Radial Bias Pilot 1

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April 28, 2021

Contents

1 Goal of Pilot 1 **1**
1.1 Parameters . . . 2
1.2 Subject Instructions . . . 2
1.3 Experimental Design . . . 2
1.4 Block sequence . . . 3

2 Data **5**
2.1 RE Psychometric Fits (Cumulative normal) . . . 5
2.2 RE Polar Performance Plots (New vs. Old) . . . 6
2.3 Quality Control & Misc. . . . 6

3 Data **7**
3.1 FH Psychometric Fits (Cumulative normal) . . . 7

4 Data **8**
4.1 BB Psychometric Fits (Cumulative normal) . . . 8

5 Current Goals **9**

6 Extending to Plaid Stimuli **10**

7 Supplemental Questions **10**

8 Updates **11**

9 To Do **11**

10 Software to Cite **12**

11 Supplementary Images **12**
11.1 FH . . . 12
11.2 BB . . . 13

1 Goal of Pilot 1

To measure radial direction bias with 1D drifting gratings at 8 polar angle locations at 7 deg eccentricity. A total of 3 motion conditions will be tested, 2 radial (inwards and outwards) and 1 tangential (combined), to measure the performance differences between (1) centrifugal and centripetal motion directions, and (2) radial and tangential motion directions.

1.1 Parameters

Eccentricity from central fixation: 7 degrees
Locations tested (polar angle relative to fixation): 0-315 degrees in 45 degree increments
Stimulus: sine wave gratings w/ 0.4 deg sigma gaussian mask
Stimulus spatial frequency: 1 c/deg
Stimulus drift speed: 8 deg/s
Stimulus contrast: 50% contrast per grating + gaussian mask
Stimulus aperature diameter: 2.5 deg
Black circular aperature was put onto screen to avoid perceptual artifacts from screen edges
Number of subjects: 1-2

1.2 Subject Instructions

For each of the following trials, a fixation dot will appear on the screen. A drifting pattern will appear at some distance from the center. Your task is to determine whether the pattern is drifting clockwise or counterclockwise relative to the reference.
Please remain fixated on the dot throughout the trials.
Press the RIGHT ARROW for clockwise direction.
Press the LEFT ARROW for counterclockwise direction.

1.3 Experimental Design

The pilot uses a 2AFC paradigm, within a block each trial includes a drifting grating presented at 1 of 4 possible positions, while the subject maintains fixation at the central dot. A method of constant stimuli is used which is set based on the performance of the training session (see Methods). The angular values added to the internal reference frame is chosen at random from the following constants [-8, -4, -2, -1, -0.5, 0.5, 1, 2, 4, 8] – logarithmic spacing from 0.5 to 8. The observer must determine whether the direction of motion if clockwise or counterclockwise relative to the internal reference. The sequence of each trial for the 4 motion standards (specific to diagonal locations) at one location is depicted below:

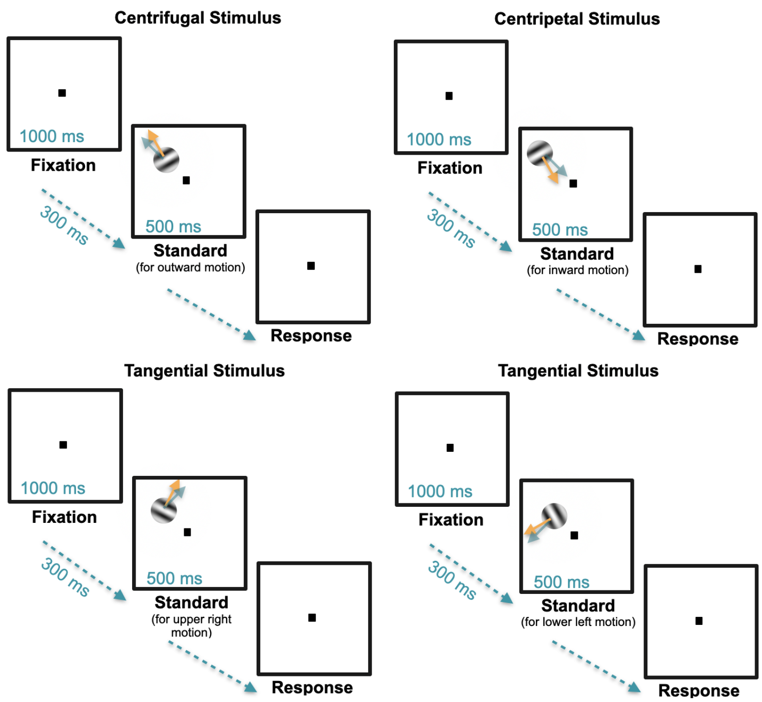
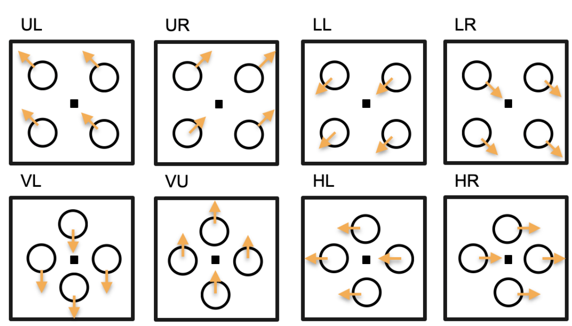


Figure 1: Blue arrow represents the internal reference, the orange arrow represents an example of the direction at which the stimulus is presented (can be clockwise or counterclockwise to the blue arrow.

1.4 Block sequence

Four blocks were run, and each block corresponded to 1 of the 4 conditions being tested (tangential lower left motion, tangential upper right motion, radial upper left motion, radial lower right motion). The internal reference frames for each block is shown below:



Prior to the actual experiment, the ”standard” motion direction corresponding to that specific block will be showed to the observer to use as an internal reference. Then a training session is conducted to determine how much tilt is required to meet 75% accuracy with staircase procedure (MLPest), and to allow subject to practice task with feedback. The estimated angular value to add/subtract to the standard to achieve 75% performance of the clockwise/counterclockwise will be used to determine constants. For this pilot, constants [-8, -4, -2, -1, -0.5, 0.5, 1, 2, 4, 8] were chosen for all 8 blocks. Note positive and negative values for clockwise v. counterclockwise tilt.
Each block contained 4 locations x 5 tilt values x 2 (clock v cc) x 20 repetitions = 800 trials. There

are 8 blocks * 800 trials = 6400 total trials (3200 tang, 1600 radial-in, 1600 radial-out). Each full-block takes 45 min; all 8 blocks took 360 min.
RE sequence of blocks

1. diag-UL [angles: +- 0.5, 1, 2, 4, 8] (45 min)
2. card-HR [angles: +- 0.5, 1, 2, 4, 8] (45 min)
3. diag-LR [angles: +- 0.5, 1, 2, 4, 8] (45 min)
4. card-VL [angles: +- 0.5, 1, 2, 4, 8] (45 min)
5. diag-UR [angles: +- 0.5, 1, 2, 4, 8] (45 min)
6. card-HL [angles: +- 0.5, 1, 2, 4, 8] (45 min)
7. diag-LL [angles: +- 0.5, 1, 2, 4, 8] (45 min)
8. card-VU [angles: +- 0.5, 1, 2, 4, 8] (45 min)

2 Data

2.1 RE Psychometric Fits (Cumulative normal)

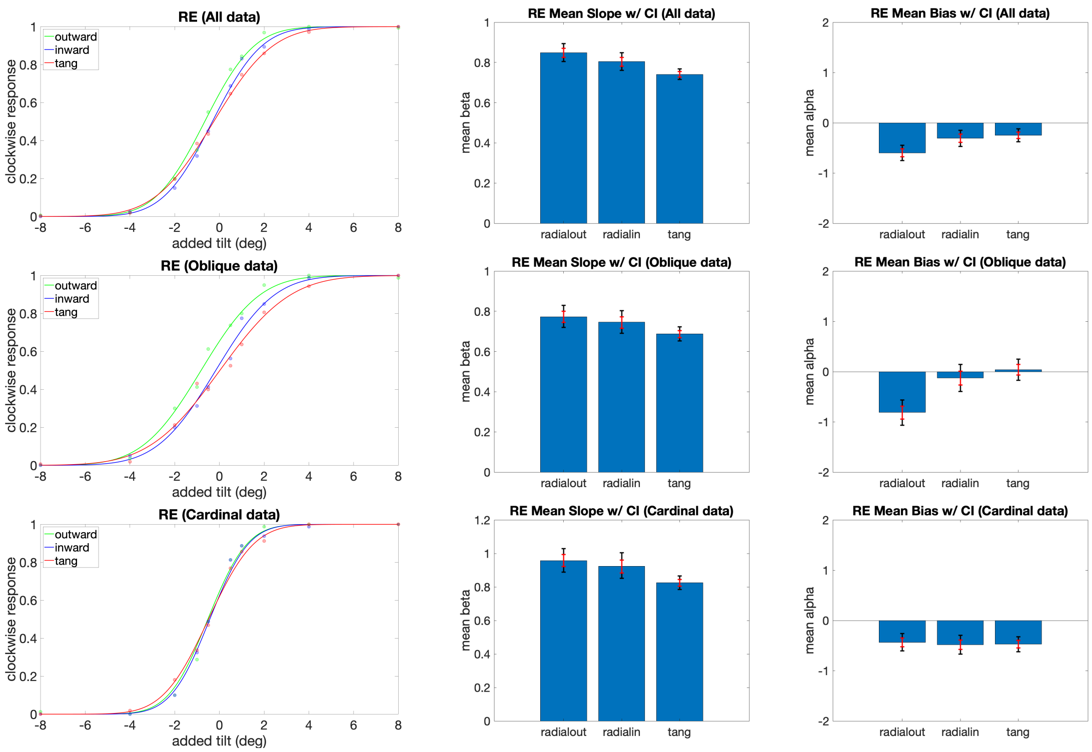


Figure 2: RE new data (speed 8 deg/s) across 8 blocks that each contain 1 reference vector. Top row: All trials (combining cardinal and oblique blocks). Each point = (20 x 8 locations); Second row: subset of data in first row, including only the oblique motion directions (diagonal locations). Each point = (20 x 4 locations); Last row: subset of data in first row, including only the cardinal motion directions (cardinal locations). Each point = (20 x 4 locations). Positive bias = more counterclockwise responses. All means/confidence intervals were computed from samples of posterior distribution using Markov chain Monte Carlo method (from PAL_PFHB_fitModel.m) - 5000 samples, 3 chains.

RE SENSITIVIY/SLOPE
Radial out beta = [cardinal & diagonal directions = 0.58, cardinal = 0.72, diagonal = 0.48]
Radial in beta = [cardinal & diagonal directions = 0.58, cardinal = 0.73, diagonal = 0.48]
Tangential beta = [cardinal & diagonal directions = 0.48, cardinal = 0.63, diagonal = 0.40]
RE BIAS
Radial out alpha = [cardinal & diagonal directions = -0.66, cardinal = -0.52, diagonal = -0.82]
Radial in alpha = [cardinal & diagonal directions = -0.31, cardinal = -0.43, diagonal = -0.16]
Tangential alpha = [cardinal & diagonal directions = -0.25, cardinal = -0.48, diagonal = 0.02]

2.2 RE Polar Performance Plots (New vs. Old)

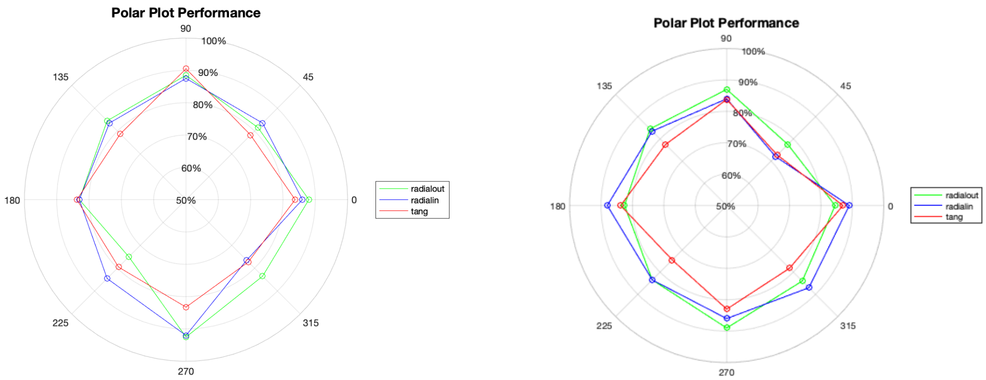


Figure 3: Polar plots by performance (range 50-100%). Each point is 400 trials (collapsed across blocks). LEFT: new data w/eyetracking. RIGHT: old data.

2.3 Quality Control & Misc.

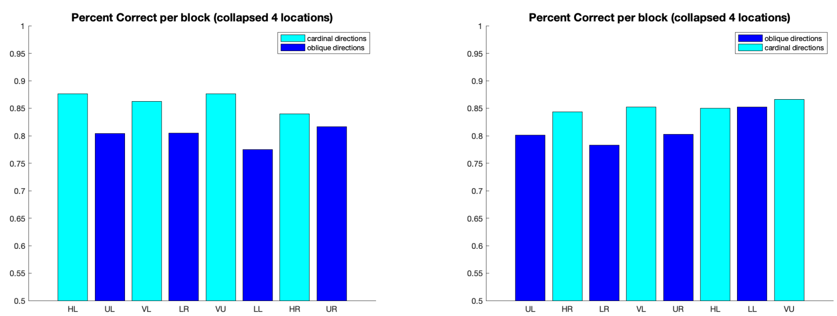


Figure 4: To check that performance does not vary too much between blocks. Cardinal blocks are interweaved with diagonal blocks, and consistently show better performance. LEFT: new data w/eyetracking. RIGHT: old data.

3 Data

3.1 FH Psychometric Fits (Cumulative normal)

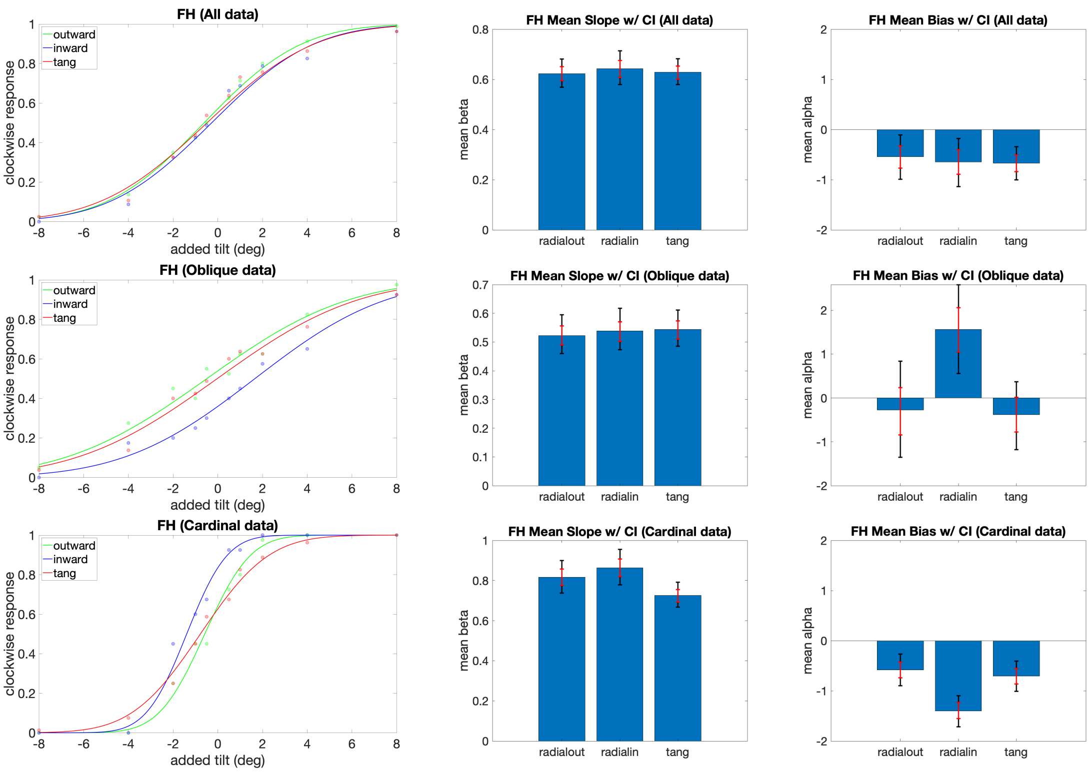


Figure 5: Same arrangement as previous page, but for subject FH (only includes half of full dataset: UR, VL, LL, HR).

FH SENSITIVIY/SLOPE

Radial out beta = [cardinal & diagonal directions = 0.29, cardinal = 0.62, diagonal = 0.20]
Radial in beta = [cardinal & diagonal directions = 0.28, cardinal = 0.70, diagonal = 0.22]
Tangential beta = [cardinal & diagonal directions = 0.27, cardinal = 0.41, diagonal = 0.20]

FH BIAS

Radial out alpha = [cardinal & diagonal directions = -0.61, cardinal = -0.59, diagonal = -0.49]
Radial in alpha = [cardinal & diagonal directions = -0.27, cardinal = -1.39, diagonal = 1.66]
Tangential alpha = [cardinal & diagonal directions = -0.48, cardinal = -0.78, diagonal = -0.03]

4 Data

4.1 BB Psychometric Fits (Cumulative normal)

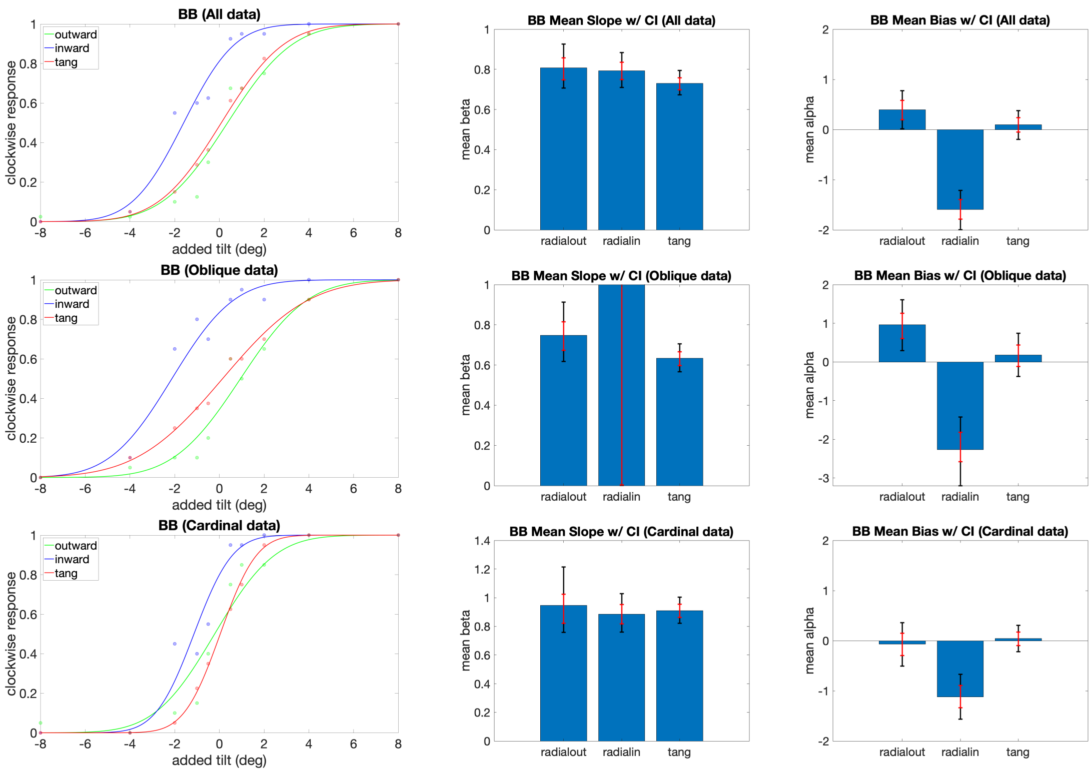
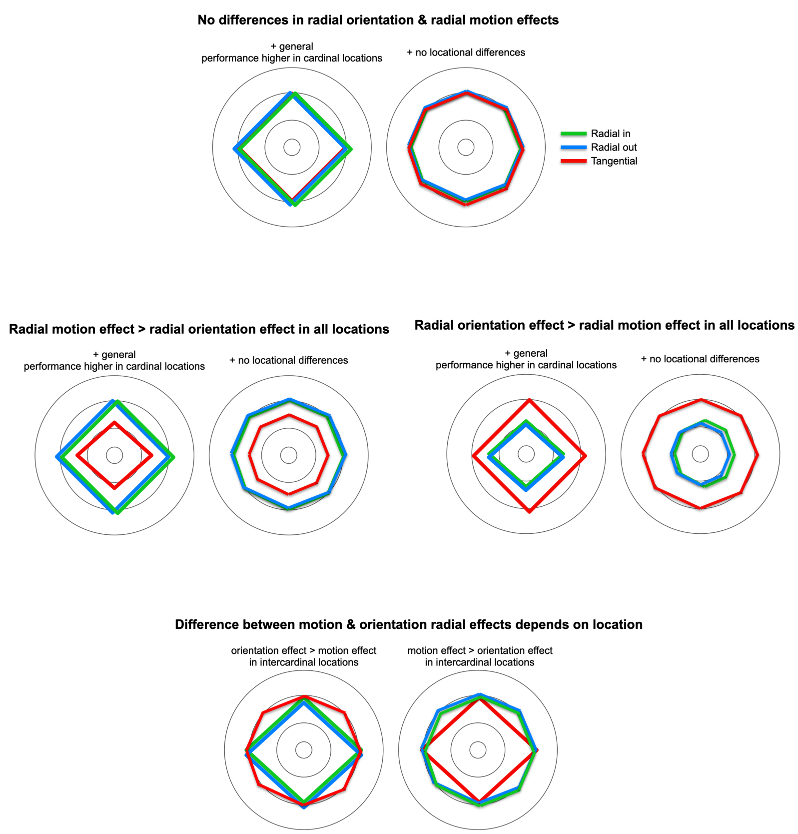


Figure 6: Same arrangement as previous page, but for subject BB (only includes partial dataset: VU, LR). Not error range is too large (uninterpretable)

BB SENSITIVIY/SLOPE
Radial out beta = [cardinal & diagonal directions = 0.44, cardinal = 0.47, diagonal = 0.43]
Radial in beta = [cardinal & diagonal directions = 0.55, cardinal = 0.74, diagonal = 0.46]
Tangential beta = [cardinal & diagonal directions = 0.45, cardinal = 0.78, diagonal = 0.33]
FH BIAS
Radial out alpha = [cardinal & diagonal directions = 0.37, cardinal = -0.21, diagonal = 0.95]
Radial in alpha = [cardinal & diagonal directions = -1.60, cardinal = -1.14, diagonal = -2.1]
Tangential alpha = [cardinal & diagonal directions = 0.09, cardinal = 0.04, diagonal = 0.14]

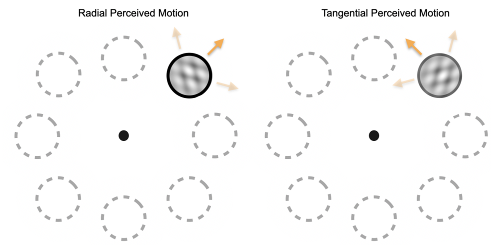
5 Current Goals

1. Several papers demontrate that sensitivity to radial orientations is greater than tangential orientations; similarly, radial direction bias is reported for moving dot stimuli. But orientation and motion direction is always orthogonal with 1D drifting gratings. Is sensitivity greater for radial motion or radial orientations w/ 1D drifting gratings? If the radial sensitivity is greater in respect to motion direction, then the radial orientation effect is weaker than the radial motion effects (or visa versa).
   - Interesting because the reported effects seem at odds, physiologically. Component neurons generally respond to motion that is orthogonal to their preferred orientation.
   - So far, data points to radial bias in respect to motion domain (conflict w/ Hong).
2. Is sensitivity generally greater in cardinal locations compared to non-cardinal locations?
   - Note: if sensitivity is higher in cardinal locations, this could be due to the location or due to the feature of the stimulus (cardinality in orientation/motion).
3. Is the difference in radial and tangential sensitivity more pronounced in non-cardinal locations compared to cardinal locations?
   - Note: Cardinal bias might enhance sensitivity disproportionately for orientation, which minimizes radial bias differences on the cardinal axes.



6 Extending to Plaid Stimuli

1. How does this extend to plaid stimuli? Does the bias apply to the component motion direction or the perceived motion direction?



120 deg angle between component gratings
Comparing these 2 conditions controls for radial orientation bias and extends findings to 2D motion

7 Supplemental Questions

1. Is there an HVA or VMA present for any/all of the conditions? (SF in design matters in this case)
2. Is there a difference in sensitivity to radial-inward vs. radial-outwards motion?
   - So far, there doesn't seem to be a difference at 7 deg eccentricity.
3. Maybe abandon question about how these biases change w/ eccentricity.

8 Updates

- Design Related
  - Aborts trials that have breaks in fixation during stimulus presentation (stimulus_start - 300 ms TO stimulus_end)
  - Changed contrast to 50% – this should not affect difficulty in motion perception
- Analysis Related
  - n/a
- Other improvements
  - n/a
- For discussion
  - Eye tracker in RM 956
    - * Afp server not compatible with PC? – where to backup data?
    - * CRT monitor calibration.
  - No longer traveling to AD (July 18 - Late Aug)
  - VSS expenses

9 To Do

- Feedback
  - Fix beep volume (lower pitch sounds lower in volume)
  - Fix aperture to ensure no sides show for different heights
  - Ensure speed is the same across locations (Billy & Jon both mention some seem faster)
  - Can I change response time to happen sooner?
  - Type up instructions for experiment
- Other
  - Re-plot polar angle plot with arrows pointing in direction (length indicating performance); change to dprime
  - Collect data with current params for 1-2 subjects w/ eyetracker
  - If we want to capture polar angle differences, might need to increase SF? (confirmed in other exp around 6 cpd, 6 deg ecc)
  - Titration for cardinal v. oblique? Or keep the constant stimuli? Dynamic staircase methods?
  - Report sensitivity (d prime) instead of performance
  - Maybe report reliability?

$$1/sigma^2 \tag{1}$$

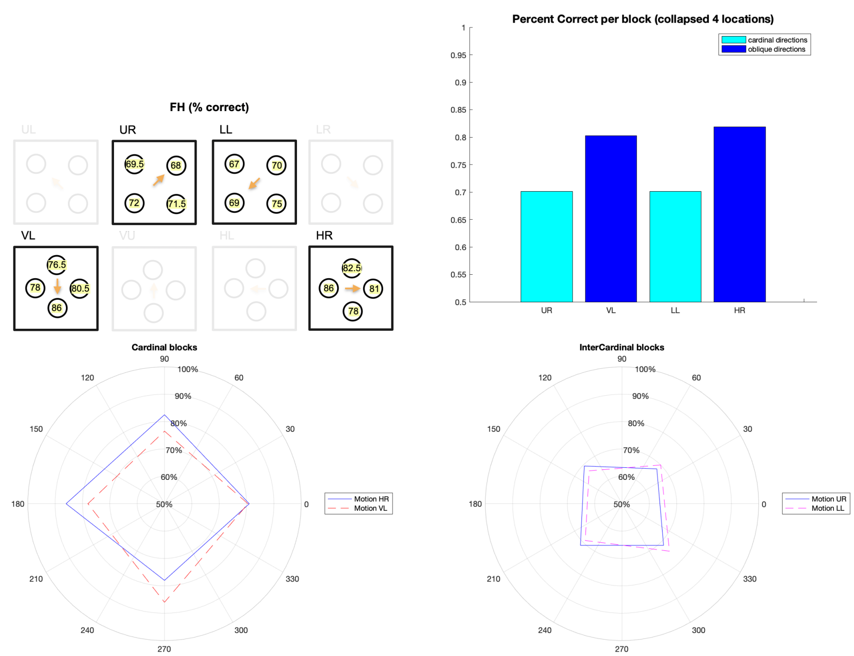
  - Double check sigma of gaussian for reporting purposes (and at what eccentricity contrast drops below 1 perc)

10 Software to Cite

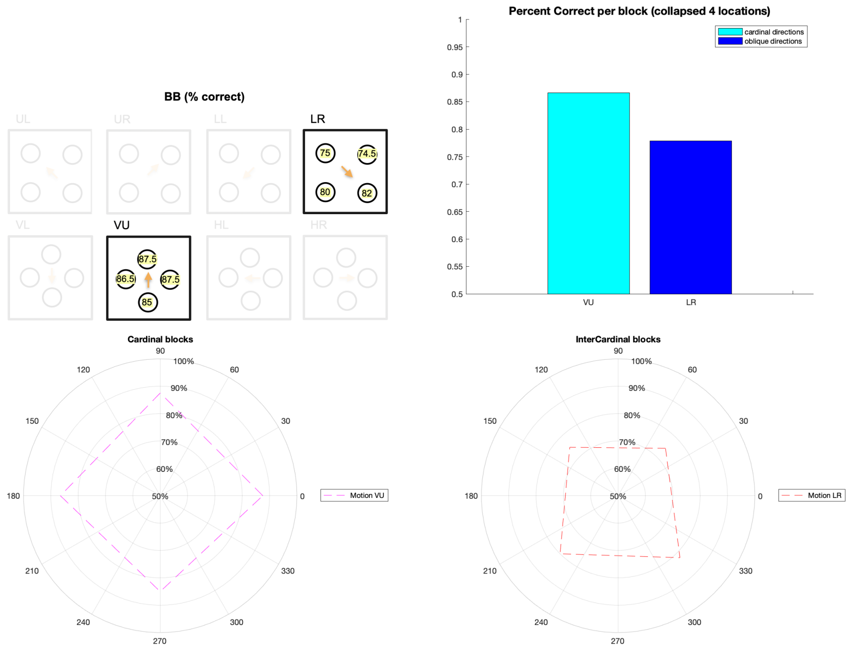
- PsychToolbox Extensions (Brainard, 1997; Pelli, 1997; Kleiner et al, 2007)
- Prins, N & Kingdom, F. A. A. (2018) Applying the Model-Comparison Approach to Test Specific Research Hypotheses in Psychophysical Research Using the Palamedes Toolbox. Frontiers in Psychology, 9:1250. doi: 10.3389/fpsyg.2018.01250
- Plummer, M. (2003, March). JAGS: A program for analysis of Bayesian graphical models using Gibbs sampling. In Proceedings of the 3rd international workshop on distributed statistical computing (Vol. 124, No. 125.10, pp. 1-10). (http://mcmc-jags.sourceforge.net/)

11 Supplementary Images

11.1 FH



11.2 BB


BB (% correct)
UL
UR
LL
LR
75
74.5
80
82
VL
VU
HL
HR
87.5
86.5
87.5
85
Percent Correct per block (collapsed 4 locations)
cardinal directions
oblique directions
VU
LR
Cardinal blocks
Motion VU
InterCardinal blocks
Motion LR