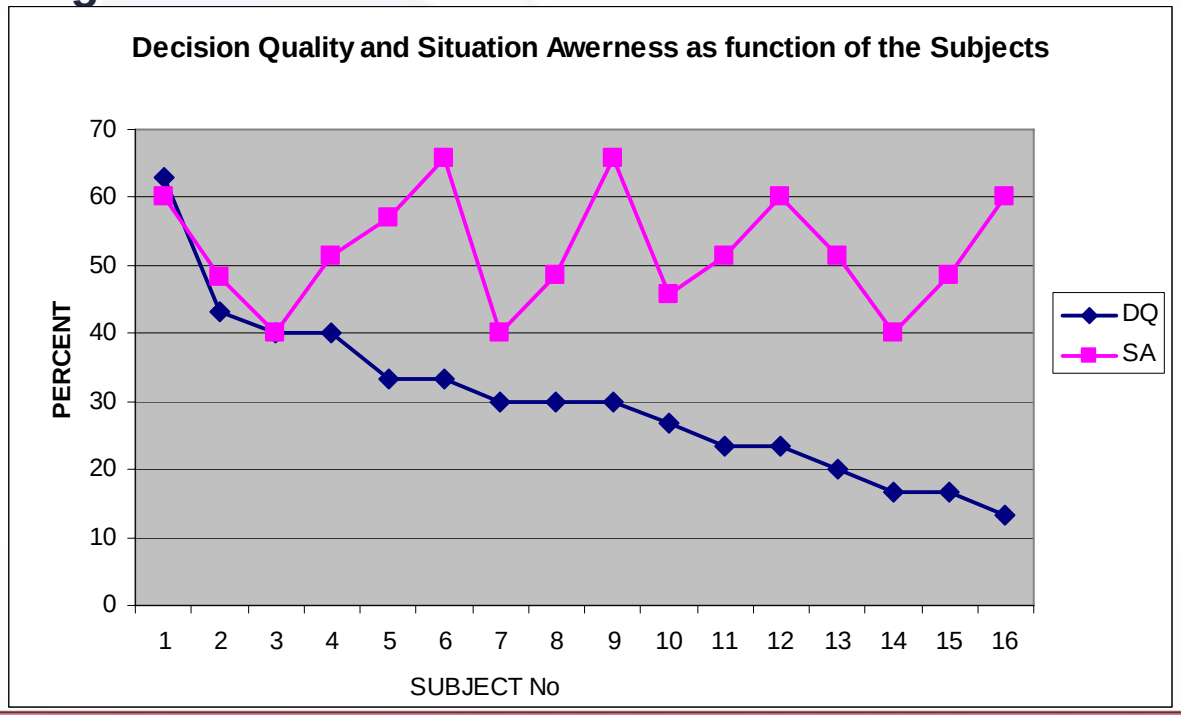
- **More requests for information made by the experimental group!**



- **However, significantly more additional information was requested by the uncertainty group in decision points without uncertainty representation.**

Results (continued)

- very large Individual differences in decision quality ranging from excellent to very poor.
- Situation Awareness - SAGAT scores were fairly high with little variability.
- Order of trial had no significant effects.



Results (continued)

- Main debriefing issues:
  - The experimental setup was realistic and representative.
  - Some but not all subjects claimed to have been aware of BMS uncertainty. This did not always affect their conduct.
  - Subjects refrained from additional information due to:
    - Feeling of insufficient time.
    - No useful information received during early stages.
    - Did not feel that it was necessary.
  - Uncertainty representation should be a display option.
  - The simulation should be developed and used as a trainer.

Discussion

- Even though all subjects were experts, several of them failed to select the best decisions in most cases.
- Poor decision making was not related to SA and seems to be related to “understanding” and knowledge” rather than “data”.
- Several subjects were not sufficiently aware of BMS uncertainty, assuming that what they see is what there is.
- Subjects did not make optimal use of available information.
- SMEs displayed many Sensemaking deficiencies defined by Klein *et. al.* (2007) (Effect of Mental Models; Confirmation Bias; Ignoring discrepant information; Available information not exploited; Overconfidence)

Conclusions

- Uncertainty representation may be useful in some but not all cases. It should, therefore be a display option.
- Commanders require better tactical training in the usage of BMS. A trainer could be developed, based on the simulation.
- Additional research is required in order to provide a broader “Meta-data” and “meta information” approach (Pfautz et al., 2007) and to enhance understanding of C4I information on Sensemaking and decision making strategies.

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