Adding Attentional Mechanisms to a Scan Path Model

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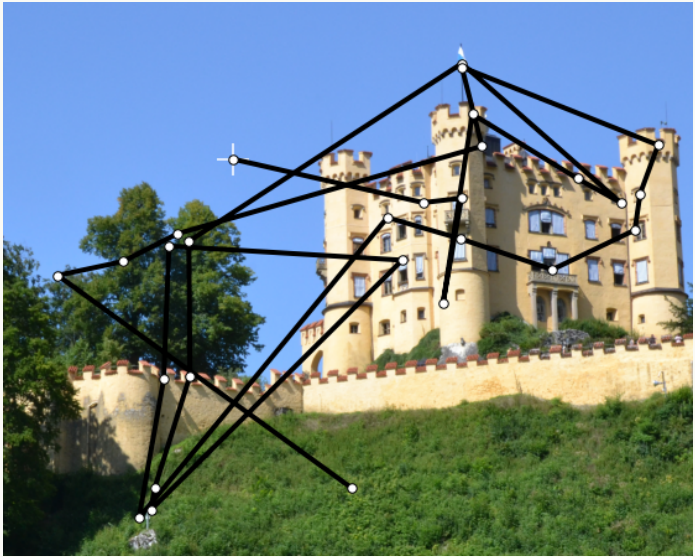
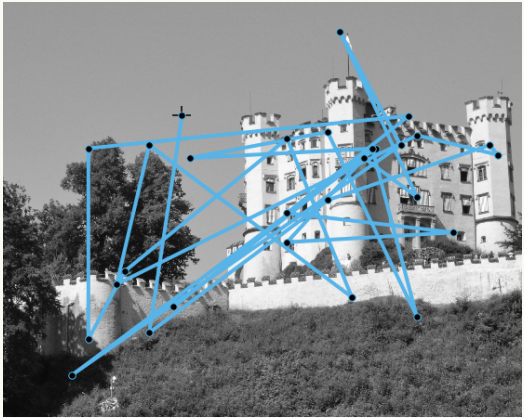
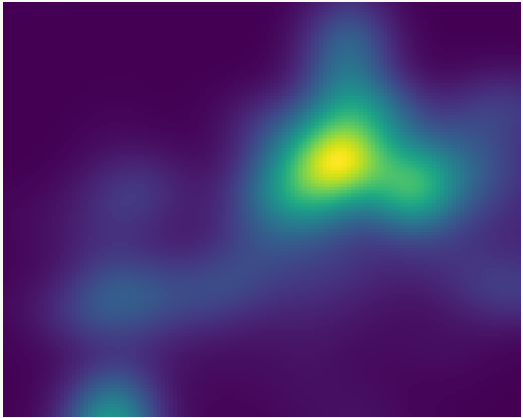


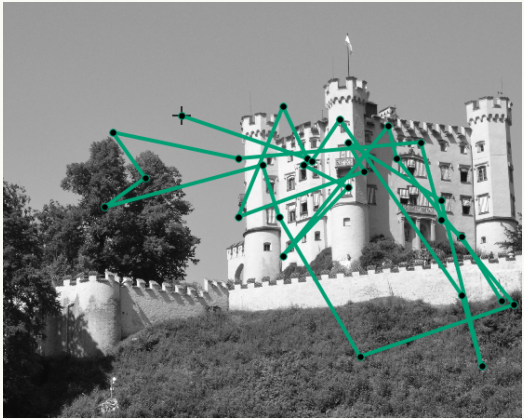
Static Saliency

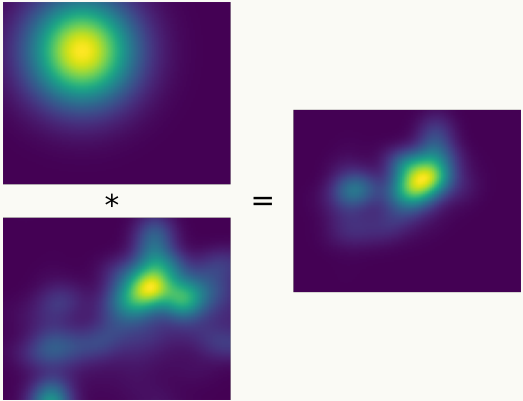




- Image features (**empirical fixation density** or model such as **GBVS** or **Deepgaze**)

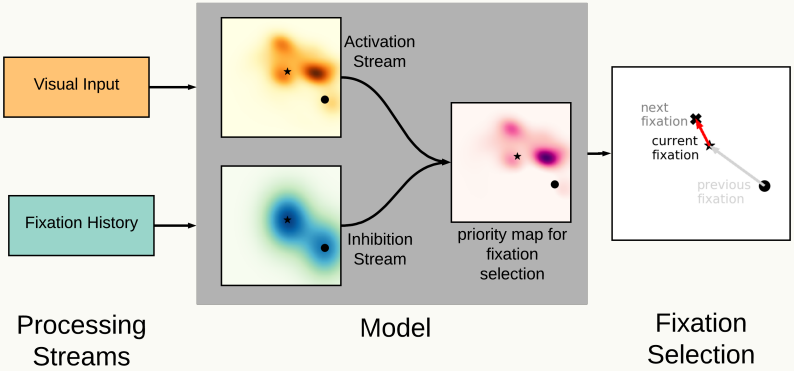
Dynamic Local Saliency





- Image features
- Gaussian approximates fovea

SceneWalk Model (Engbert et al, 2015)



- Image features and Gaussian activation
- Inhibition of previous locations (neurophysiological basis in FEF (Mirpour et al, 2019))

Animation

Assumptions

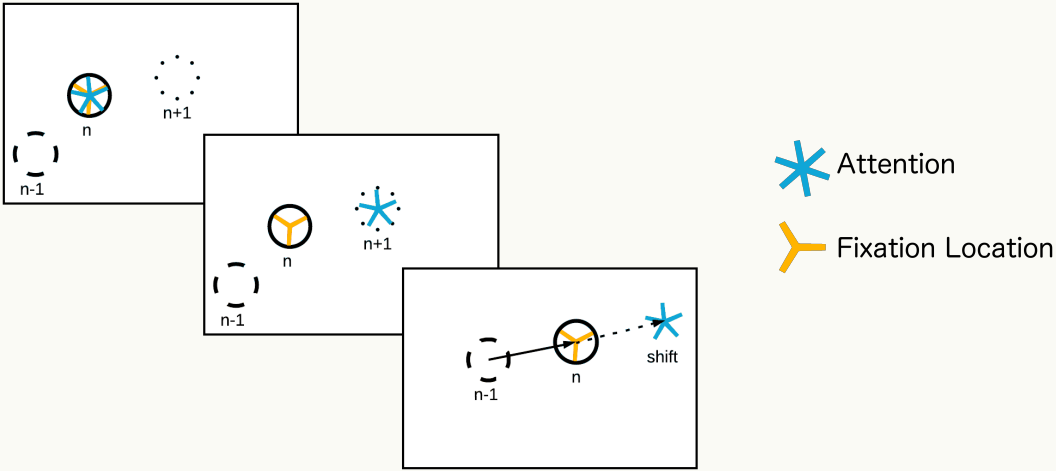
	 Image	 Foveation	 Inhibition
Static saliency	✓	x	x
Dynamic local saliency	✓	✓	x
SceneWalk model	✓	✓	✓

Perisaccadic Attention

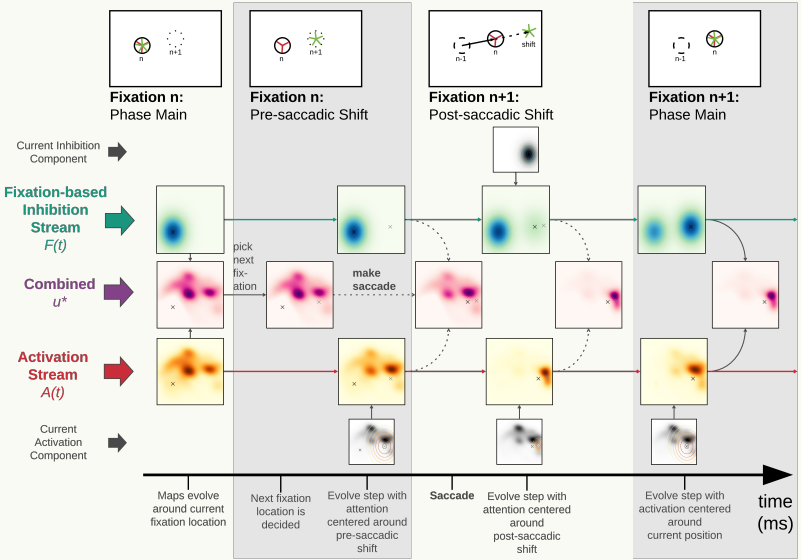
1. Attention precedes the fixation to its target [1] [2] [3]
2. Attention moves retinotopically leaving an activation trace [3] [4] [5]
3. Return saccades indicate attention at the one-back fixation location [6]

[1] Deubel & Schneider (1996)
[2] Irwin & Gordon (1998)
[3] Rolfs, Jonikaitis, Deubel & Cavanagh (2011)
[4] Golomb, Chun & Mazer (2008)
[5] Golomb, Marino, Chun & Mazer (2010)
[6] Smith & Henderson (2009)

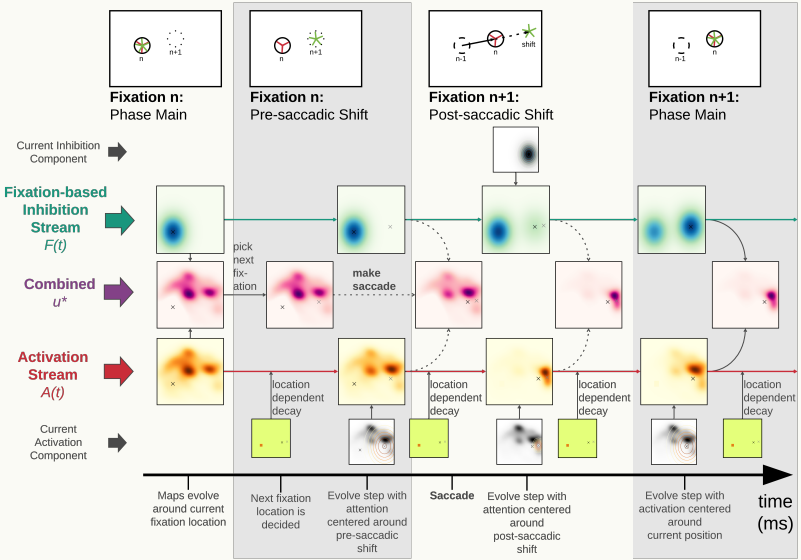
Perisaccadic attention (Theory)



Extended SceneWalk Model

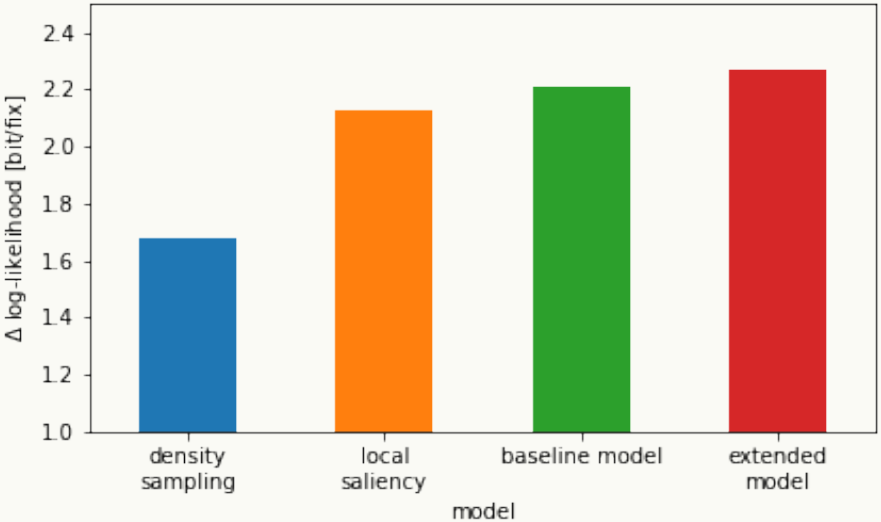


Extended SceneWalk Model

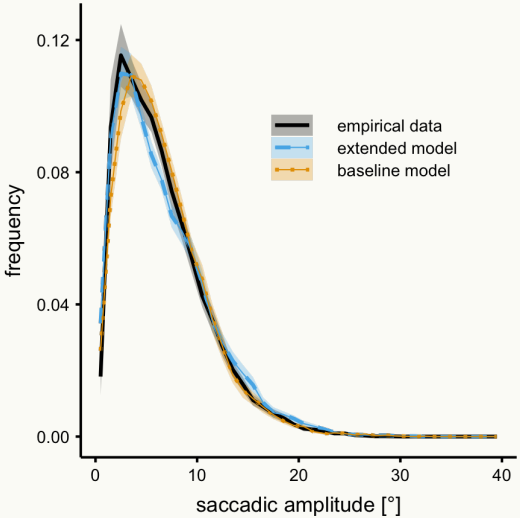


Animation

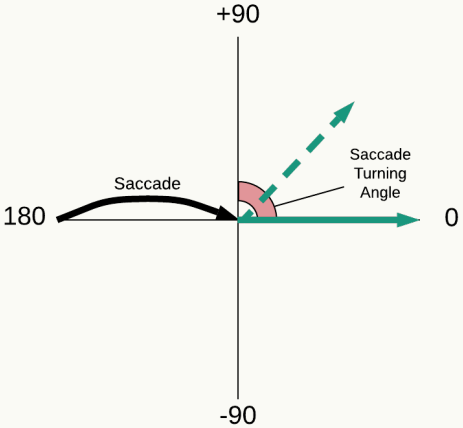
General Likelihood



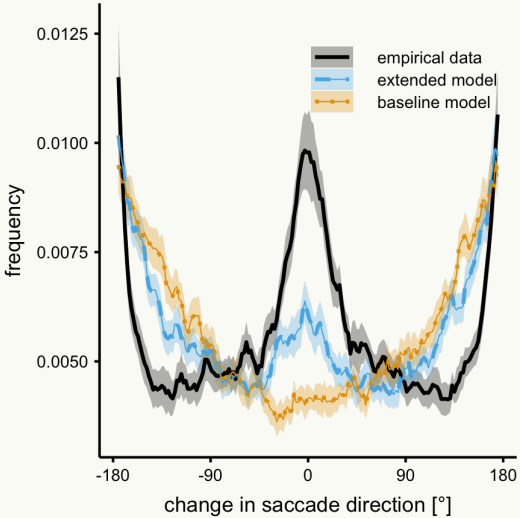
Saccade Amplitude Distribution



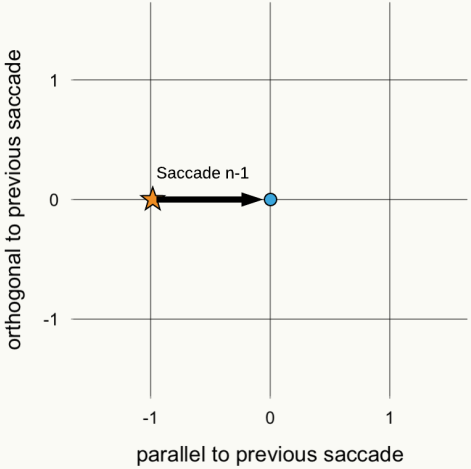
Serial Dependencies



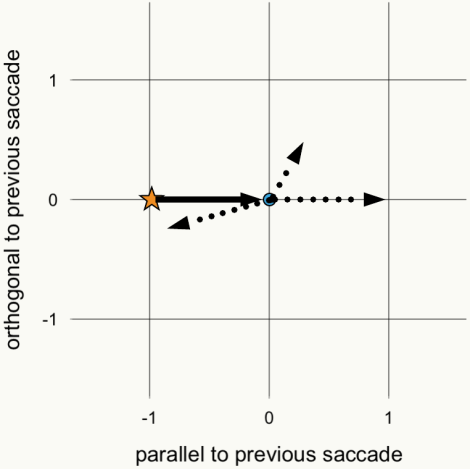
Saccade Turning Angle Distribution



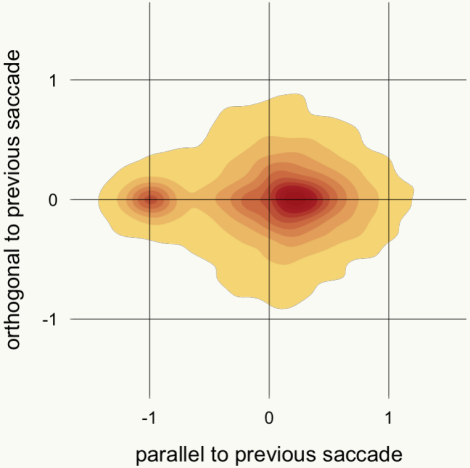
Turning Angle–Amplitude Relation



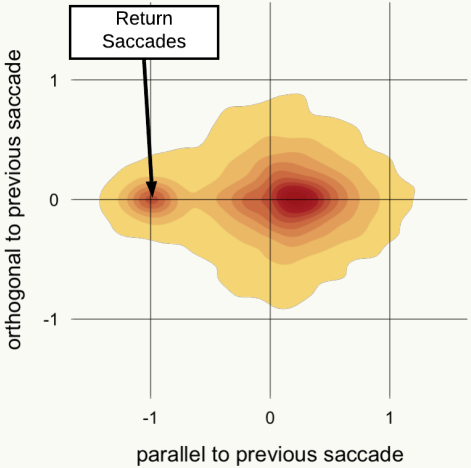
Turning Angle–Amplitude Relation



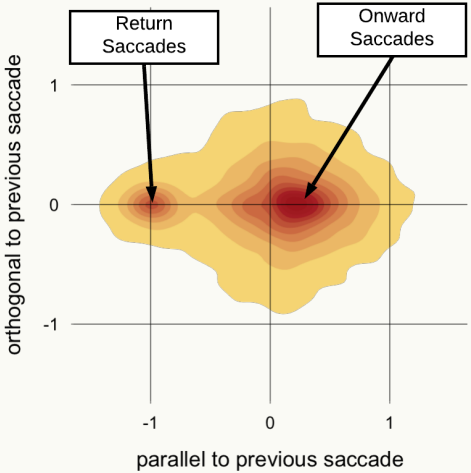
Turning Angle–Amplitude Relation



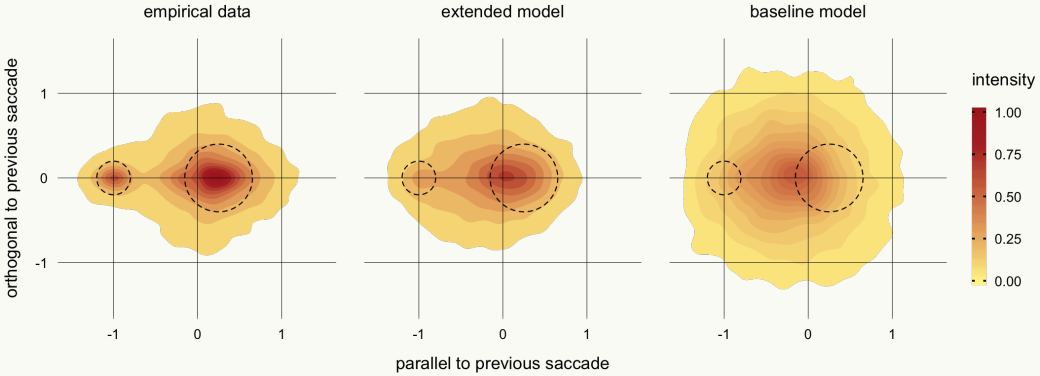
Turning Angle–Amplitude Relation



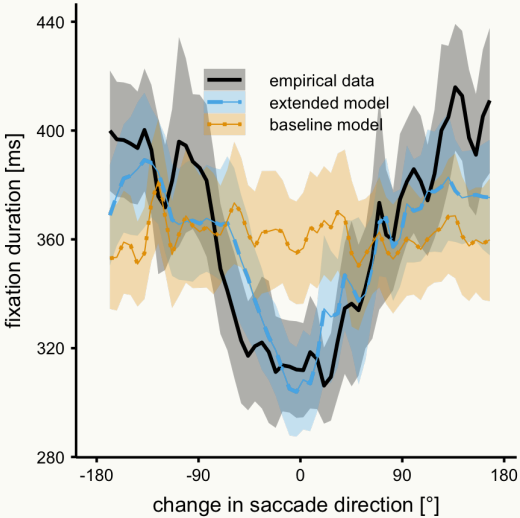
Turning Angle–Amplitude Relation



Turning Angle–Amplitude Relation



Turning Angle and Fixation Duration



- Scan path models frequently assume attention = fixation position
- Research on perisaccadic mechanisms suggests attentional shifts
- Adding these shifts improves the model performance on saccade statistics
- The model converges on these estimates with (despite?) very non-specific likelihood-based fitting procedure

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OSF

osf.io/qsx4w/

PsyArXiv

opsyarxiv.com/zcbny/

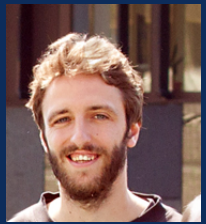
github.com/lschwetlick/SceneWalk_Model

SFB 1294 Data Assimilation

DFG Deutsche Forschungsgemeinschaft

Universität Potsdam

Thank you



Lars Rothkegel

Ralf Engbert

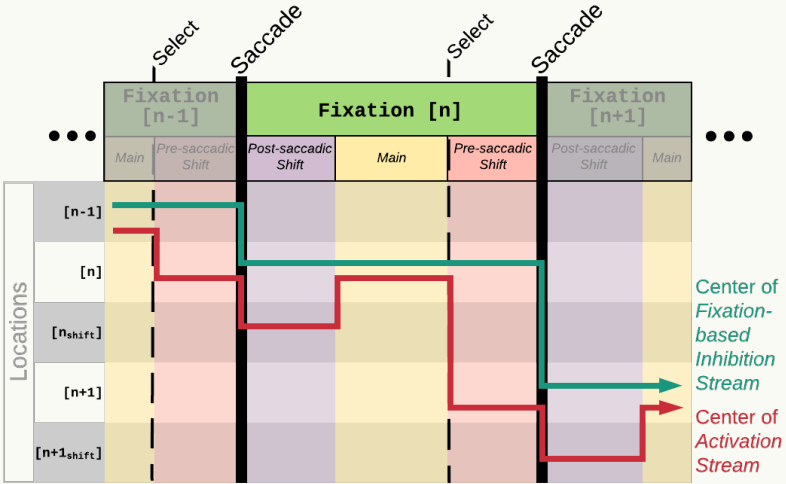
Hans Trukenbrod

Appendix

Experiment

- Subset of Potsdam Sceneviewing Corpus (`https://osf.io/n3byq/`)
- 34 participants, viewed 30 images from each category without a task
- Categories (in that order):
  - 15 left biased
  - 15 right biased
  - 15 bottom biased
  - 15 top biased
  - 15 center biased
  - 15 Patterns
- Model-fitting on the training data set. Model comparisons on the test data.

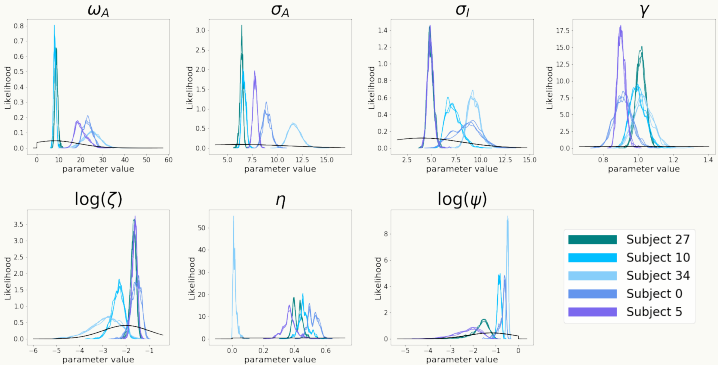
Phases


Select
Saccade
Select
Saccade
Fixation [n-1]
Fixation [n]
Fixation [n+1]
Main
Pre-saccadic Shift
Post-saccadic Shift
Main
Pre-saccadic Shift
Post-saccadic Shift
Main
Locations
[n-1]
[n]
[n_shift]
[n+1]
[n+1_shift]
Center of Fixation-based Inhibition Stream
Center of Activation Stream

Assumptions

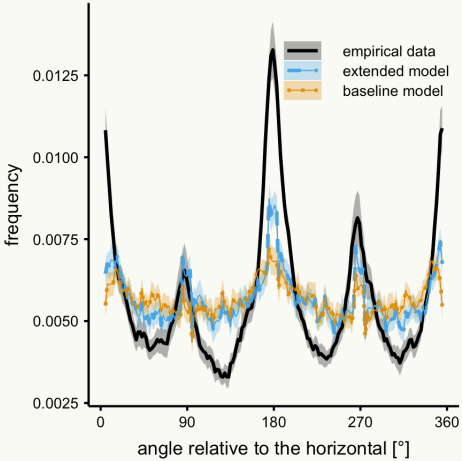
	Image	Foveation	IoR	FoR	Att. Shifts
Static Saliency	✓	x	x	x	x
Dynamic Local Saliency	✓	✓	x	x	x
SceneWalk	✓	✓	✓	x	x
SceneWalk Extension	✓	✓	✓	✓	✓

Marginal Posterior Distributions of Parameters

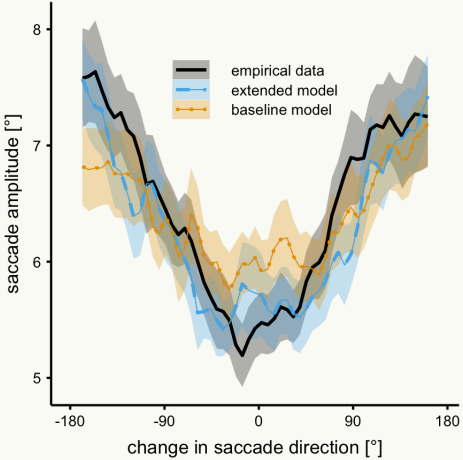


- estimate 6 parameters
- estimation using general likelihood sampling - pyDREAM (**D**iffe**R**ential **E**volution **A**daptive **M**etropolis)
- fit each subject individually
- test and training data sets

Absolute saccade Angle Distribution



RSA and Amplitude



Distance to Center