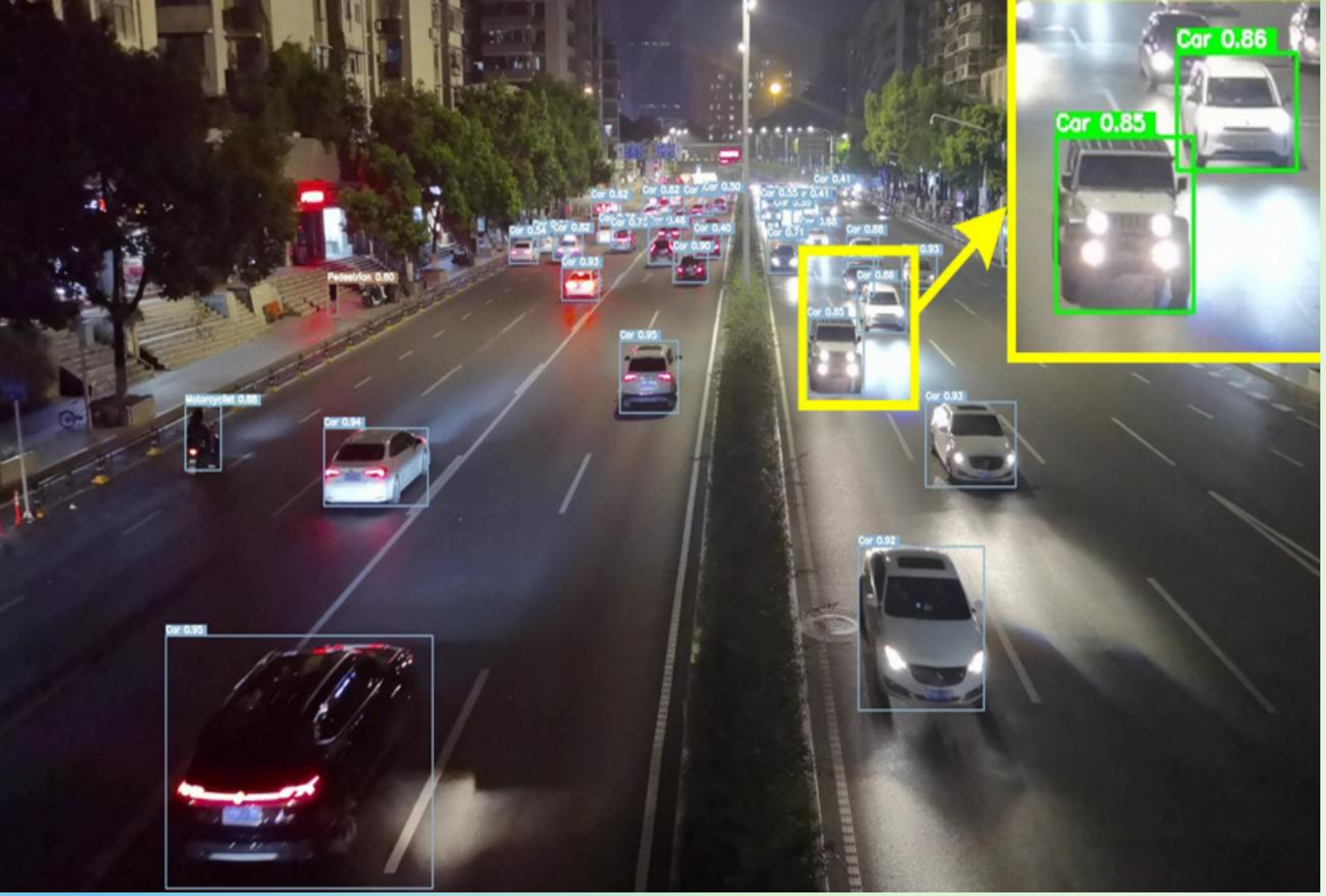
AuGhostmentation

Making Artificial Vision more Robust, Inspired by Biology



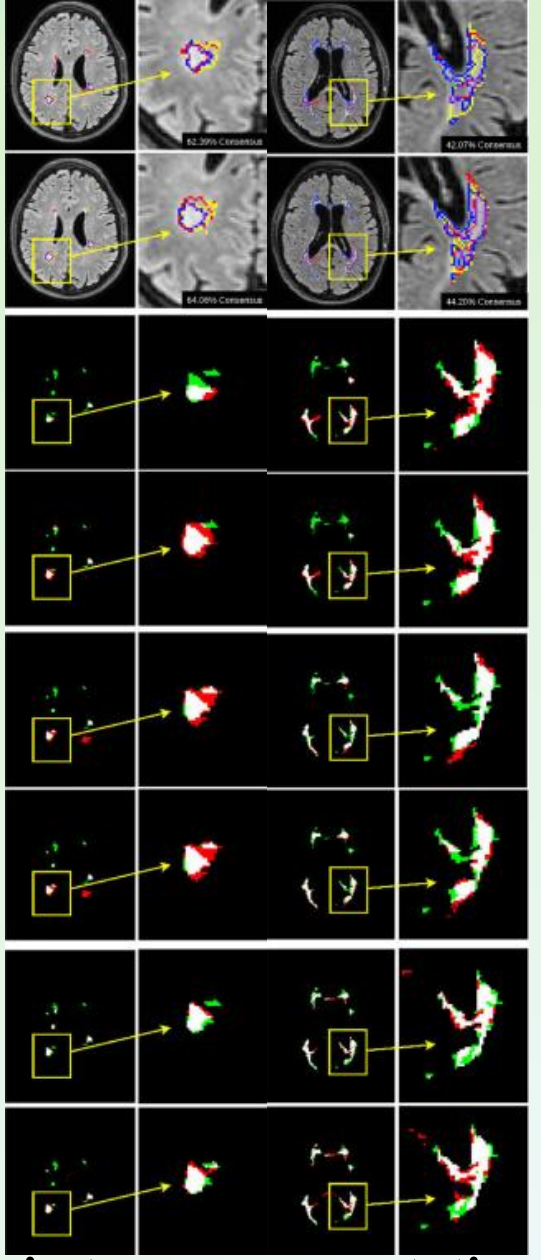
Emirhan Inan,
MsC in Data Science and Artificial Intelligence at Boğaziçi University

Suayb S. Arslan,
Director of Institute for Data Science and Artificial Intelligence, Professor of Computer Science at Boğaziçi University



Roadside detection of multiscale and occluded traffic objects

Liu et al., Sensors, 2024



Brain tumor segmentation

Zhang et al., Pattern Recognition, 2023

How Do Neural Networks See?



Image



Edges



Parts

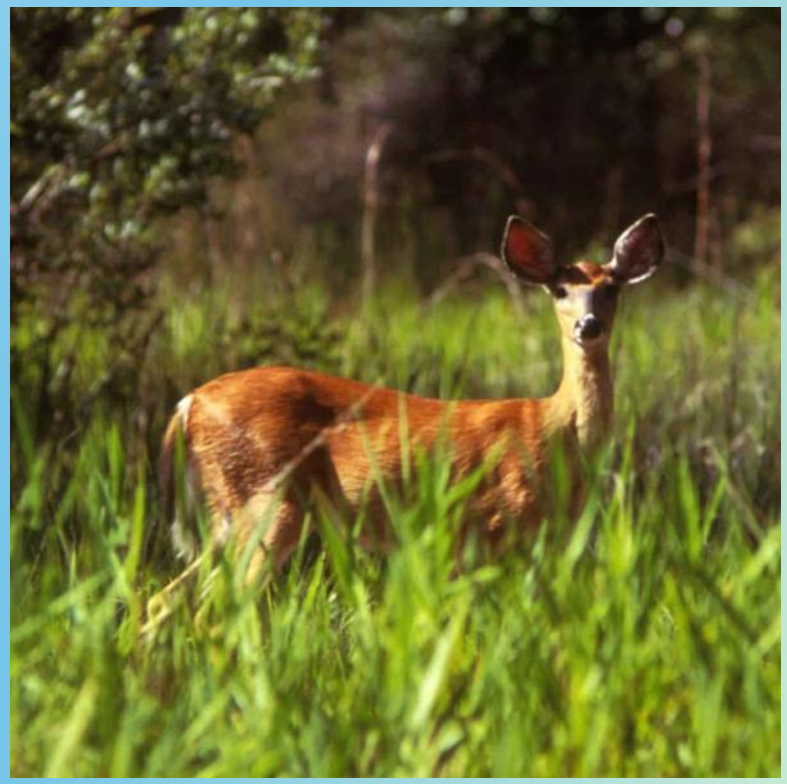


Falcon!

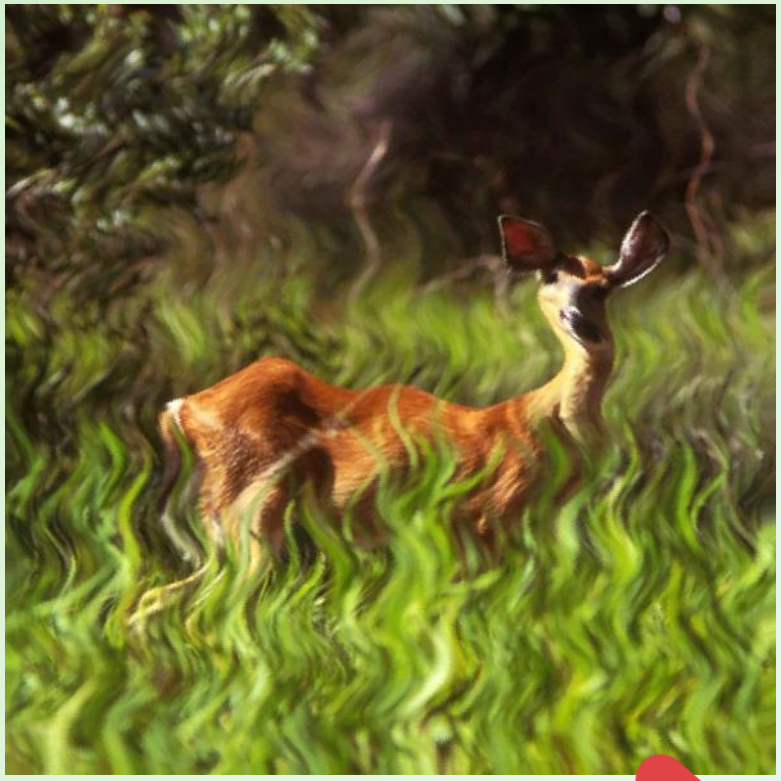
Neural Networks Are *Brittle*

They **deviate** from human perception in **unexpected** ways

Neural Networks Are *Brittle*



deer ✓



banana ✗

Neural Networks Are *Brittle*



Normal

ε = 2/255

ε = 8/255

Predictions

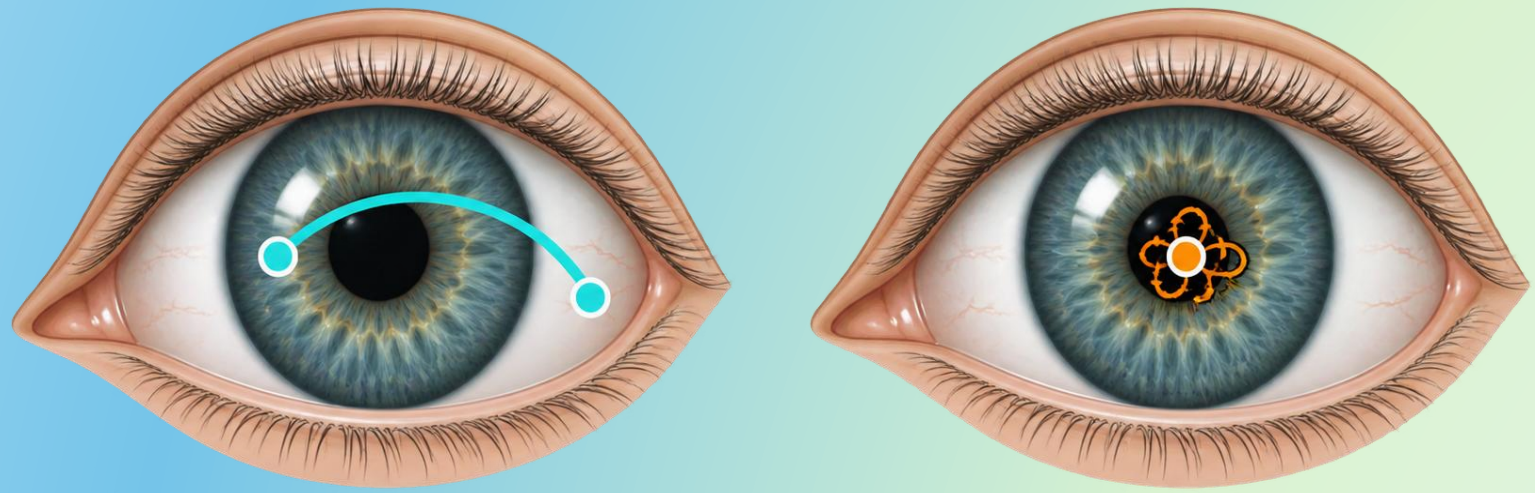
Normal		ε = 2/255		ε = 8/255	
Deer	92%	Gazelle	48%	Shark	62%
Gazelle	6%	Elk	31%	Monkey	27%
Elk	2%	Deer	18%	Deer	2%

Neural Networks Are *Lazy*



Can We Fix It Using Biology Itself Again?

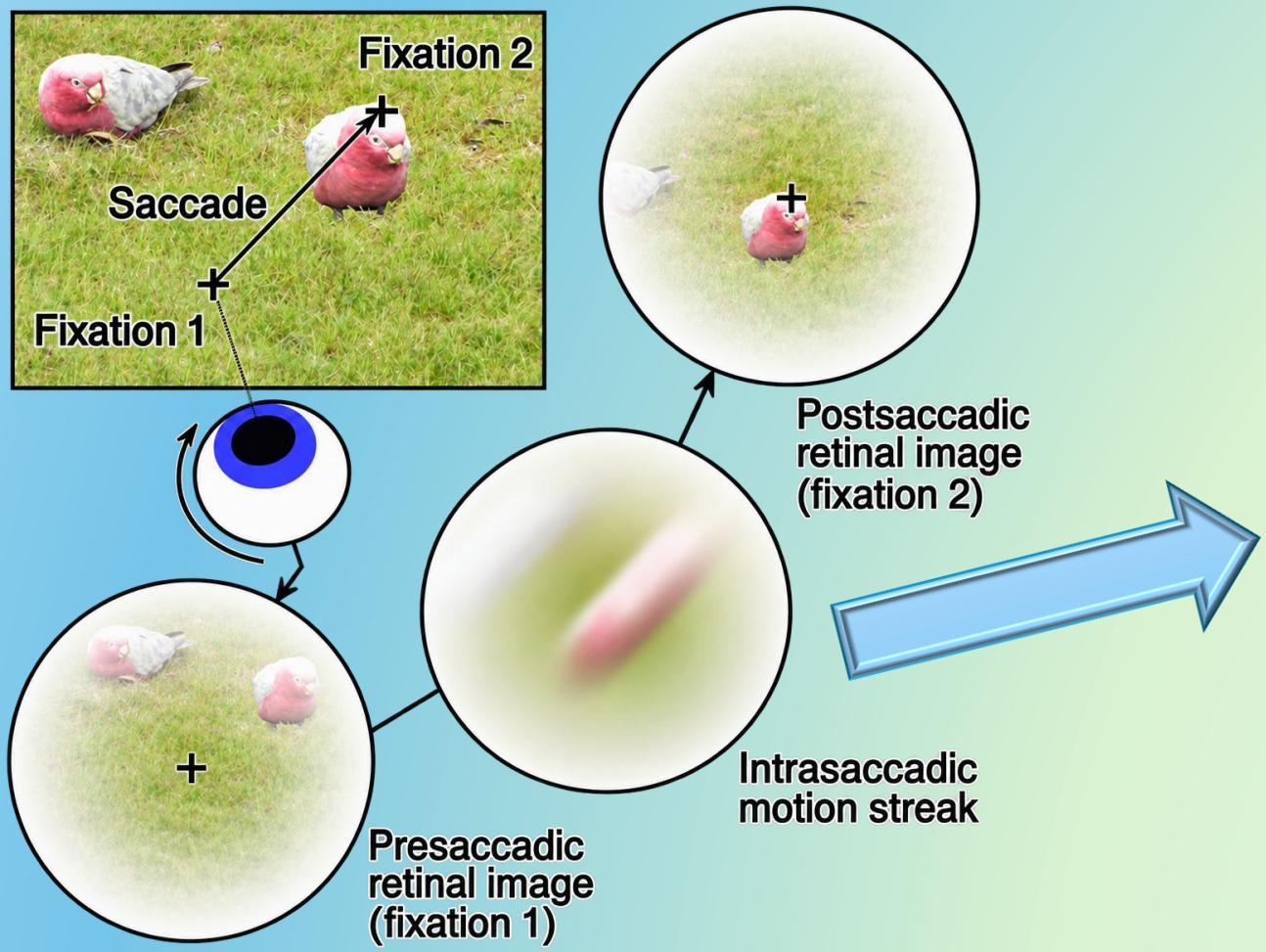
Saccades and Microsaccades



same oculomotor origin



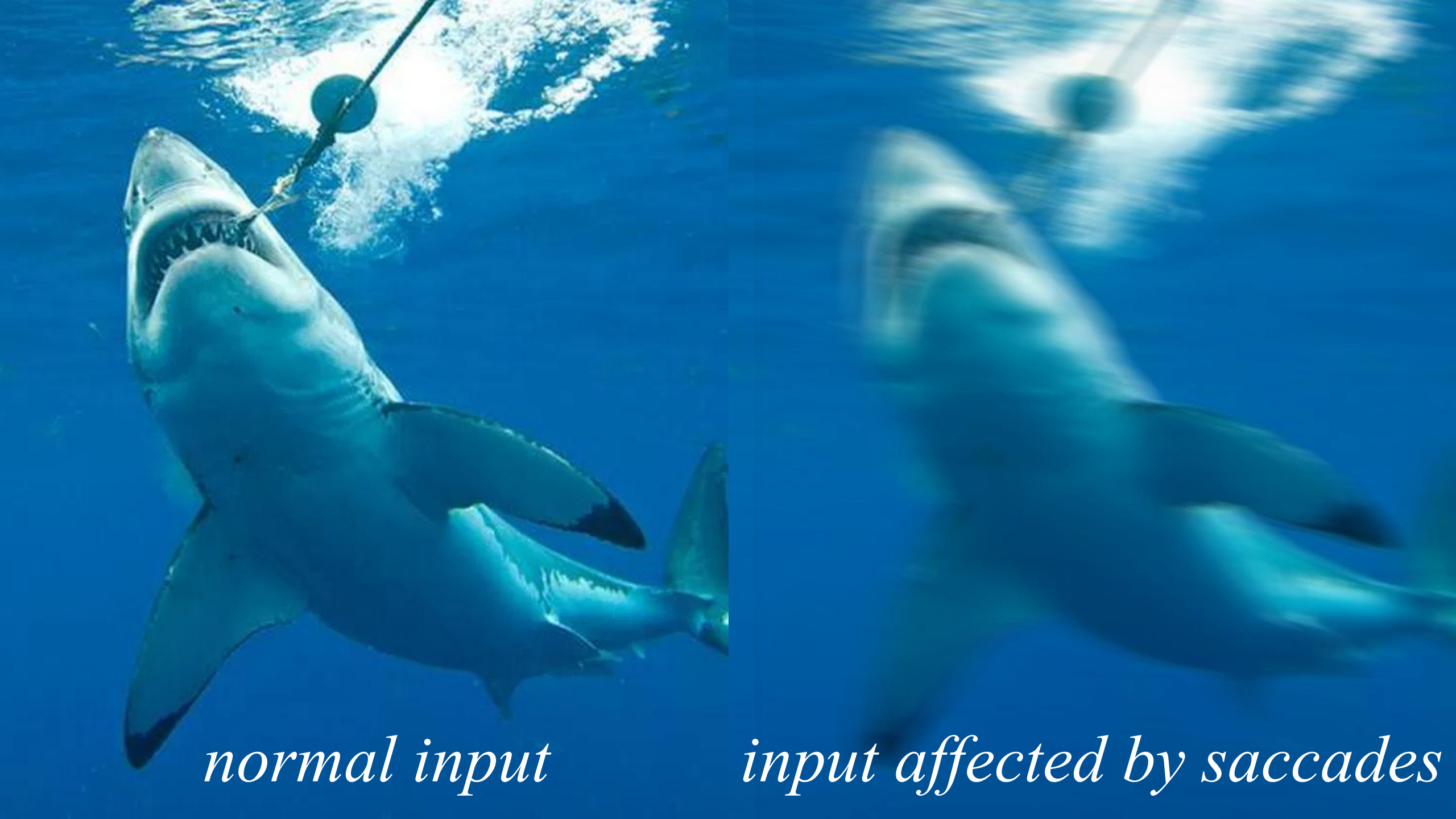
Intrasaccadic Motion Streak





Neural Network

Intrasaccadic motion streaks jump-start gaze correction, Schweitzer and Rolfs, 2021


normal input
input affected by saccades

Method



GazeBase Eyelink Dataset

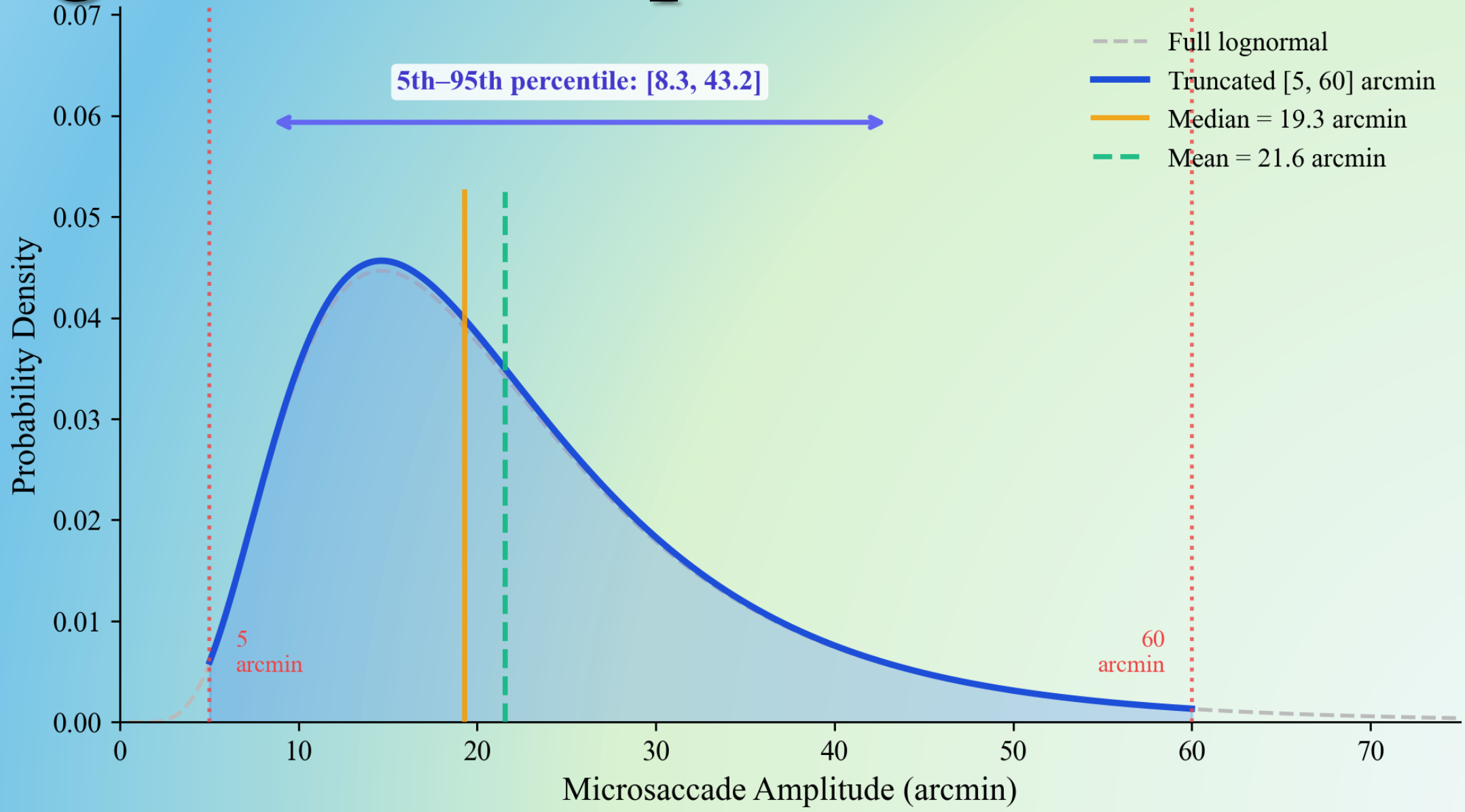
Griffith et al., 2021, "GazeBase, a large-scale, multi-stimulus, longitudinal eye movement dataset"

- ✓ Amplitude lognormal
- ✓ Direction p_h
- ✓ Duration λ



Subjects: 322 college-aged participants
Size: 12,334 eye-movement recordings overall
Sampling: 1,000 Hz, sample every 1 ms
Tasks: Fixation

Lognormal Amplitude Distribution



Horizontal Smearing Is Favorable



p_h



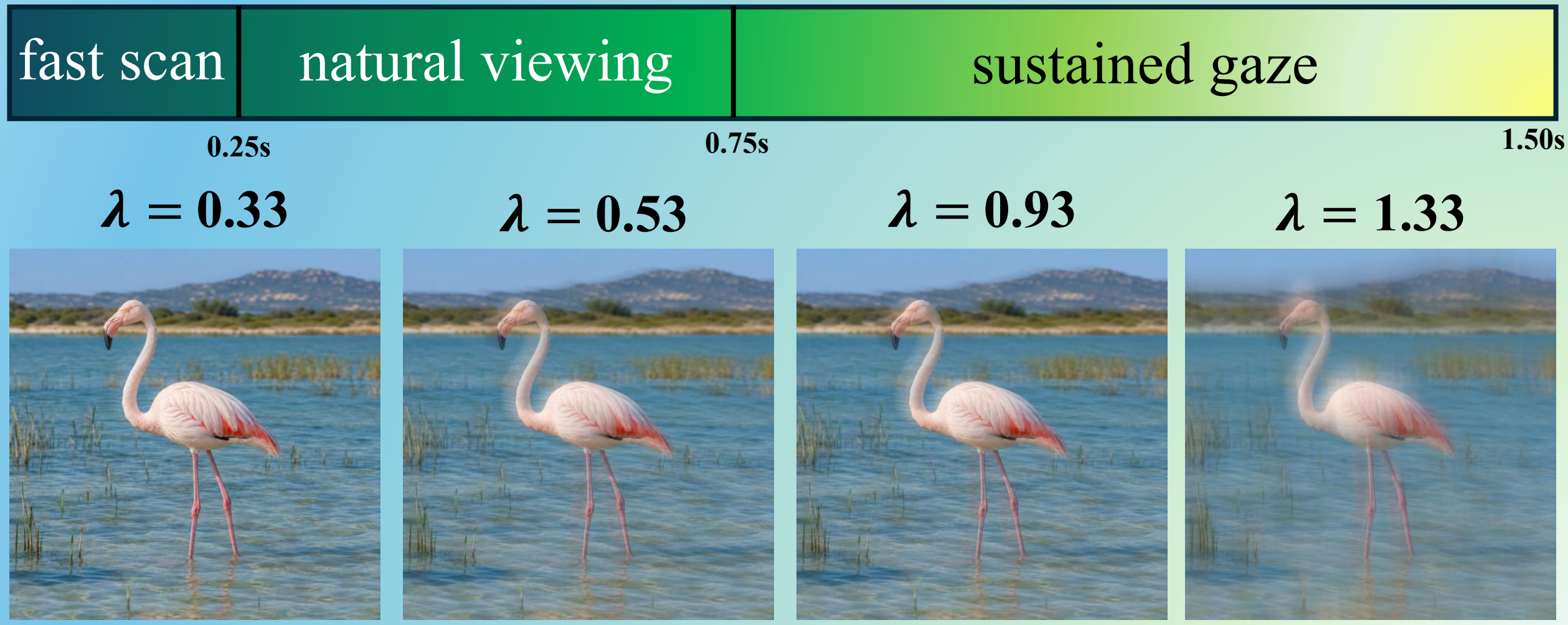



$n = 1$ $n = 2$ $n = 3$ $n = 4$

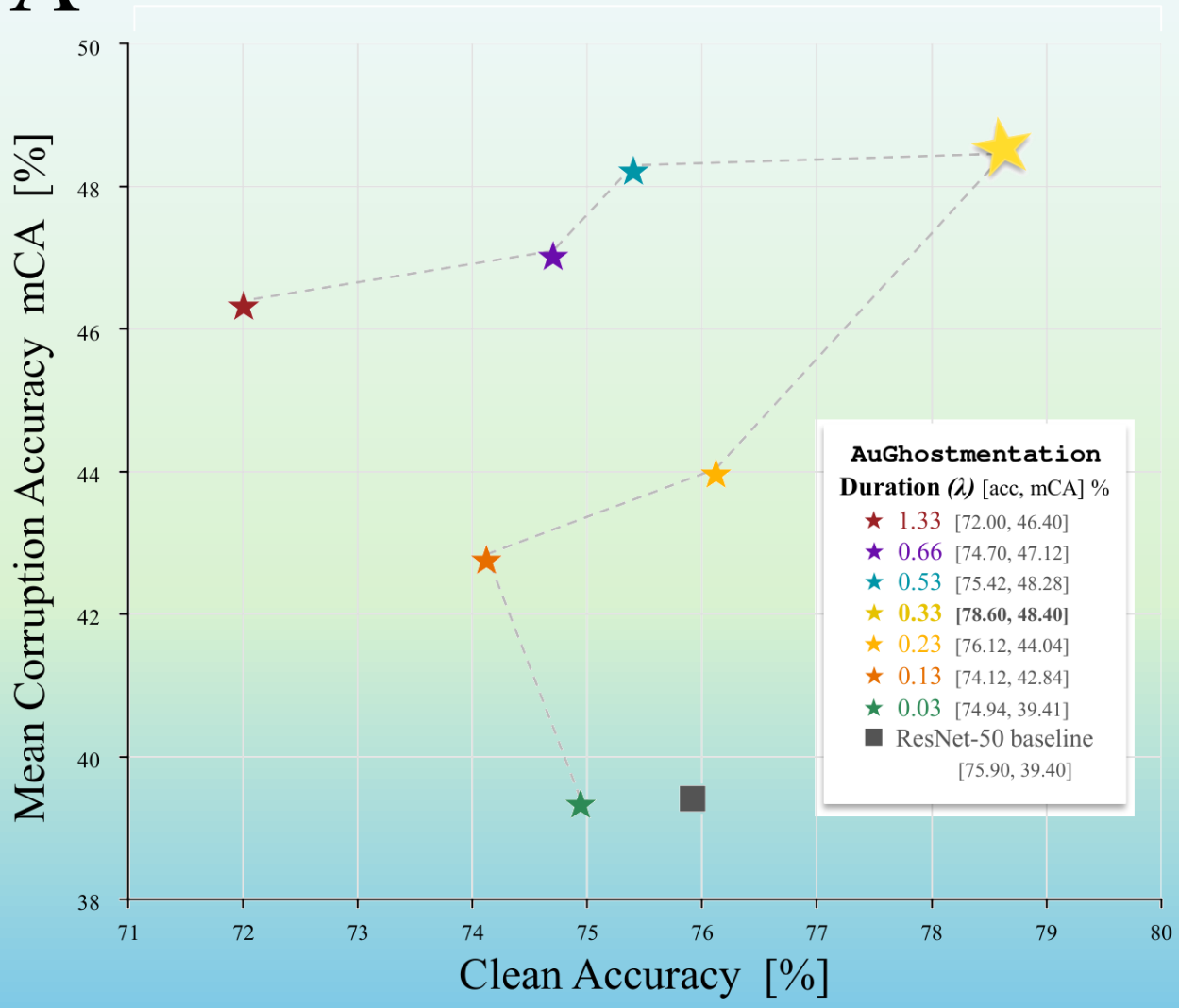





Gaze Duration

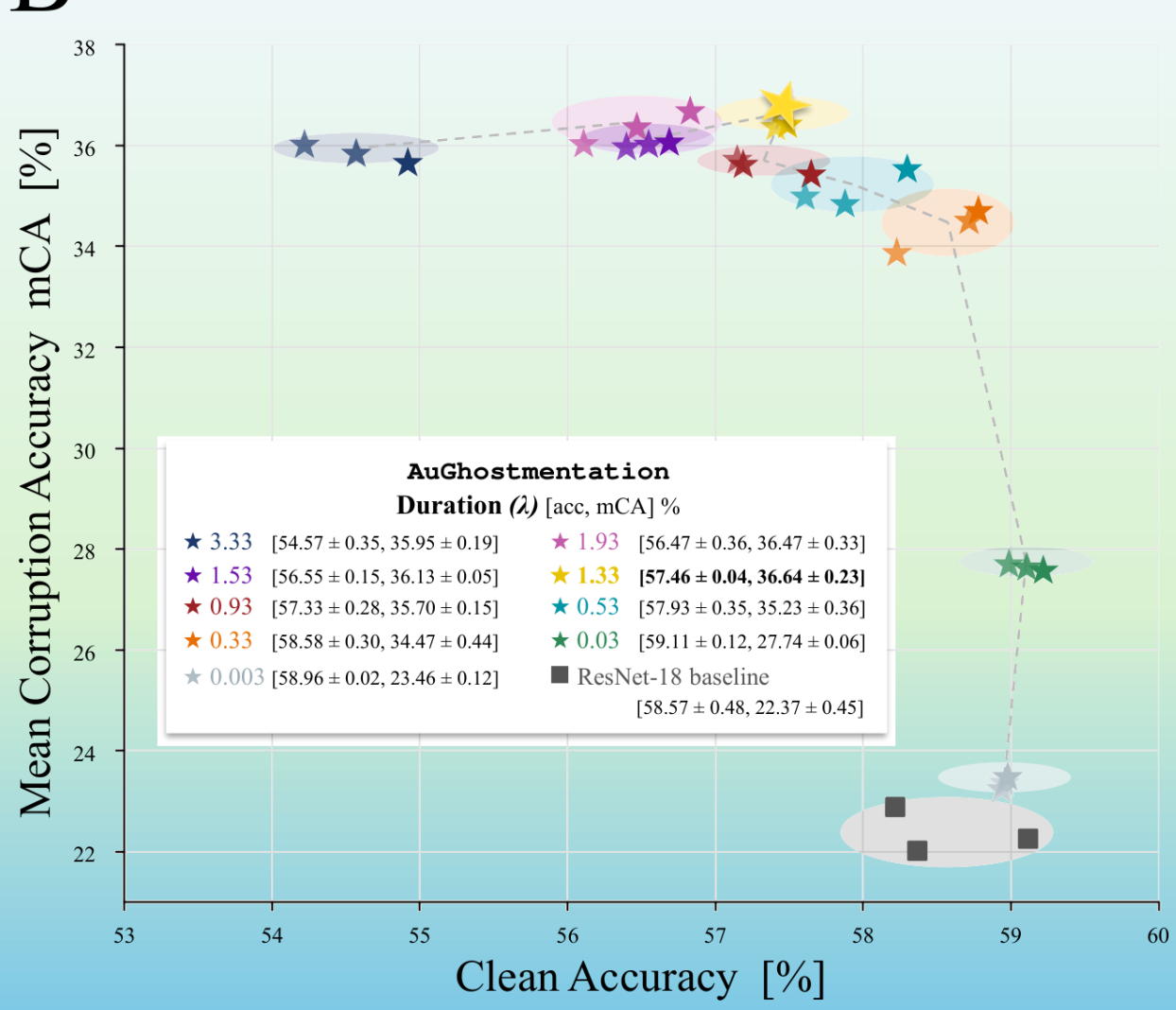


A

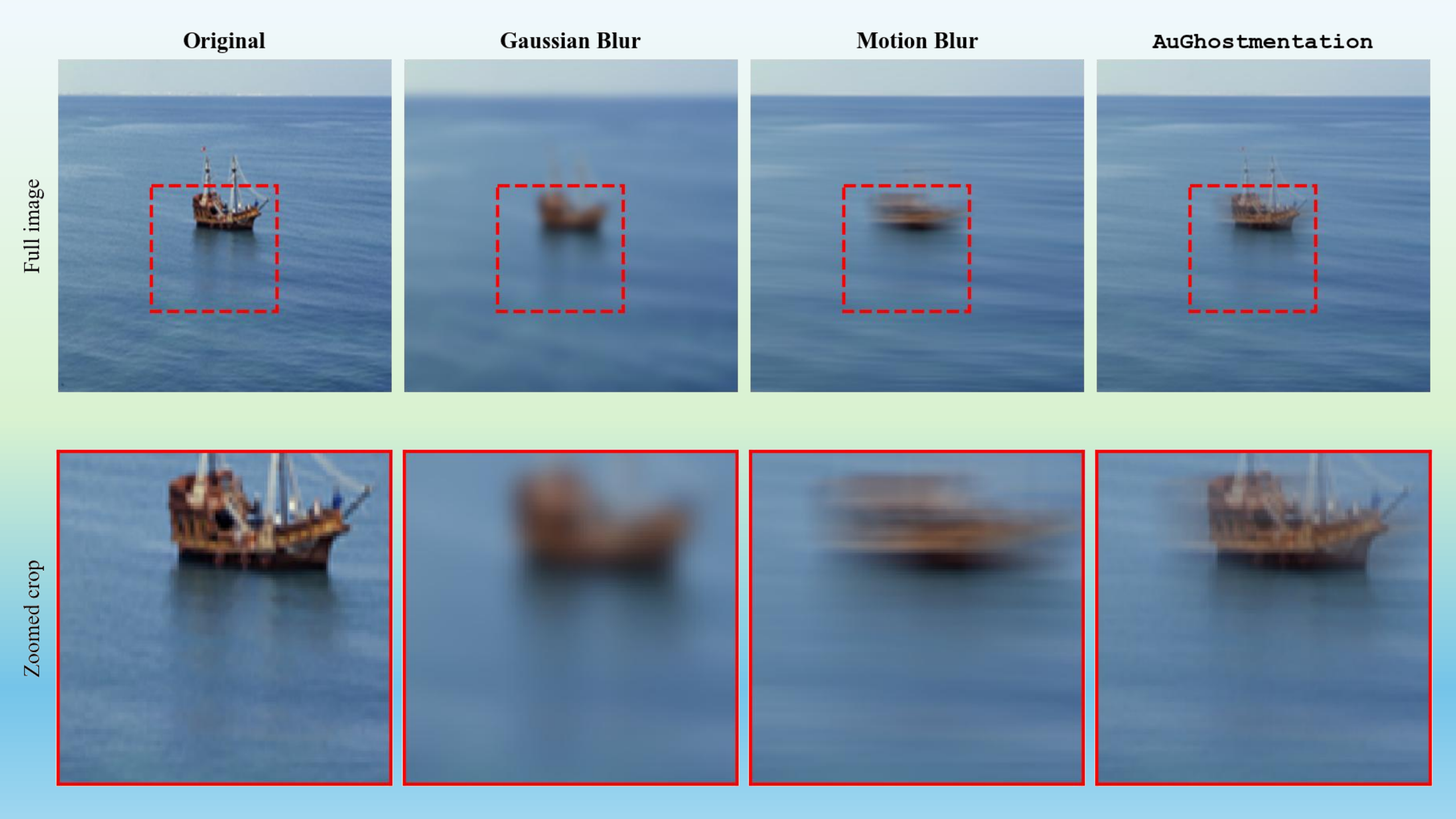


ImageNet

B

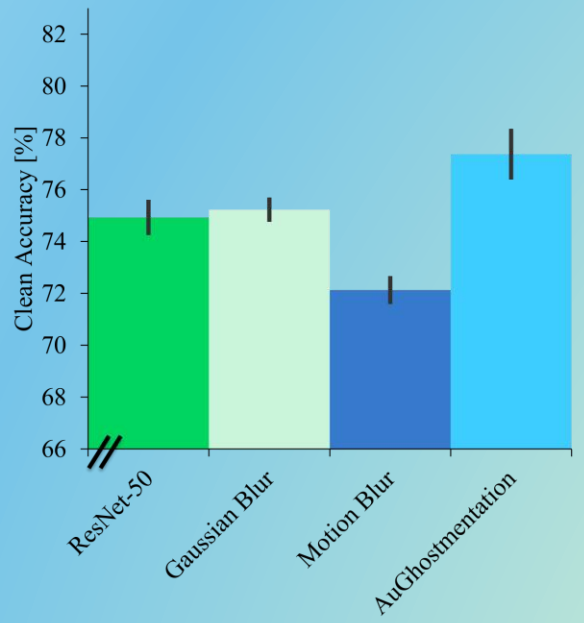


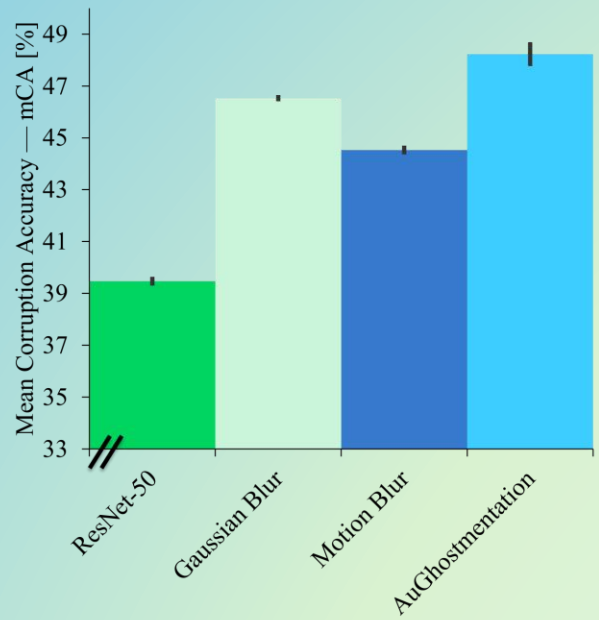
Tiny ImageNet

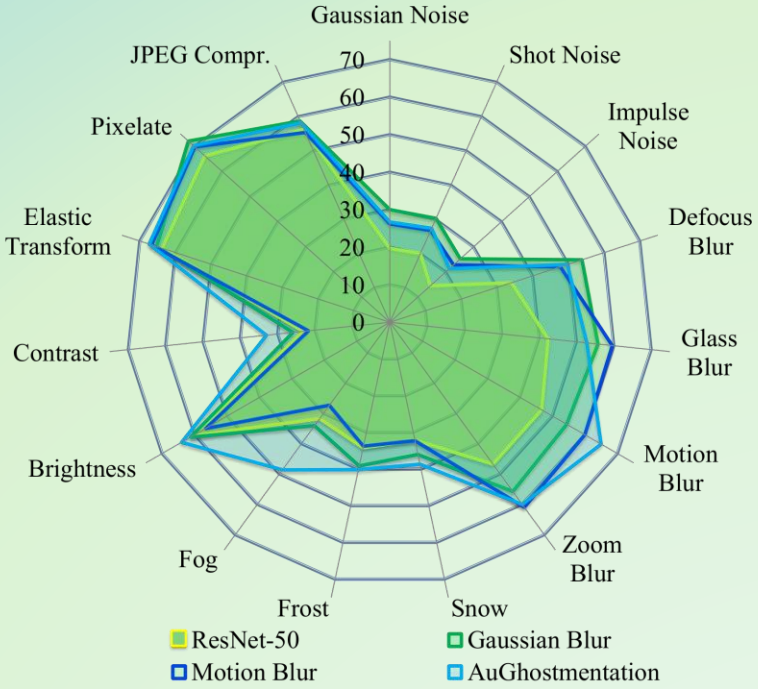

Original
Gaussian Blur
Motion Blur
AuGhostmentation
Full image
Zoomed crop

A

IMAGENET-100

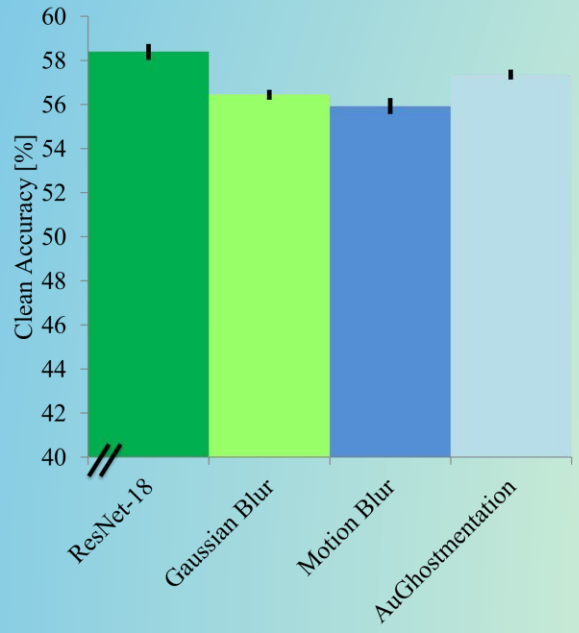


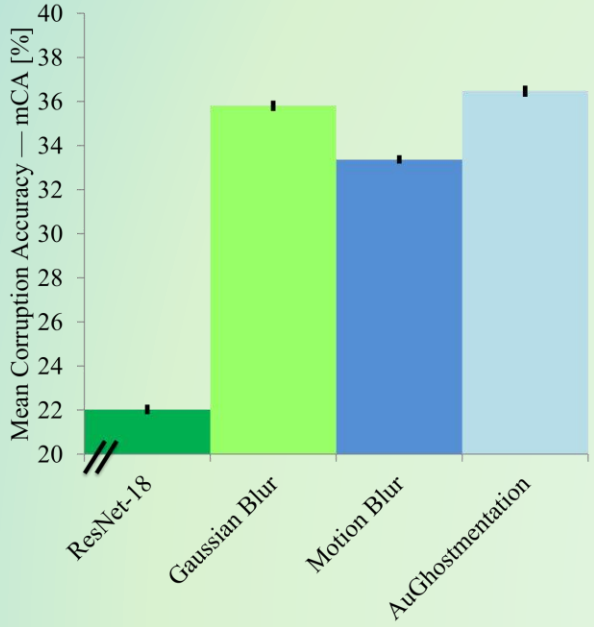


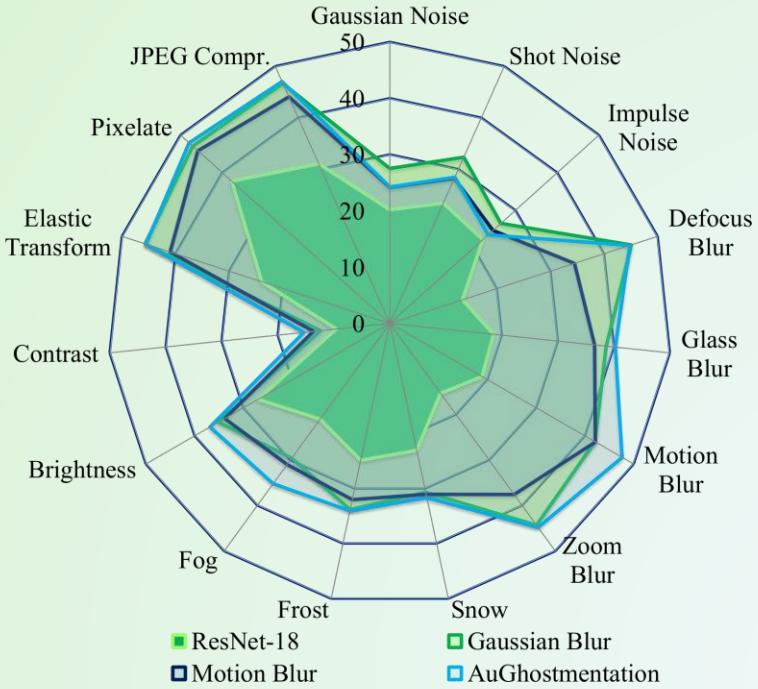


B

TINY IMAGENET





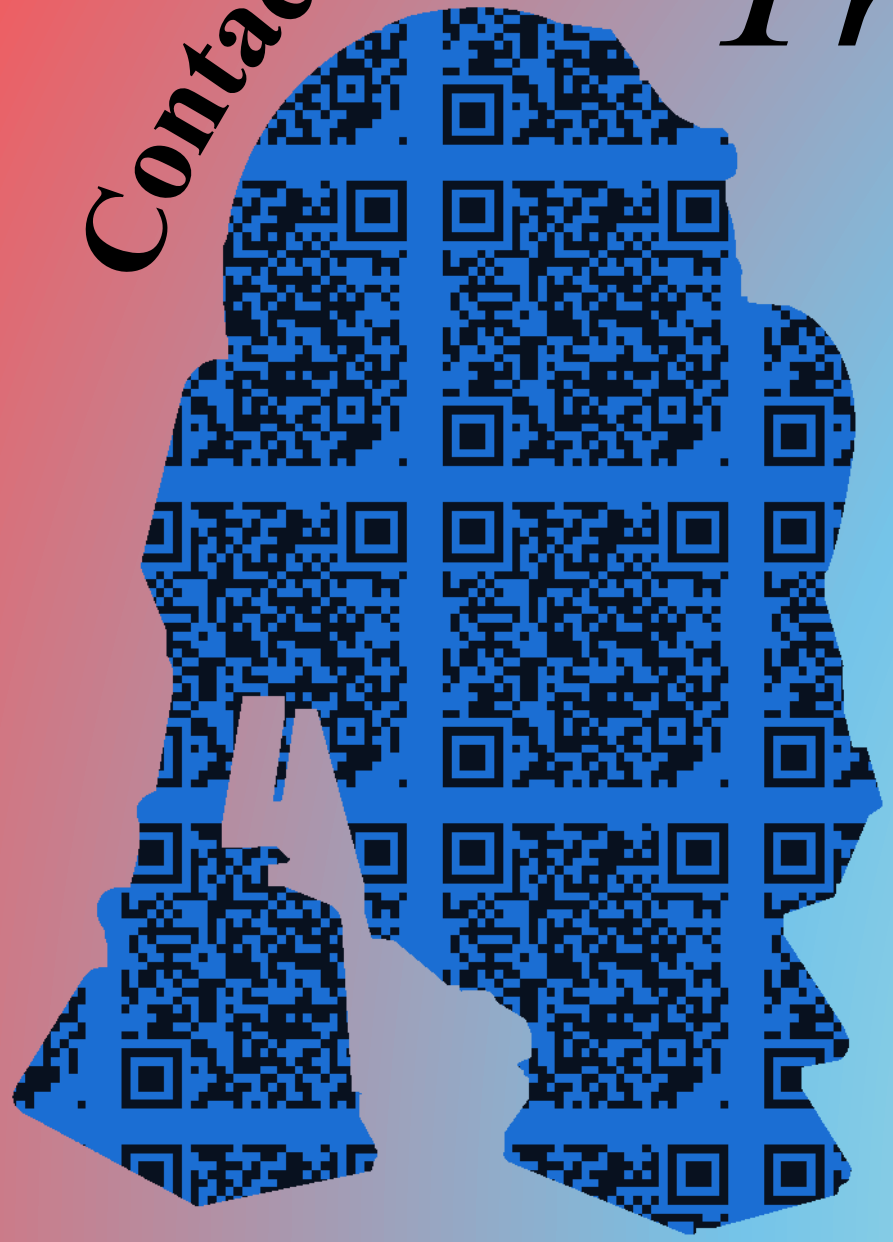


Conclusion

- Biological vision offers computational principles for robust artificial vision
- The shared preference for horizontal smearing in eyes and neural networks suggests some biological regularities are also mathematically advantageous
- The accompanying shape bias indicates biological priors alter not just performance but also representation
- More importantly, brains and learning algorithms may independently converge on similar solutions for robust perception

Thank you!

Contact:



www.emirhaninan.com

www.suaybarslan.com.tr

NEXUSLab
BOĞAZİÇİ UNIVERSITY