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Effects of Professional Visual Search Experience on Domain-General Visual Search Tasks

Susan Stevens Adams

Laura Matzen, Michael Haass, Laura McNamara, Stephanie McMichael

Sandia National Laboratories

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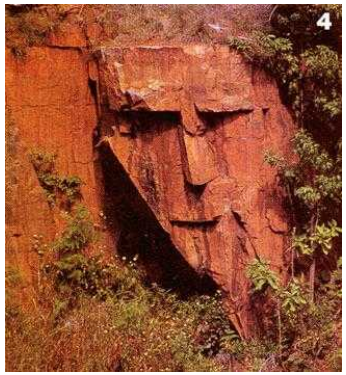
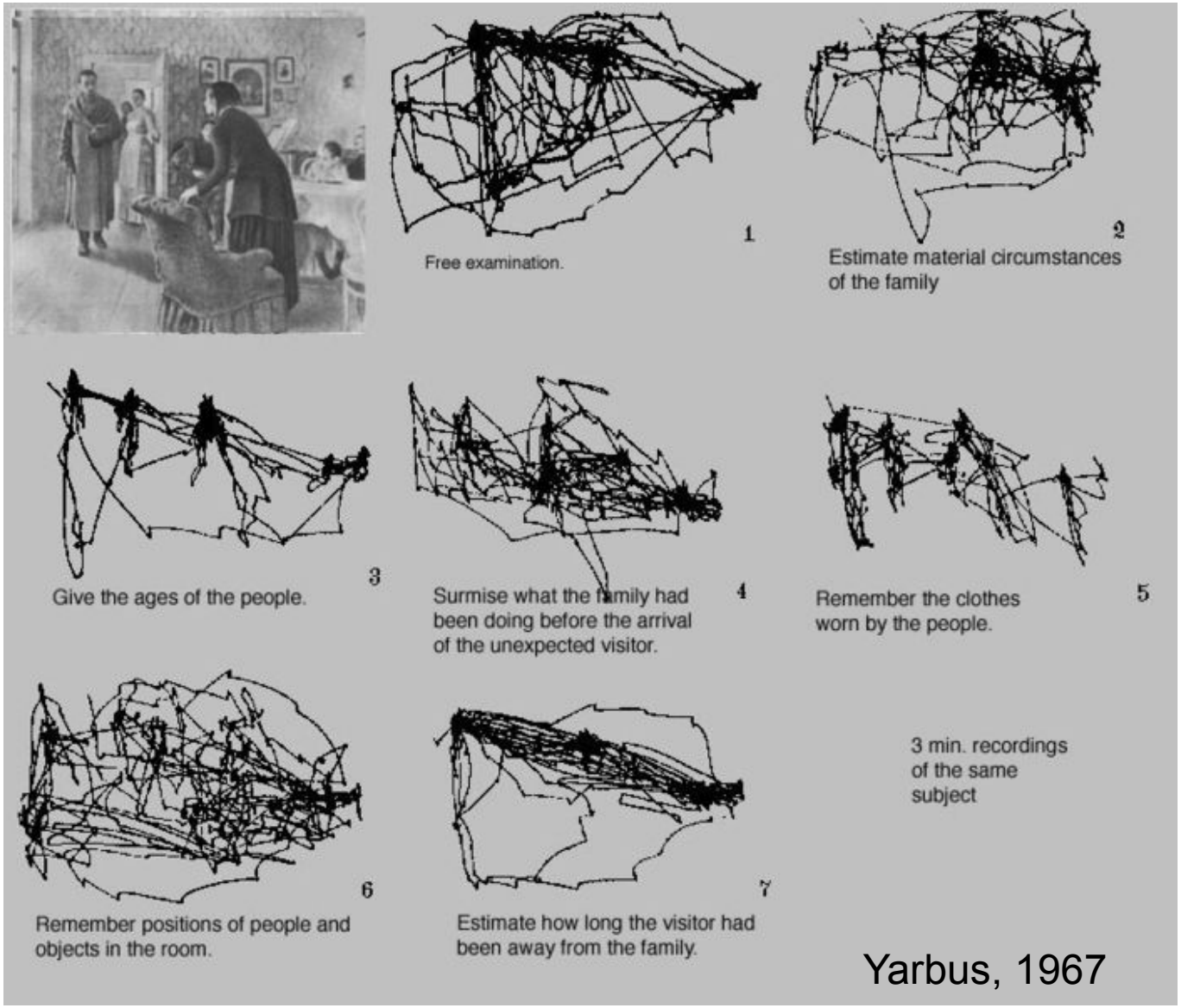
Visual Cognition Basics



- The human visual system is VERY good at:
  - Finding patterns
  - Making inferences
- Perceptual systems are constantly receiving ambiguous information and trying to make sense of it

- Draws on both perceptual cues and conceptual knowledge (bottom-up and top-down processing)
  - Parameters for bottom-up are well understood and can be modeled
  - Parameters for top-down processing are NOT well understood

Top-Down Control of Eye Movements



Yarbus, 1967

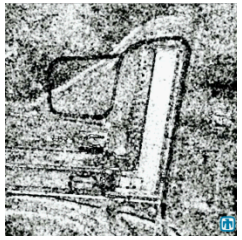
Illustrates top-down aspects of visual search:

- The person's task influences eye movements

Core Scientific Questions:

What features capture attention in different kinds of imagery?
How does domain experience influence visual search/inspection?
How can top-down visual attention be modeled?
Do people with expertise in one domain perform differently on domain-general tasks?

SAR
CCD Products

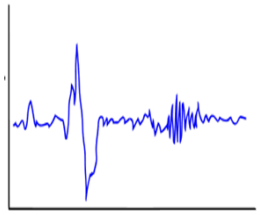


Intended to make important features more salient

TSA
False color X-rays

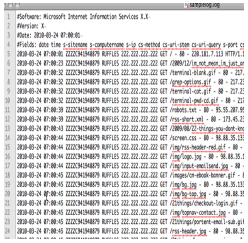
Intended to make important features more salient

Design Engineers
Waveforms



Visualizations of raw data

Cyber
Log Files



Raw data

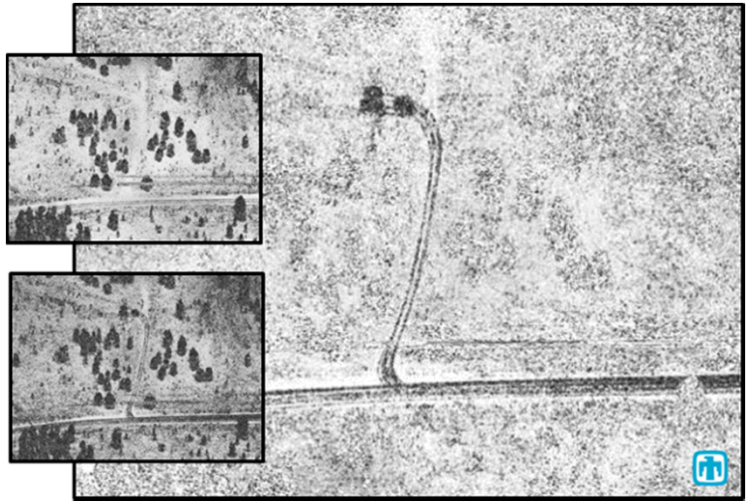
Novices

Experienced with optical imagery only

All participants will complete a battery of domain-general tasks and a domain-specific tasks

A Case Study: Synthetic Aperture Radar (SAR) Imagery Analysis

- SAR analysts recognize and classify patterns using SAR imagery.
- The same scene is repeatedly imaged over extended periods of time, allowing the analyst to see changes.



Courtesy of Sandia National Laboratories, Airborne ISR

Study Details

Participants:

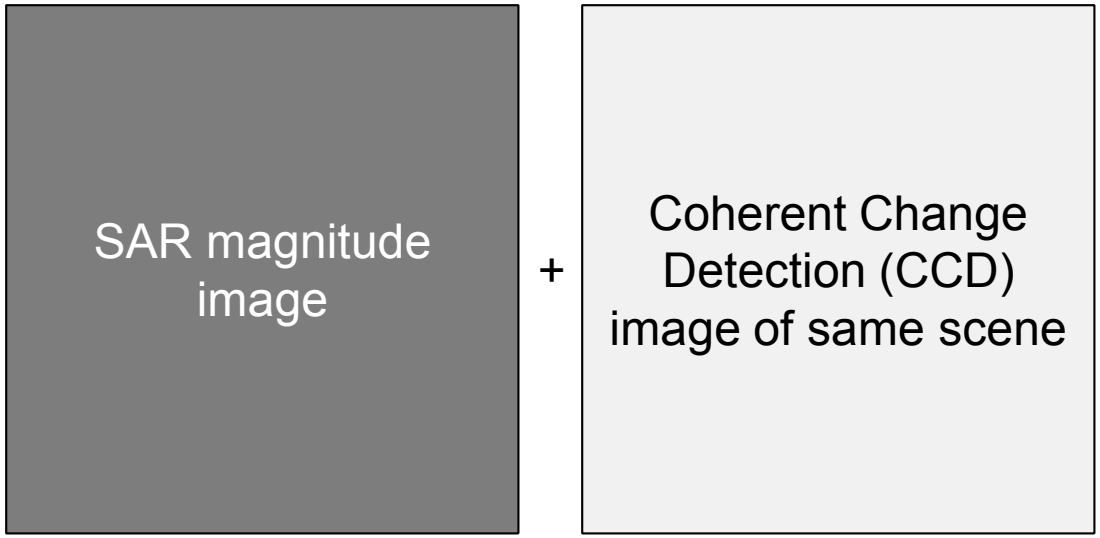
- 8 SAR imagery analysts, 8 engineers experienced with the domain ("knowledgeable non-analysts"), 8 SAR novices

Data collected:

- Behavioral
  - Reaction time, Accuracy
- Eye Tracking
  - Quantitative
    - Time to first fixation in region of interest (ROI)
    - Percentage of fixations in ROIs
    - Counts and frequencies of transitions between ROIs
    - Classification of error types (scanning error, recognition error, decision error)
  - Qualitative
    - Characterization of scan paths
    - Characterization of search strategies
    - Identification of features with high top-down saliency

Domain-Specific Task: SAR

- Target detection task using two images, presented side by side
  - 50% prevalence of targets
  - Participants rate images on 1-4 scale
    - sure no, unsure no, unsure yes, sure yes



Domain-General Tasks

- Parallel vs. Serial Visual Search
- Visual Inspection Task
- Spatial working memory, Mental rotation, Useful field of view

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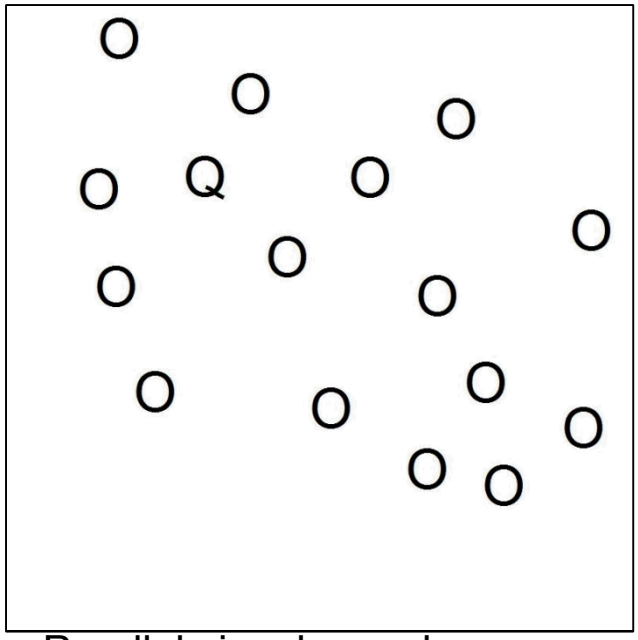
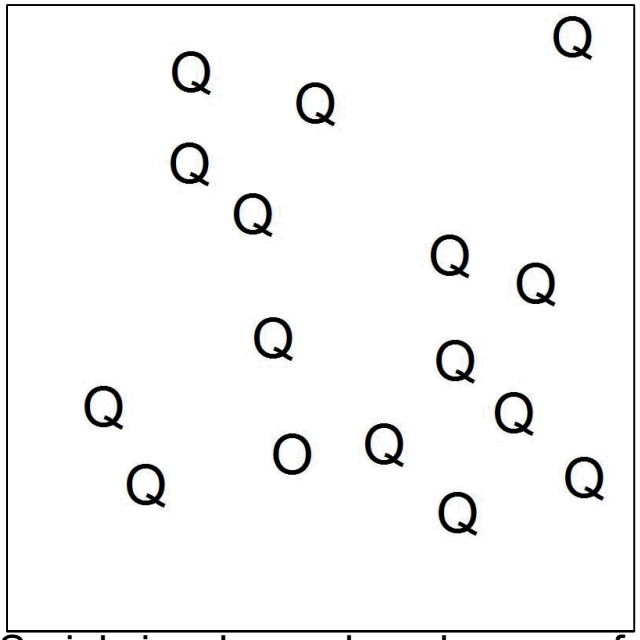


Parallel visual search – unique features “pop out”



Serial visual search – absence of a feature requires deliberate searching

Domain-General Tasks

- Parallel vs. Serial Visual Search
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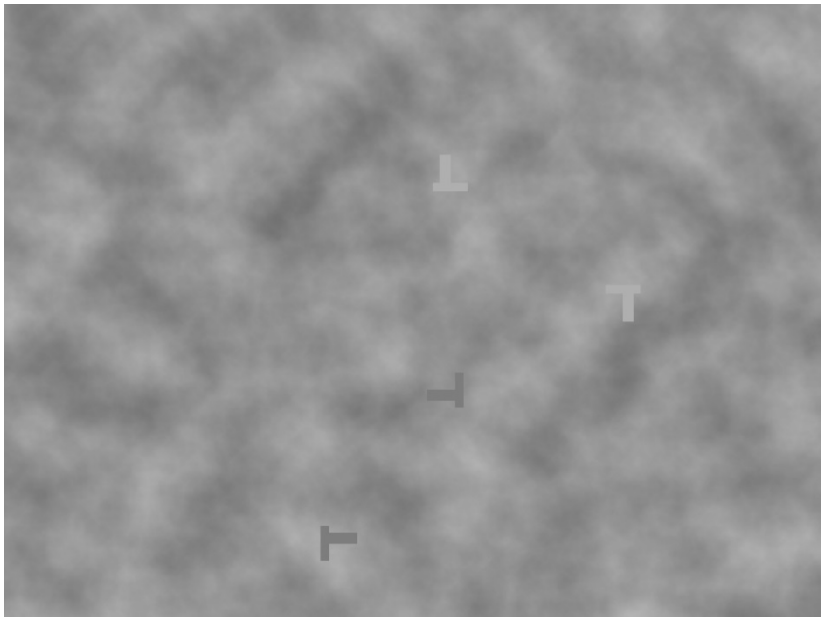

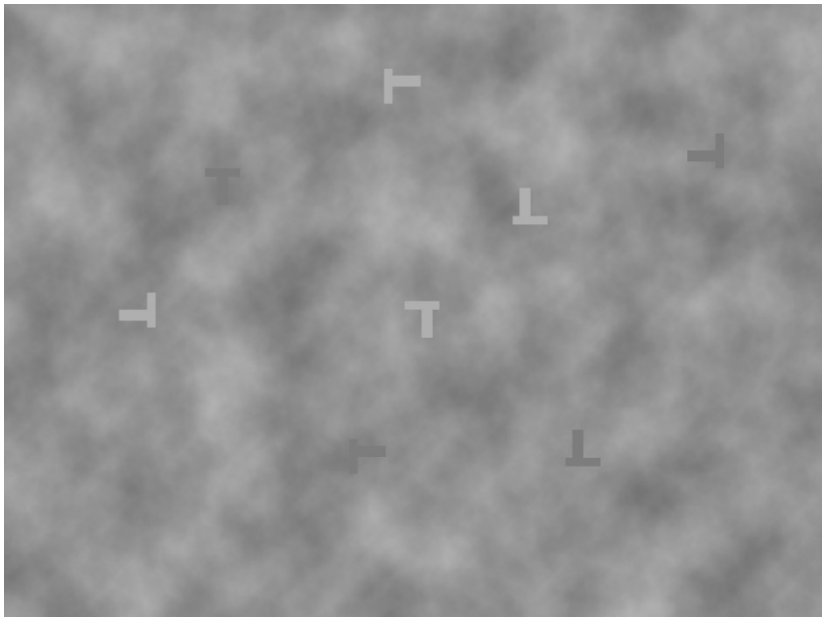

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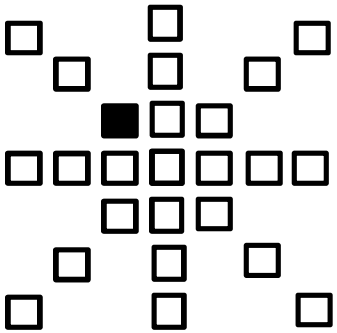
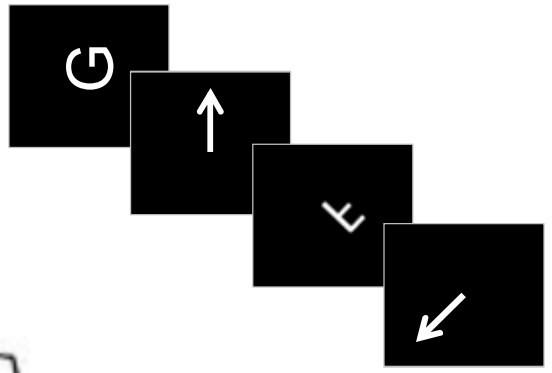
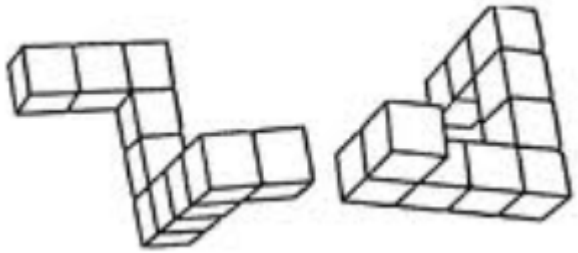
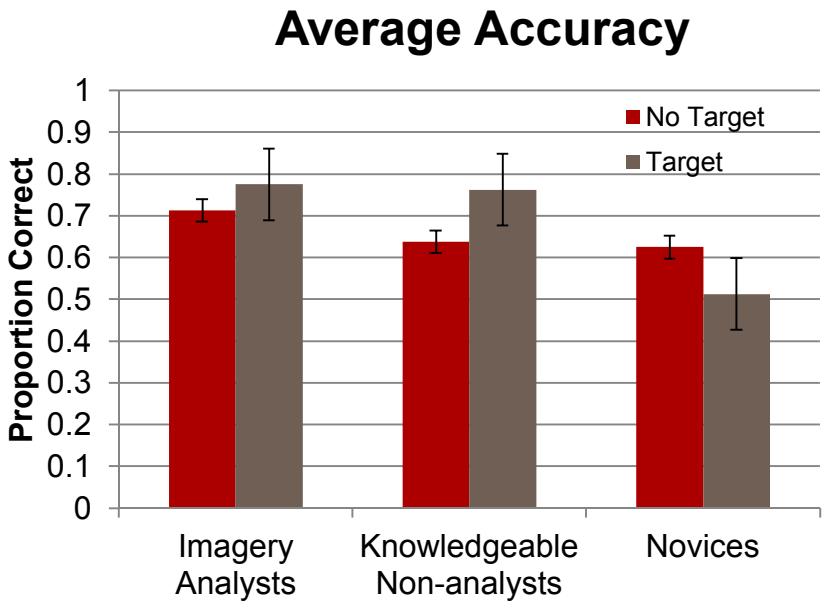
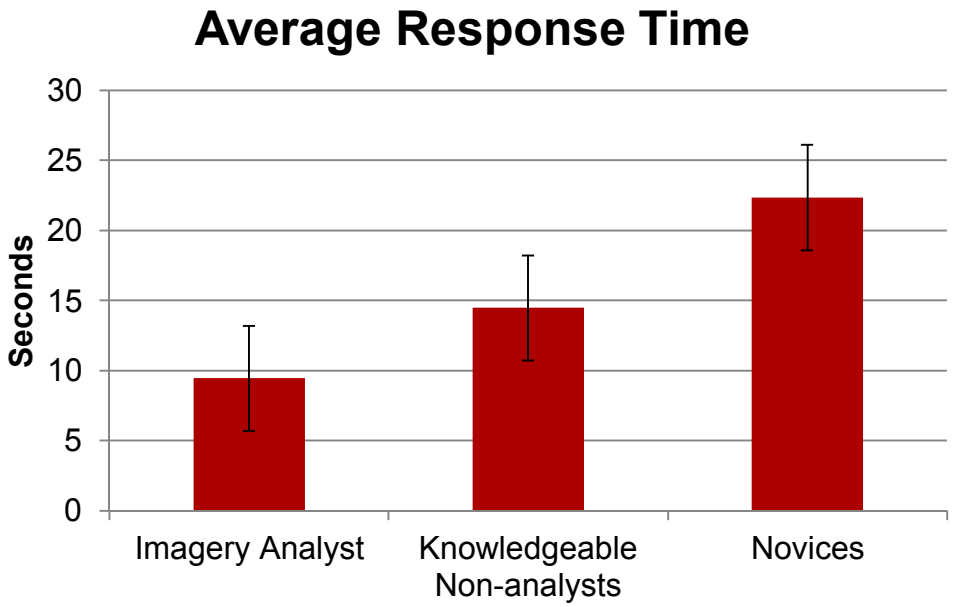




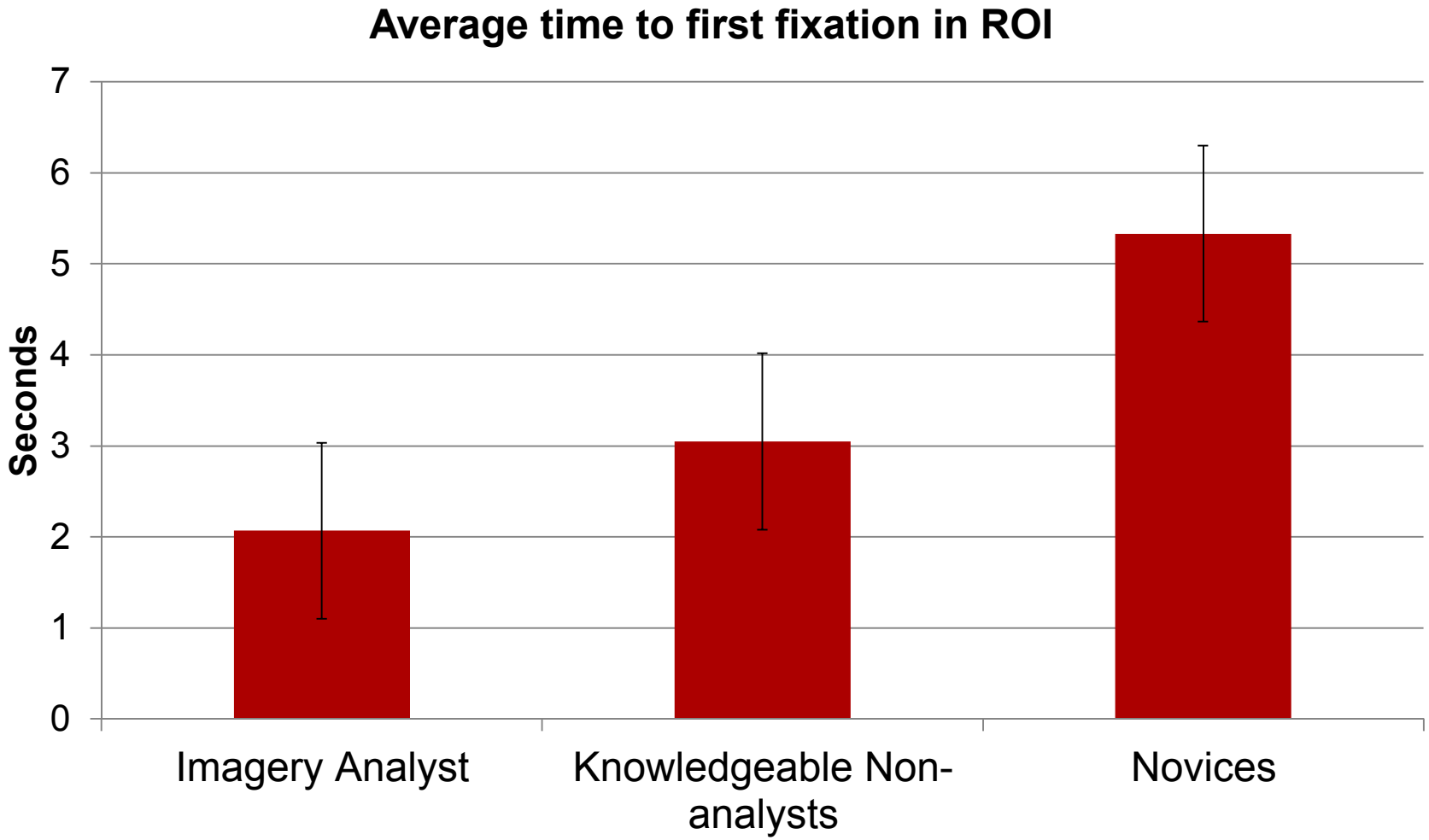


SAR Task – Behavioral Results





SAR Task - Eye Tracking Results



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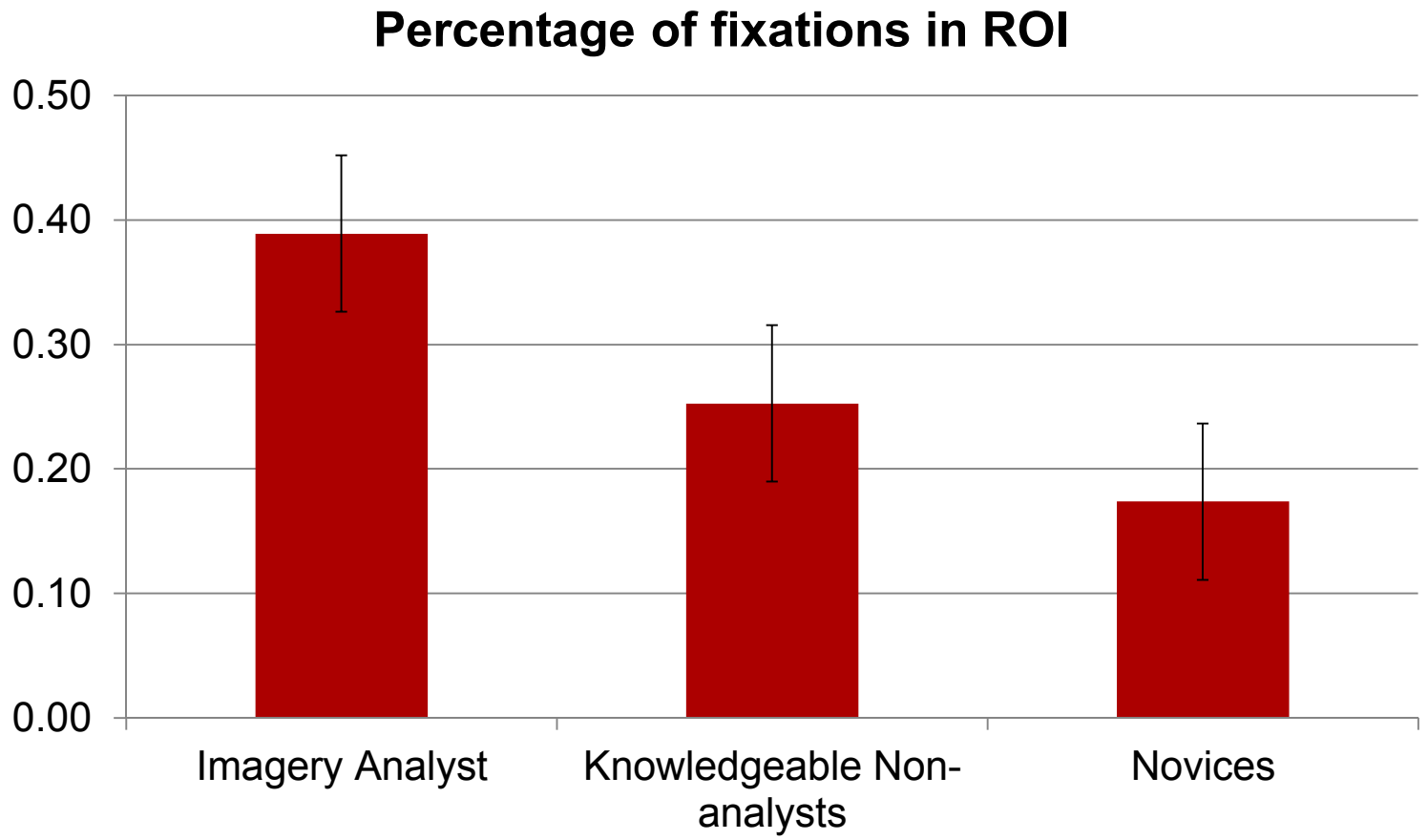
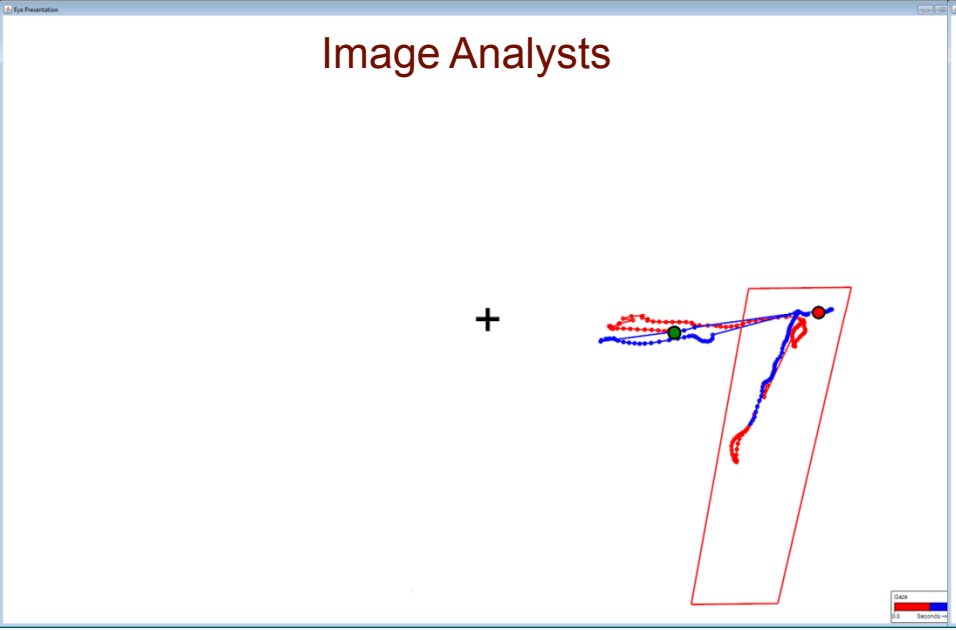
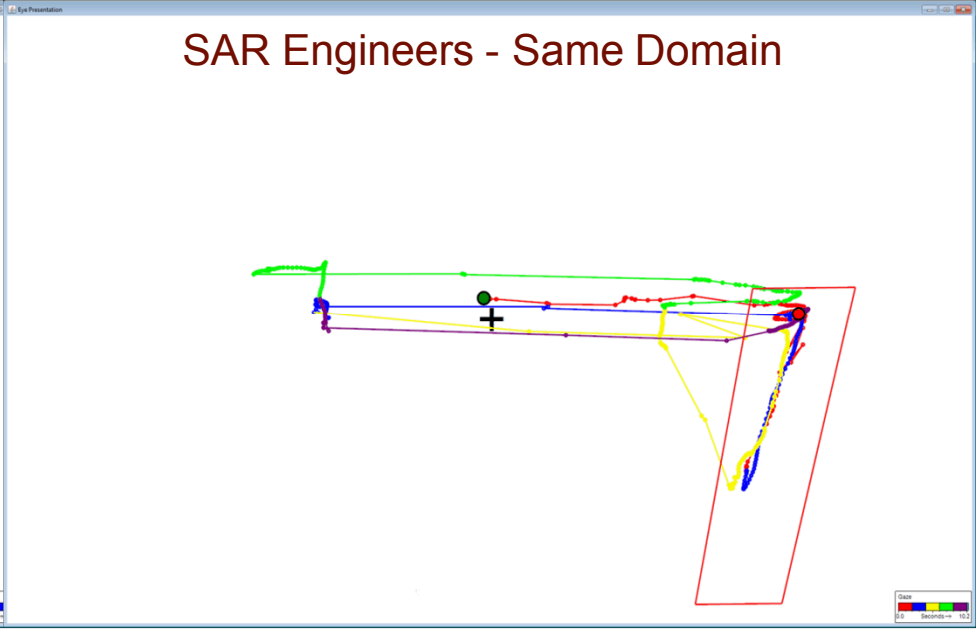


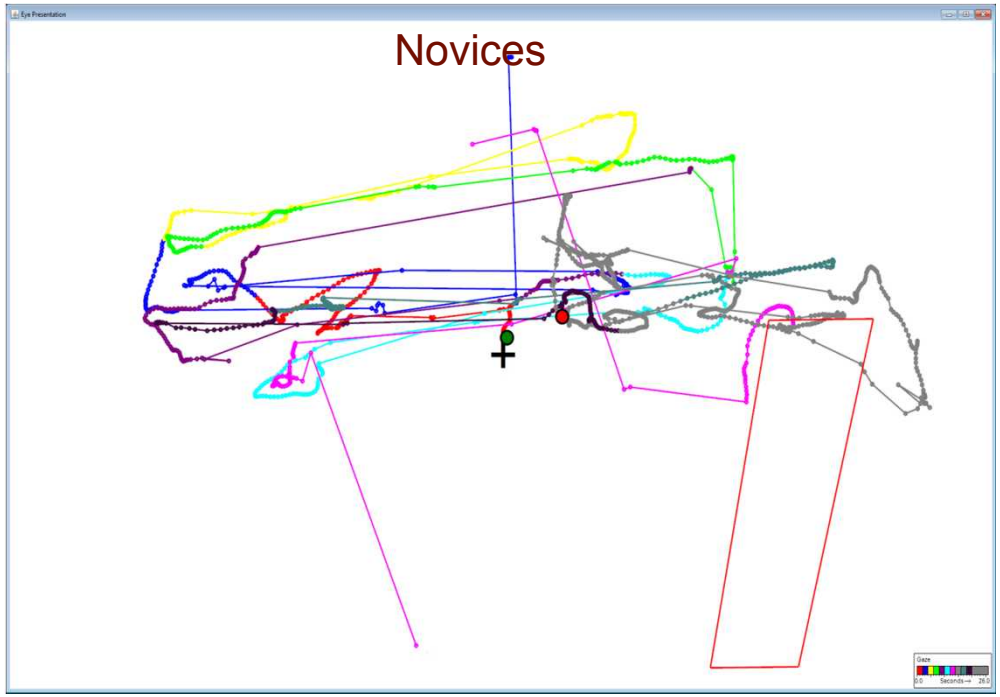
Image Analysts



SAR Engineers - Same Domain



Novices



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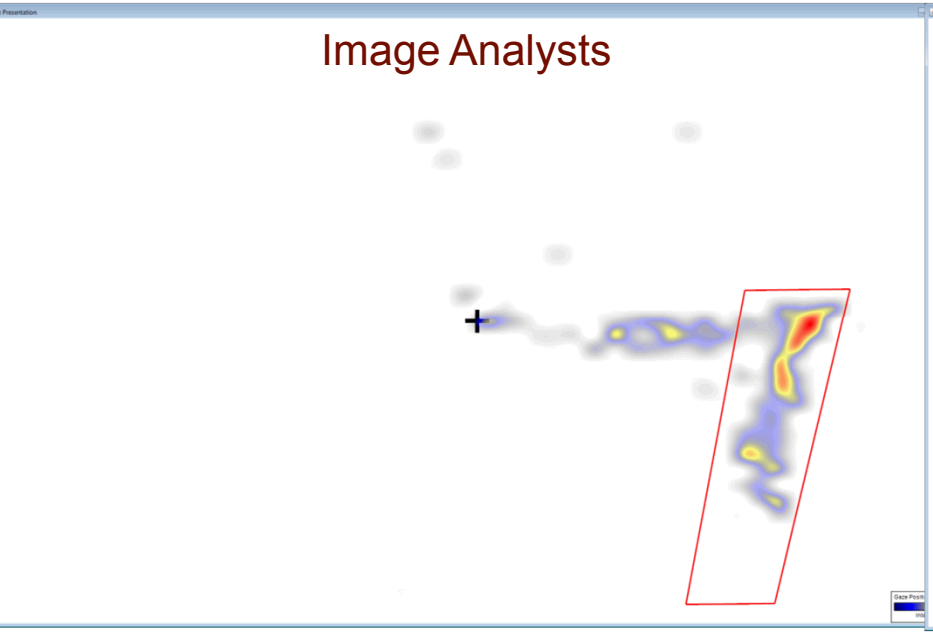

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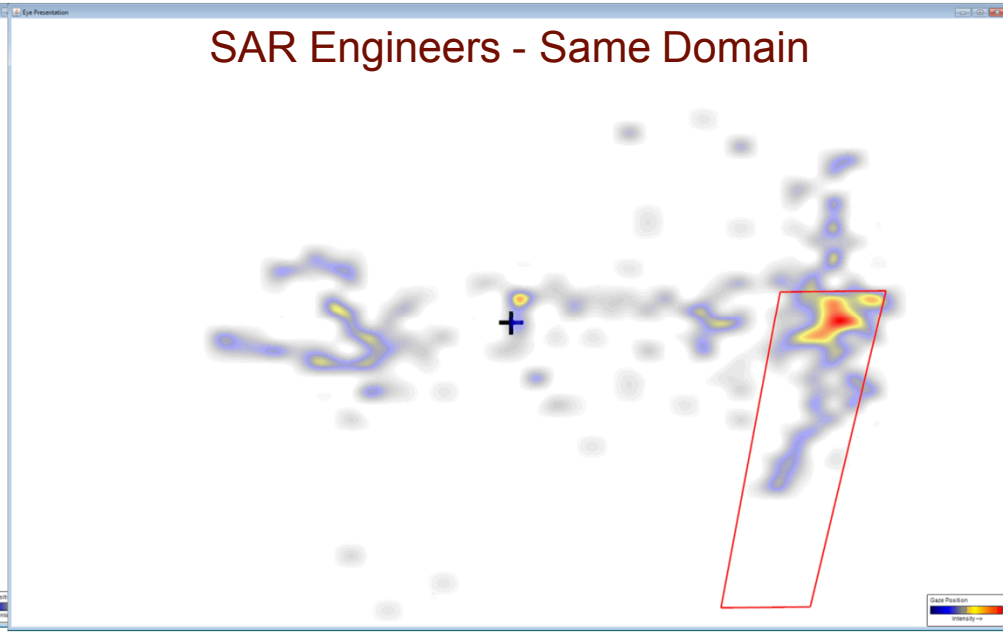

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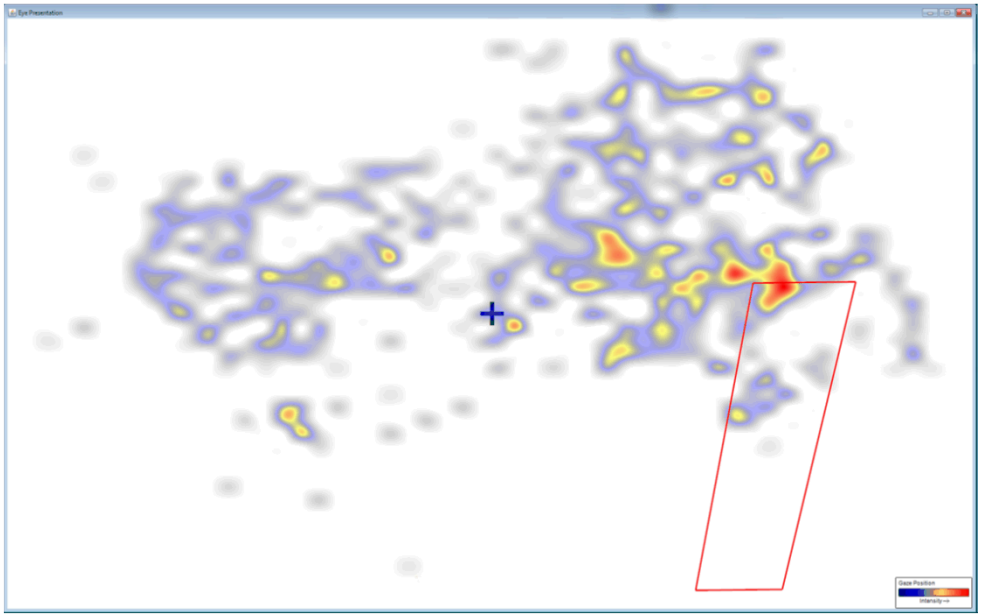


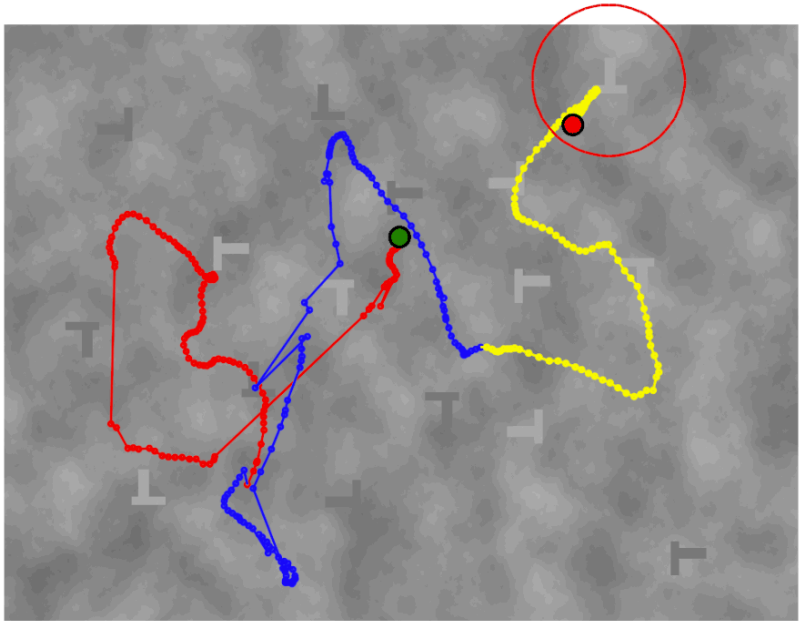
Domain-General Task Results

- Mental rotation
- Useful field of view
- Spatial working memory

No significant differences between groups

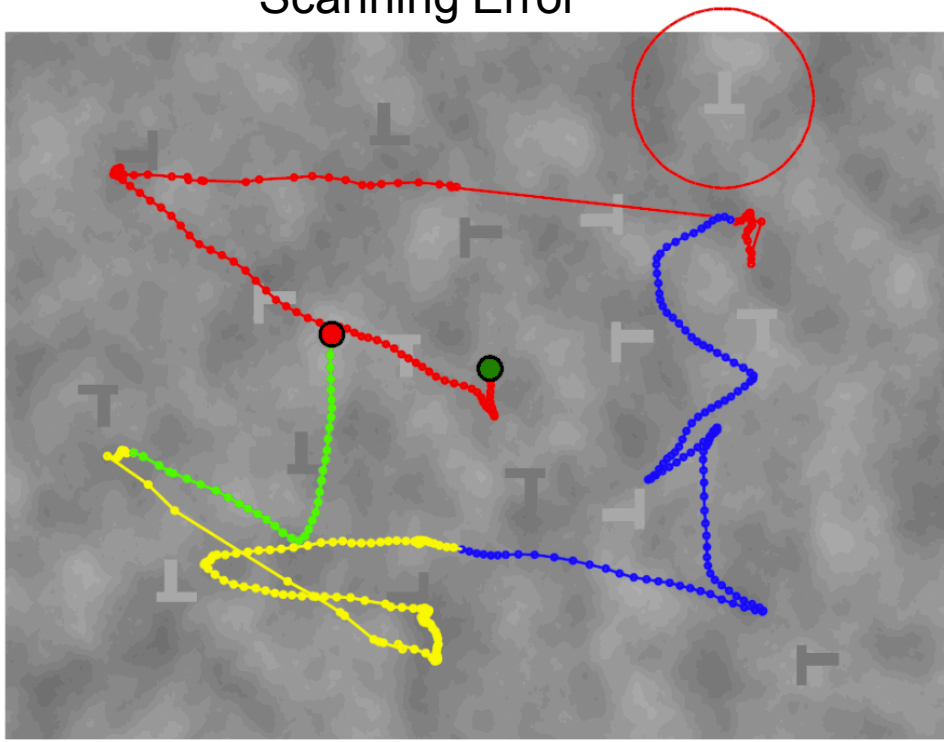
- Serial Visual Search Task
  - No significant difference between groups
- Parallel Visual Search Task
  - Participants with SAR experience significantly faster than novices
- Visual Inspection Task
  - Imagery analysts significantly faster than novices

Classification of Error Types

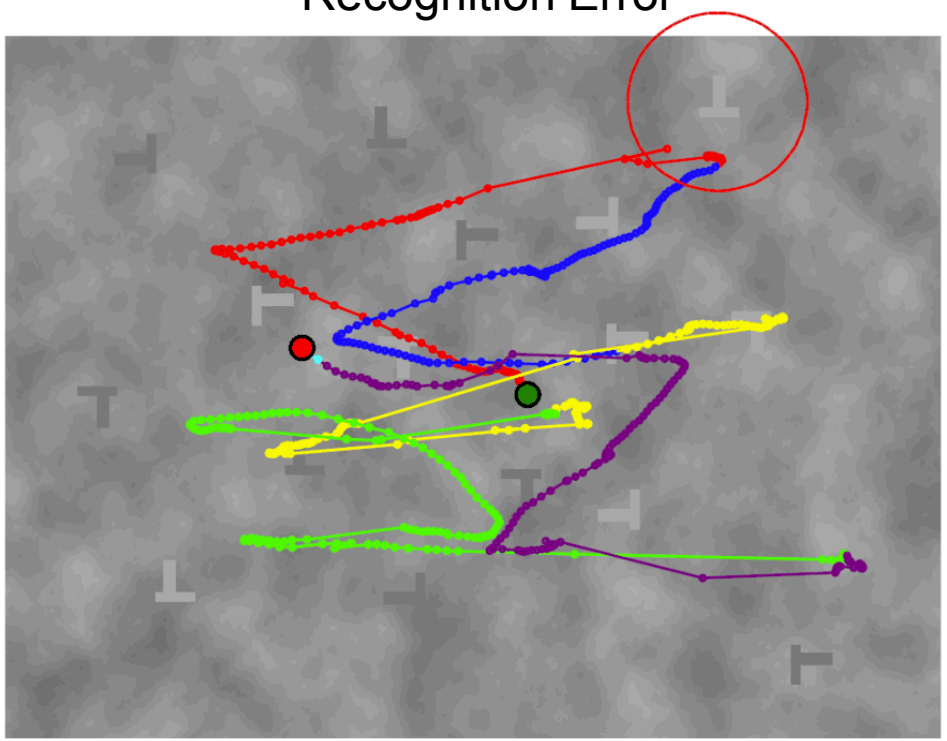


Correct identification of target

Scanning Error



Recognition Error



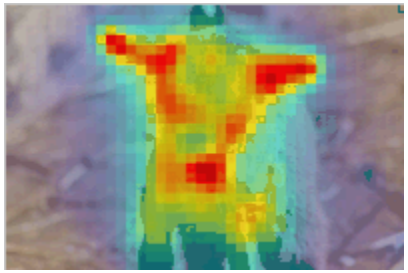
Conclusions and Next Steps

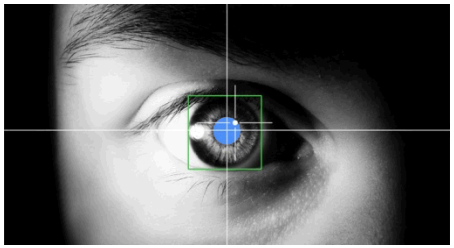
- Novel evidence that professional expertise in visual search influences general visual cognition processes
  - SAR imagery analysts were faster and more accurate on the domain-specific SAR task
  - SAR imagery analysts were faster on the T&L task
  - SAR imagery analysts were faster on the Q pop-out task (surprising!)

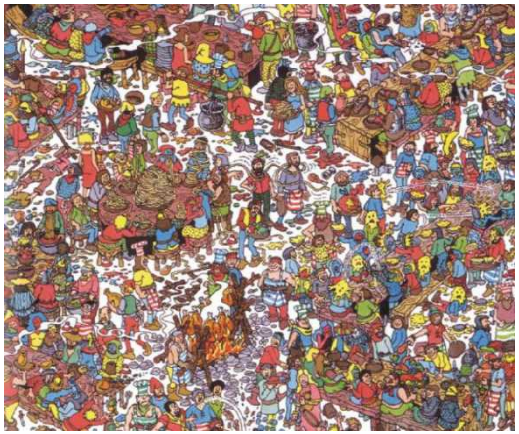
- Aim for development of new methods for analyzing eye tracking data
  - Further data analysis is warranted
- Better understanding of parameters of and ability to model top-down processing

Questions? Thank you!

- Susan Stevens Adams - smsteve@sandia.gov

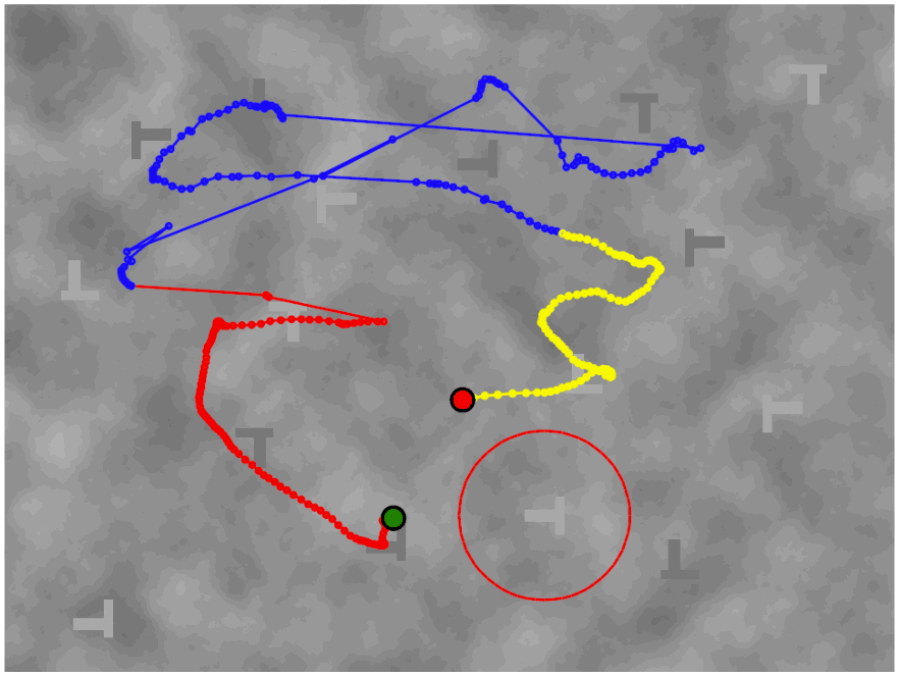


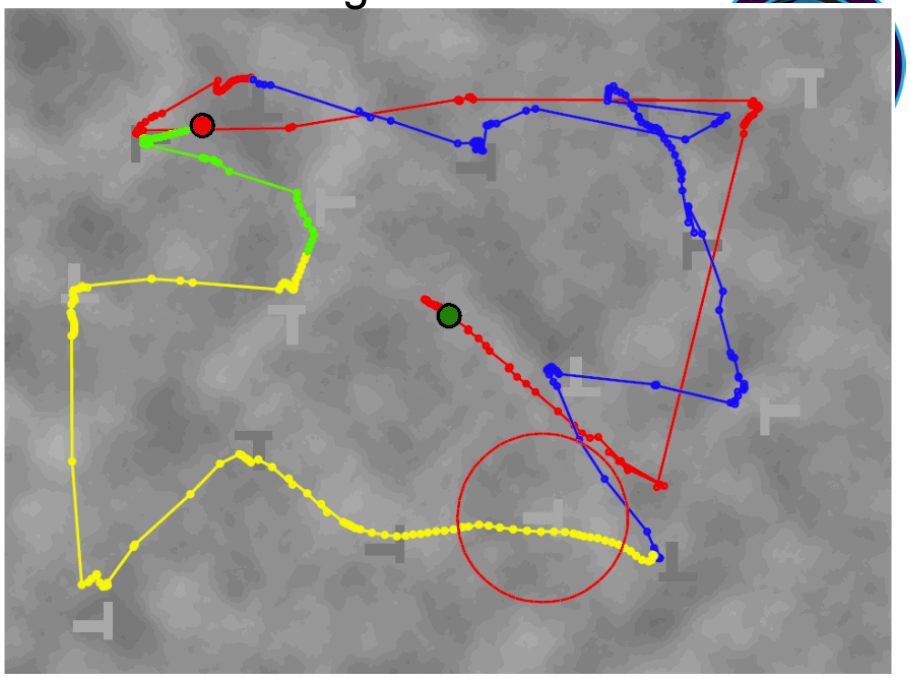


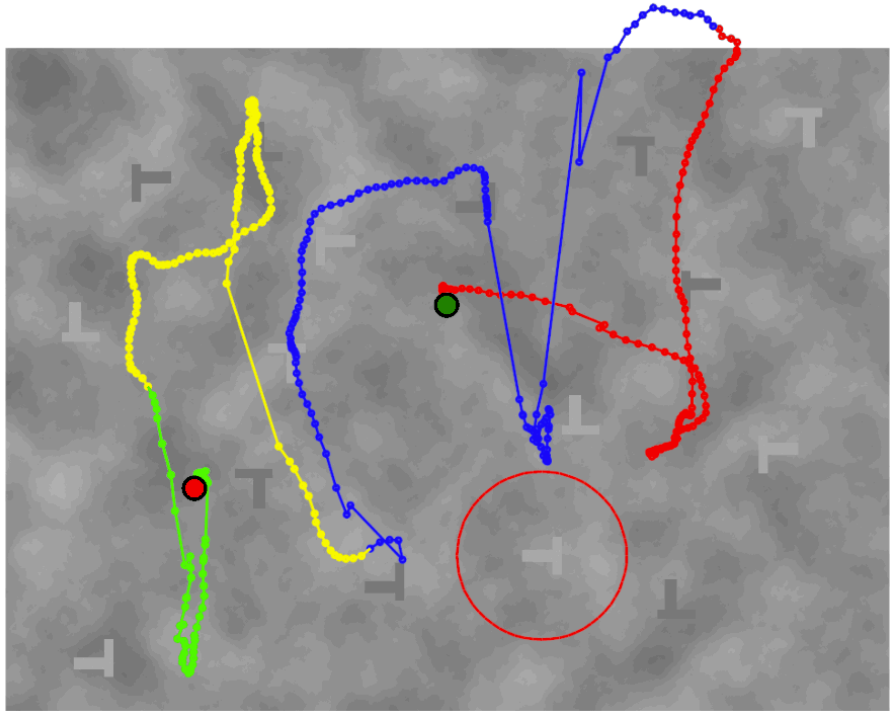


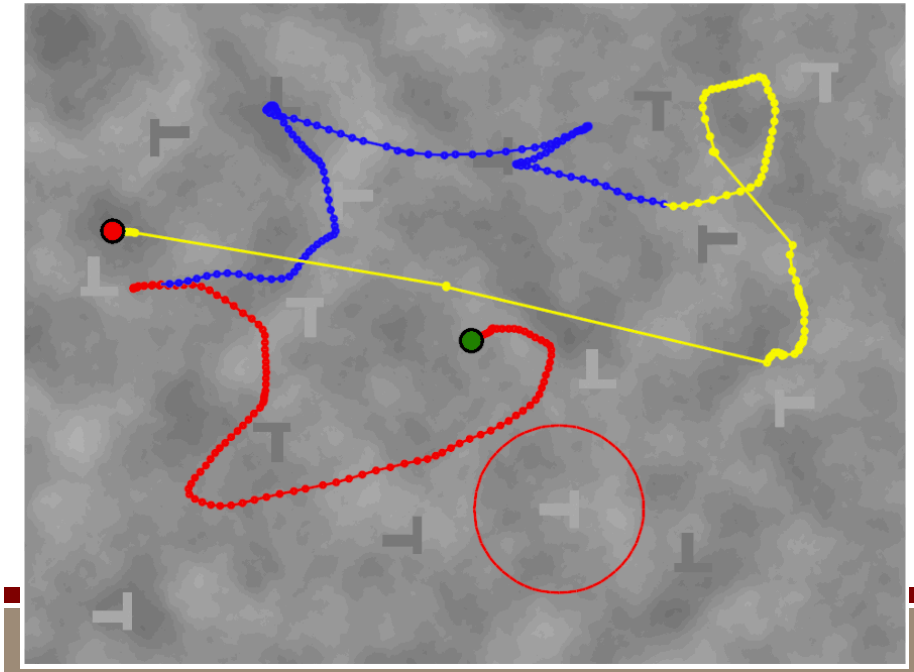
Back-up slides

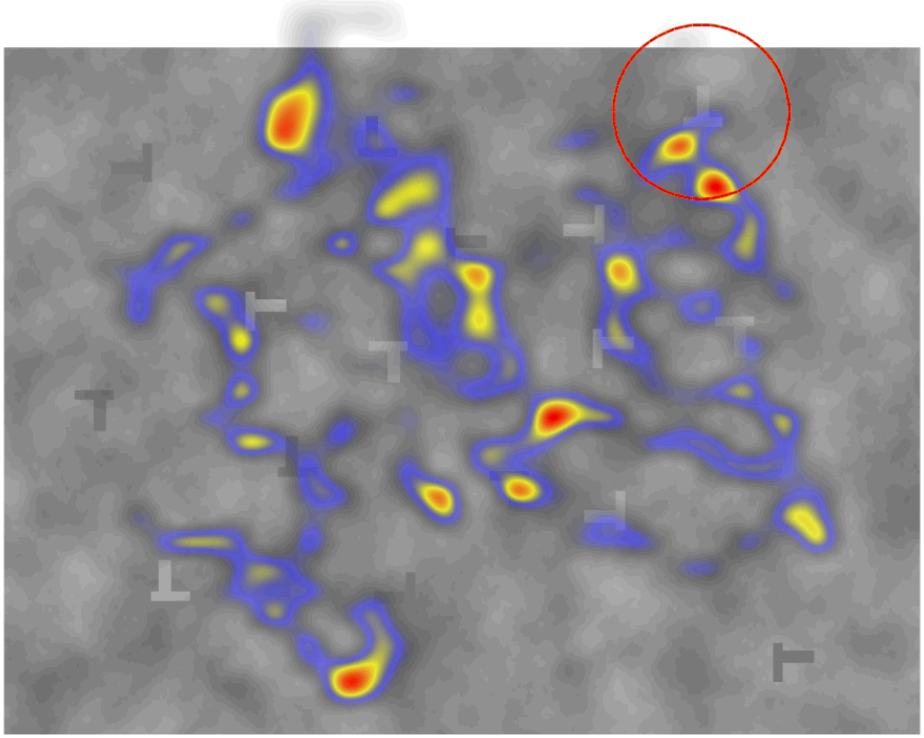
Search Patterns – Who found the target?



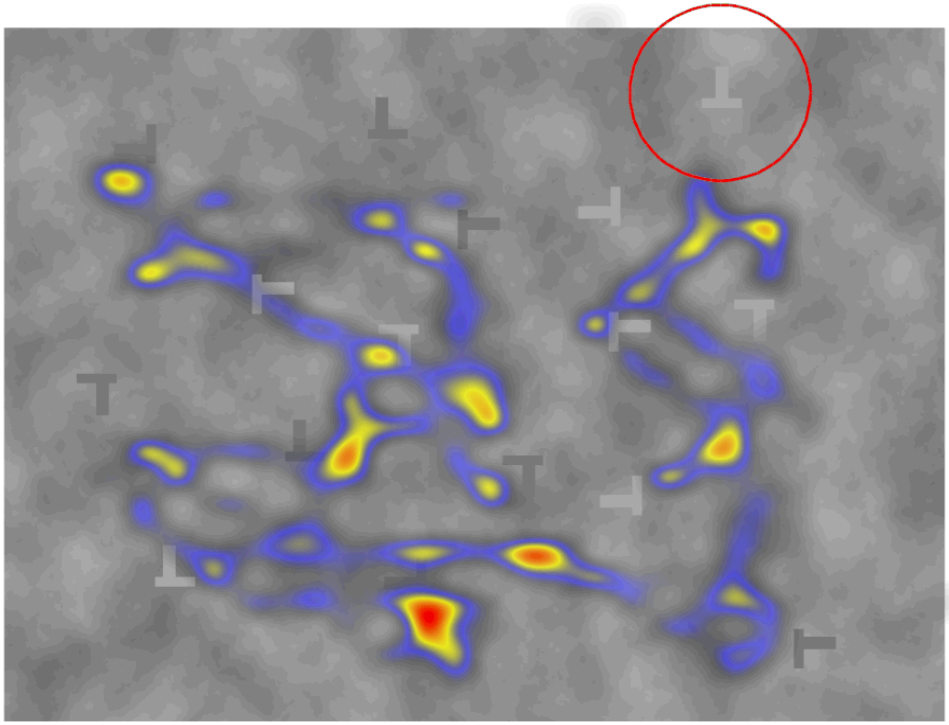








Correct



Incorrect

Correlation between gaze and salien