# Artificial Intelligence as a 'Second Pair of Eyes': Surgeons' Visual Orientation Strategies and Perceptions for Gaze Guidance in Laparoscopic Cholecystectomy


Taylor Quinn[1], Elena Lopez[2], Joseph C L'Huillier, MD, MS-HPEd[3], John M Woodward, MD, MS-HPEd[3], Manohar Golleru[1], Rachel Clipp, PhD[4], Andinet Enquobahrie, PhD, MBA[4], Lora Cavuoto, PhD[1], Steven D Schwaitzberg, MD, FACS[3]

[1] Department of Industrial & Systems Engineering, University at Buffalo, [2] Jacobs School of Medicine and Biomedical Sciences, [3] Department of Surgery, University at Buffalo, [4] Kitware, Inc.


## Introduction

- Visual misperception accounts for up to 97% of surgical errors in laparoscopic cholecystectomy[1]
- Surgical trainees and experts perceive visual cues differently[2-5]; experts prioritize visual comprehension, anatomy recognition, and risk avoidance[6]
- Technology may be the best way to prevent human perceptual errors[7,8]
- AI shows high accuracy in structure identification (98%), but struggles with individual anatomy[8]

### Objective:

- **Explore how surgical expertise and imaging condition influence visual orientation strategies and how AI may best support these processes**

## Methods

- **71 surgeons** (38 attendings, 33 residents) recruited at the Society of American Gastrointestinal & Endoscopic Surgeons 2025 Meeting
- Task: View laparoscopic cholecystectomy video clips **(Fig. 1)** and respond to open-ended questions
- Responses analyzed using latent content analysis **(Fig 2.)**

*Figure 1:*. Experimental setup.

| Category | Attending | Resident |
|---|---|---|
| Response | "First, I look **at where the instrument is**…and at moments where there were pauses…**scan the surroundings to orient myself**…to **look at anything that is unusual**…" (S52) | "Focusing on the site **where the surgeon is working** for example…at the dissection place" (S54) |
| Primary Theme | Procedural Activity | Procedural Activity |
| Subtheme 1 | Gaze Shifting | |
| Subtheme 2 | Establish Spatial Orientation | |
| Subtheme 3 | Check for Abnormalities | |

*Figure 2:* Coding of responses by primary and subthemes.

## Results

- Responses were coded into primary and subthemes of visual orientation **(Fig. 3)** and preferred AI features **(Fig. 4-5)**
- Visual orientation was layered and dynamic, shaped by expertise
- **Attendings** prioritized critical structures (26.3%) and procedural activity (15.8%)
- **Residents** emphasized procedural activity (27.3%) and structure identification (21.2%)

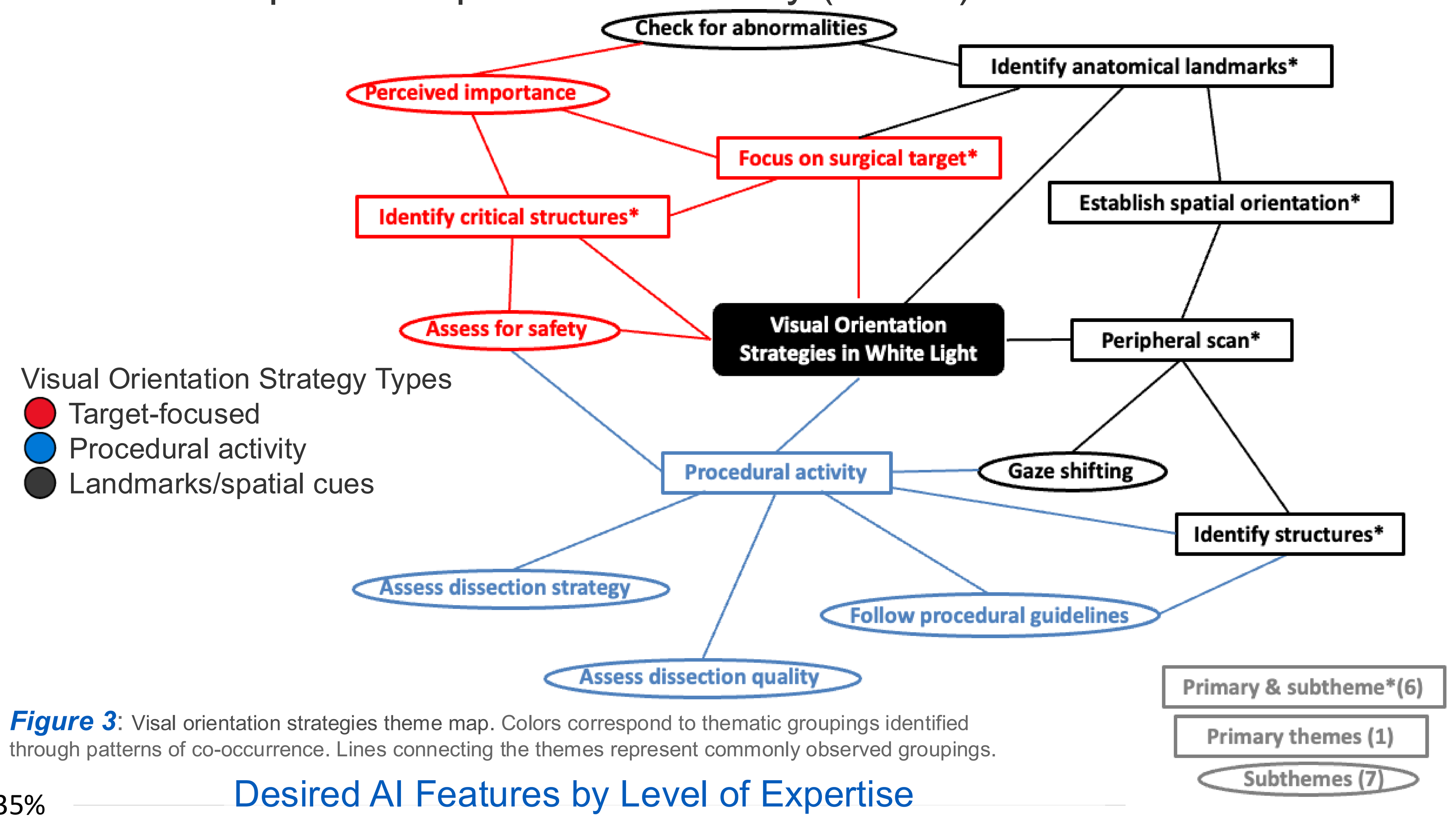


*Figure 3*: Visual orientation strategies theme map. Colors correspond to thematic groupings identified through patterns of co-occurrence. Lines connecting the themes represent commonly observed groupings.

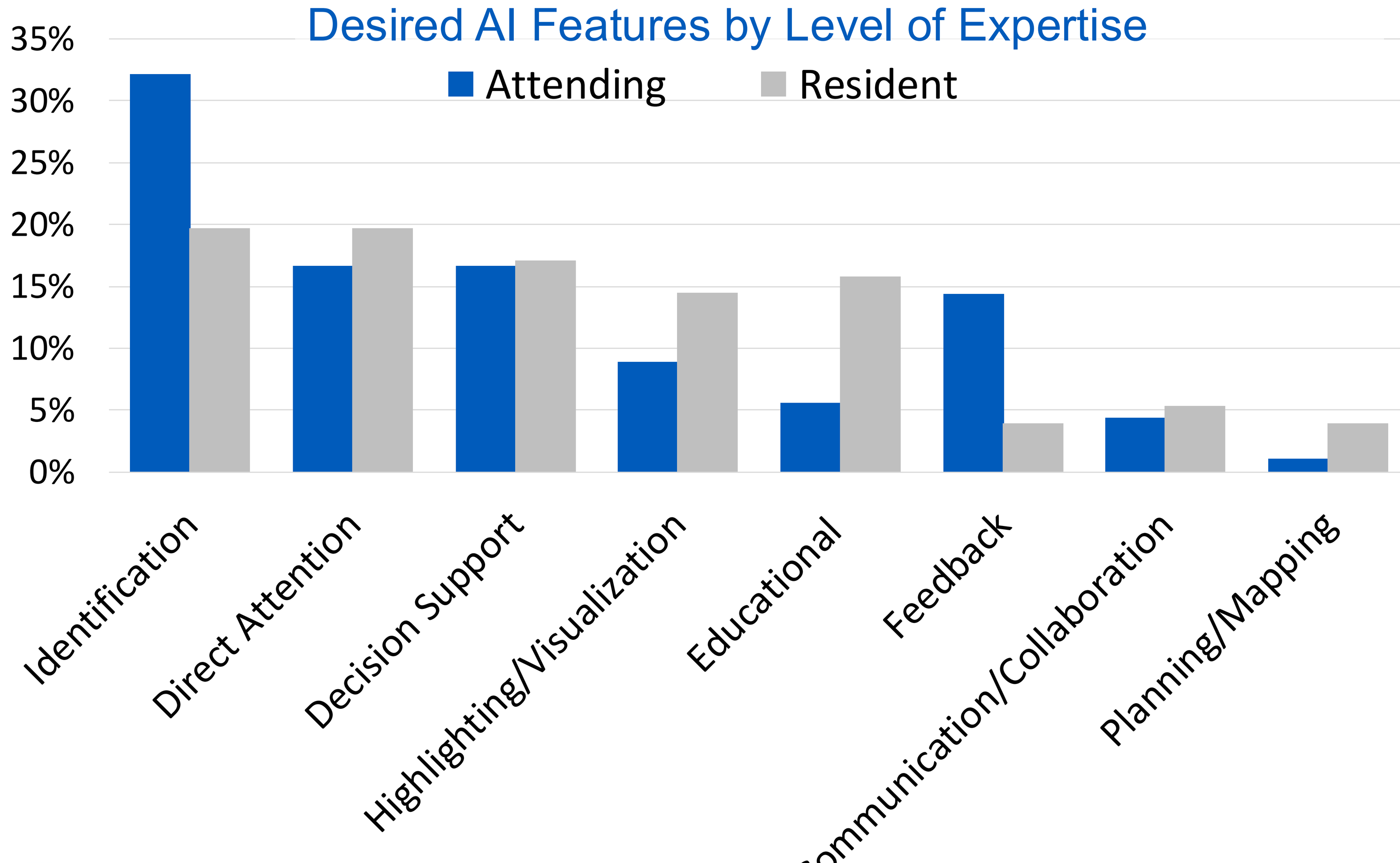


*Figure 4*: Plot of identified features.

- **Identification & attention guidance preferred across groups (Fig. 4)**
- Attendings favored decision support (16.7%), feedback (14.4%)
- Residents prioritized highlighting/ visualization (14.5%)

## Design Implications for AI Gaze Guidance

| | |
|---|---|
| Guidance | Supervisory role, second opinion, generating best practices, guiding gaze points |
| Visualization | Confirm anatomy, mapping structures, on-screen feedback, patient imaging overlay, visualize big picture |
| User Control | Voice command, ability to turn on/off, on-demand activation |
| Educational | Gaze recording, differentiate trainee versus teacher perspectives, marker of user's attention |
| Safety | Injury prevention, support for trainees |
| Design | Invisible, ambient, analogous to blind spot monitor in car, adjunct mode |

*Figure 5*: Categorization of AI technology features

## Conclusion

- Positive toward AI: Attendings (92%), Residents (82%)

### Design Considerations:

- Serve a supportive role as a "second pair of eyes," not a replacement for the expert
- Minimize distractions and reduce additional visual demand
- AI for surgery should adapt to level of expertise
- Implications for surgical training and AI-based tools

## References


1. Way LW, Stewart L, Gantert W, et al. Causes and prevention of laparoscopic bile duct injuries: analysis of 252 cases from a human factors and cognitive psychology perspective. *Ann Surg*. 2003;237(4):460-469. doi:10.1097/01.SLA.0000060680.92690.E9
2. Popov V, Chen X, Wang J, et al. Looking Together ≠ Seeing the Same Thing: Understanding Surgeons' Visual Needs During Intra-operative Coordination and Instruction. In: *Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems*. CHI '24. Association for Computing Machinery; 2024:1-12. doi:10.1145/3613904.3641929
3. Goodwin C. Professional vision. *American Anthropologist*. 1994;96(3):606-633. doi:10.1525/aa.1994.96.3.02a00100
4. Mentis HM, Chellali A, Schwaitzberg S. Learning to see the body: supporting instructional practices in laparoscopic surgical procedures. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI '14. Association for Computing Machinery; 2014:2113-2122. doi:10.1145/2556288.2557387
5. Wilson M, McGrath J, Vine S, Brewer J, Defriend D, Masters R. Psychomotor control in a virtual laparoscopic surgery training environment: gaze control parameters differentiate novices from experts. *Surg Endosc*. 2010;24(10):2458-2464. doi:10.1007/s00464-010-0986-1
6. Green CA, Lin J, Higgins R, O'Sullivan PS, Huang E. Expertise in perception during robotic surgery (ExPeRtS): What we see and what we say. *The American Journal of Surgery*. 2022;224(3):908-913. doi:10.1016/j.amjsurg.2022.05.006
7. Brunt LM, Deziel DJ, Telem DA, et al. Safe Cholecystectomy Multi-society Practice Guideline and State of the Art Consensus Conference on Prevention of Bile Duct Injury During Cholecystectomy. *Ann Surg*. 2020;272(1):3-23. doi:10.1097/SLA.0000000000003791
8. Corallino D, Balla A, Coletta D, et al. Systematic review on the use of artificial intelligence to identify anatomical structures during laparoscopic cholecystectomy: a tool towards the future. *Langenbecks Arch Surg*. 2025;410(1):1-16. doi:10.1007/s00423-025-03651-6





Department of Industrial & Systems Engineering
tlquinn@buffalo.edu