A Comparison of Eye-Movement Patterns Between Experienced Observers and Novices in Detecting Harmful Intention from Surveillance Video

University of California, Los Angeles
Joseph M. Burling — jmburling@ucla.edu
Hongjing Lu — hongjing@ucla.edu

University of Glasgow
Greta Todorova — 2028282t@student.gla.ac.uk
Frank E. Pollick — frank.pollick@glasgow.ac.uk

Questions Addressed Regarding Visual Expertise and Predictive Looking Behavior

How does visual experience and expertise change the way we view dynamic scenes?

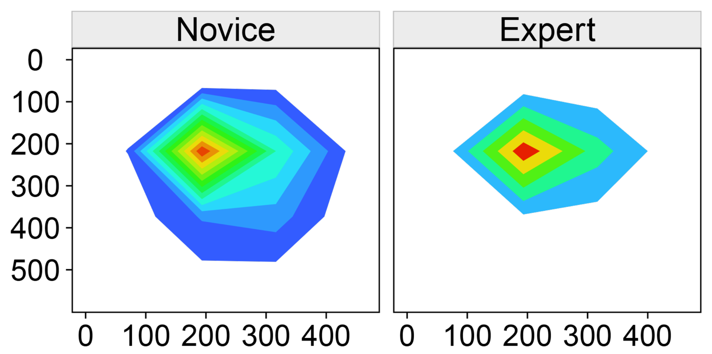
1. Do experienced observers have a unique eye-movement “signature?”
2. Do these signature eye-movements correspond to experts’ predictions about future actions?
3. How can we quantify sequences of eye-movement trajectories to compare looking behavior between experienced and novice observers?

Eye Gaze Scanning Patterns for both Experts and Novices

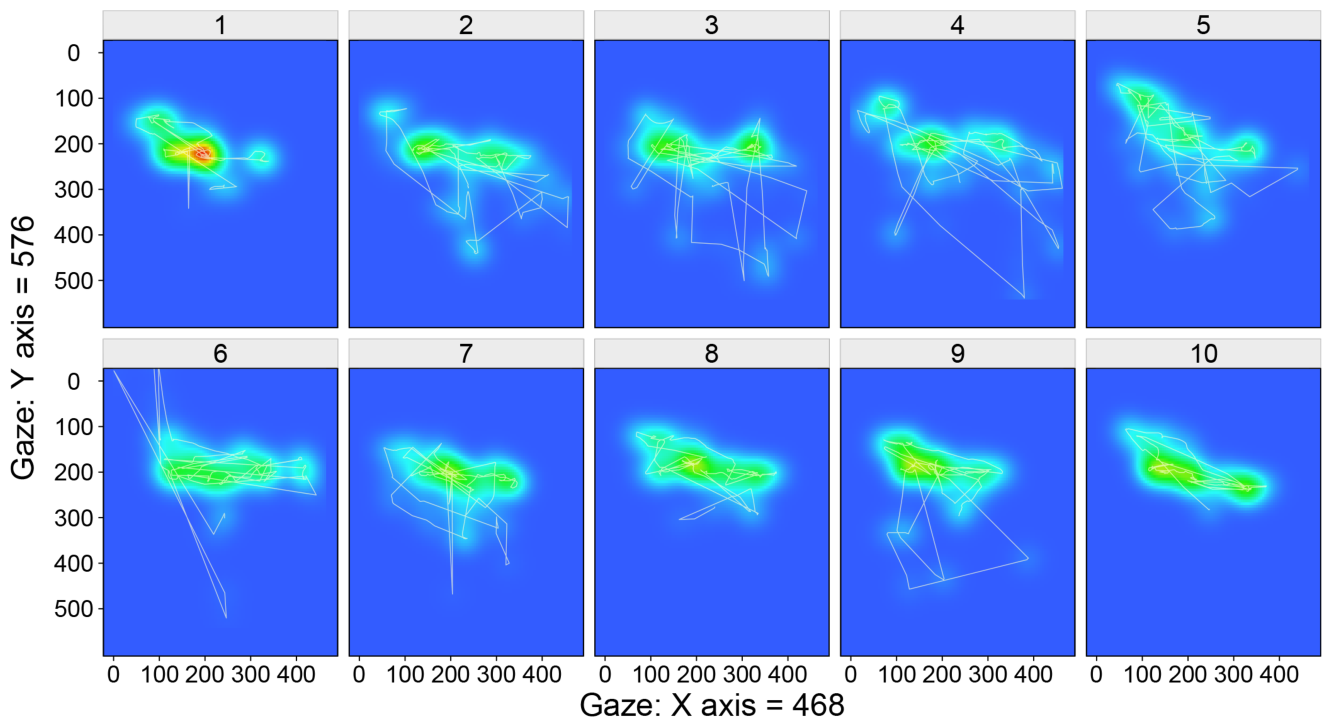
Video corpus used for eye-gaze analysis

11 Expert CCTV operators and 10 novices viewed 36 different 16-second-long clips of surveillance footage. Video clips ended before one of four events/contexts were shown: *Fighting*, *Confrontation*, *Playing*, and as a control, *Nothing*.

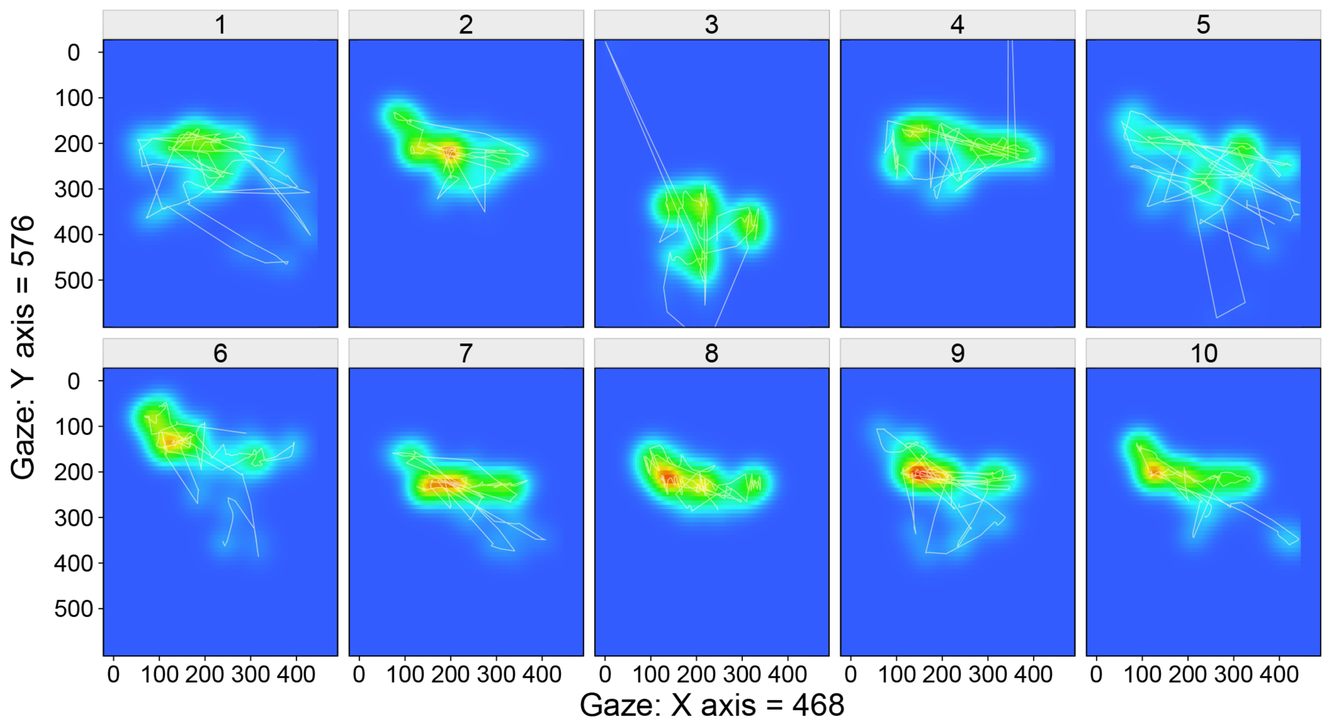
Right: These eye-movement patterns are from one video clip (*Confrontation*), and show how viewers scan the scene while anticipating an event. **Below**: Experts’ looking behavior and search area is more constrained compared to Novices, suggesting increased efficiency in knowing where to look.



Experts show consistency is scanning behavior.



Novices tend to have unique scanning paths.



References and Acknowledgment

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- Petrini, K., McAleer, P., Neary, C., Gillard, J., & Pollick, F. E. (2014). Experience in judging intent to harm modulates parahippocampal activity: An fMRI study with experienced CCTV operators. Cortex, 57, 74–91.

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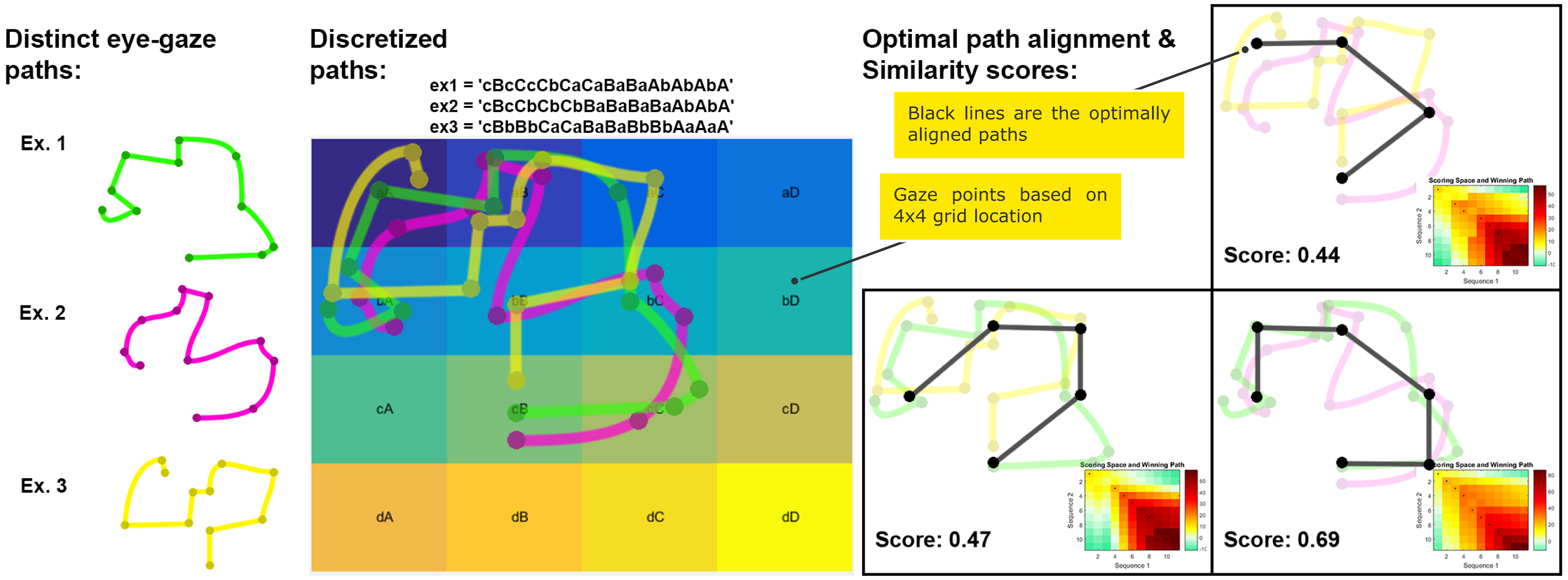
Quantifying Similarity Between Two Distinct Eye-Gaze Sequences

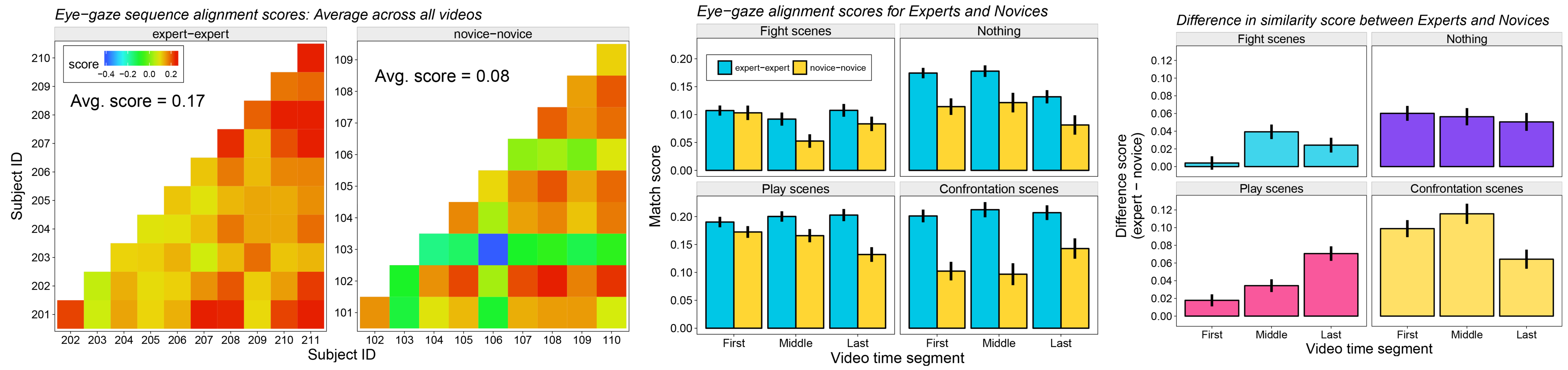
A simplified example comparing three separate scanning patterns. Paths are first discretized, then similarity scores are computed for each pairwise comparison.



Using the Needleman-Wunsch Algorithm for optimal alignment of two discrete sequences of eye-movements

Gaze fixation points are indexed by grid location (e.g., the **cA** square above), then similarity scores are calculated by optimally aligning the two sequences based on a scoring system. A dynamic programming algorithm chooses the optimal path along a user provided substitution matrix (the score board). This matrix stores the points to be awarded given the grid index. Higher scores are given to fixation points that are closer together. The example above shows how similar sequences generate higher similarity scores, such as between **Ex. 1** and **Ex. 2**.

Results: Pairwise Comparisons Within Groups and Similarity Scores Between Groups



Summary of results

Expert operators yielded higher gaze fixation similarity scores, suggesting in-group consistency among experienced observers. Similarity scores varied by context and time segment (first, middle, and last portions of the clips). For *Confront* and *Fight* contexts, differences in gaze patterns between experienced observers and novices were largest for the middle segment, whereas for the *Play* context, the largest difference was at the end. The *Nothing* context yielded higher scores for experts but no time differences.

Conclusions on expertise & predictive looking

These results suggest that expert CCTV operators may arrive at similar predictions of actions based on attending to the relevant events within a scene, and for critical events such as aggressive behaviors, important cues (context markers that result in signature looking patterns) are attended to well before the onset of the disruptive action.

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