Radial Bias Pilot 1

Rania Ezzo

Mar 31, 2021

Contents

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: full contrast + 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 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:

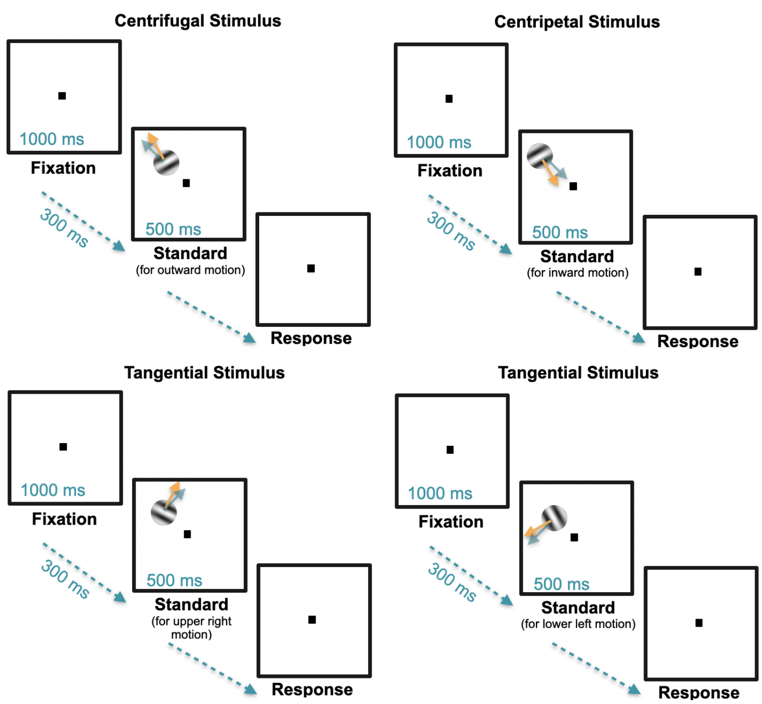
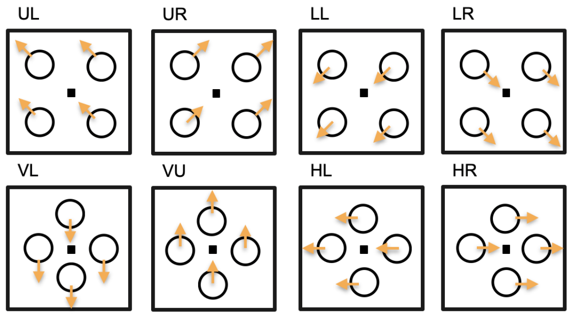


Figure 1: Blue arrow represents the internal reference, the orange arrow represents an example of the direction at which the stimulus is presented (can be clockwise or counterclockwise to the blue arrow.

1.3 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 35 min; all 8 blocks took 280 min.
RE sequence of blocks

1. diag-UL [angles: +- 0.5, 1, 2, 4, 8] (35 min)
2. card-HR [angles: +- 0.5, 1, 2, 4, 8] (35 min)
3. diag-LR [angles: +- 0.5, 1, 2, 4, 8] (35 min)
4. card-VL [angles: +- 0.5, 1, 2, 4, 8] (35 min)
5. diag-UR [angles: +- 0.5, 1, 2, 4, 8] (35 min)
6. card-HL [angles: +- 0.5, 1, 2, 4, 8] (35 min)
7. diag-LL [angles: +- 0.5, 1, 2, 4, 8] (35 min)
8. card-VU [angles: +- 0.5, 1, 2, 4, 8] (35 min)

2 Data

2.1 Psychometric Function (Cumulative normal)

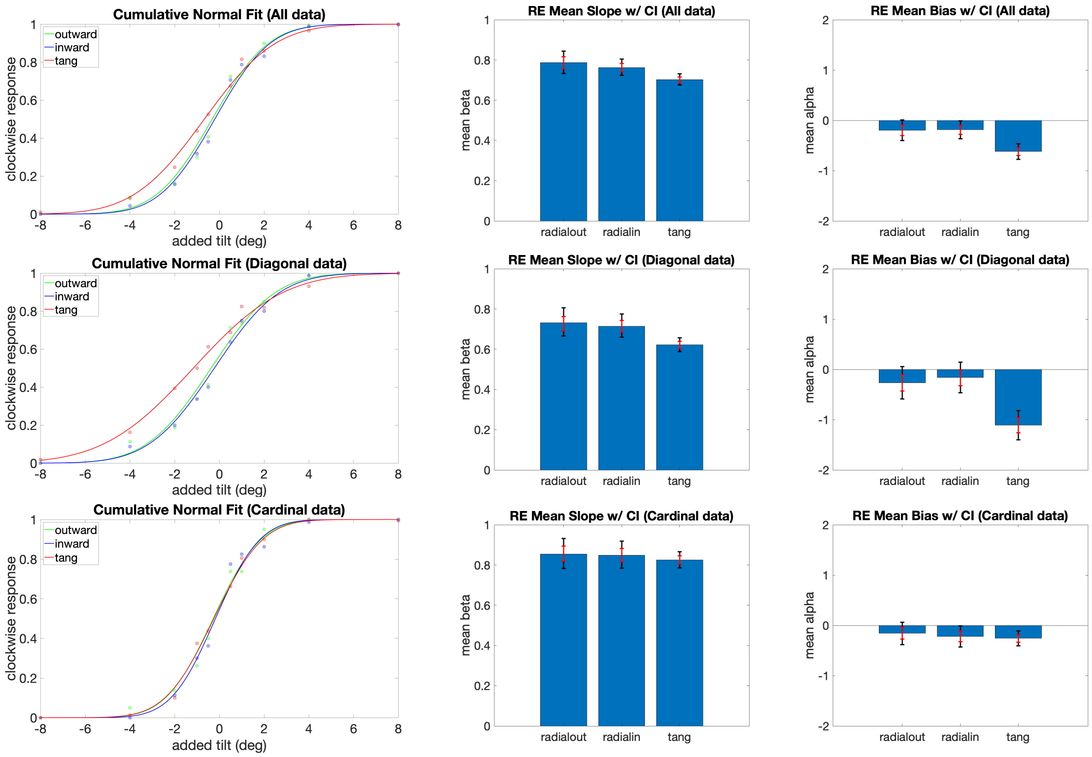


Figure 2: RE new data (speed 8 cyc/deg) across 8 blocks that each contain 1 reference vector. Top row: All trials (combining cardinal and oblique blocks). Each point = (20 x 8 locations); Second row: subset of data in first row, including only the oblique motion directions (diagonal locations). Each 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 = 0.51, cardinal = 0.6, diagonal = 0.44]
Radial in beta = [cardinal & diagonal directions = 0.52, cardinal = 0.64, diagonal = 0.44]
Tangential beta = [cardinal & diagonal directions = 0.4, cardinal = 0.58, diagonal = 0.32]
RE BIAS
Radial out alpha = [cardinal & diagonal directions = -0.32, cardinal = -0.28, diagonal = -0.37]
Radial in alpha = [cardinal & diagonal directions = -0.21, cardinal = -0.18, diagonal = -0.22]
Tangential alpha = [cardinal & diagonal directions = 0.67, cardinal = -0.25, diagonal = -1.17]

2.2 Polar Angle Plot

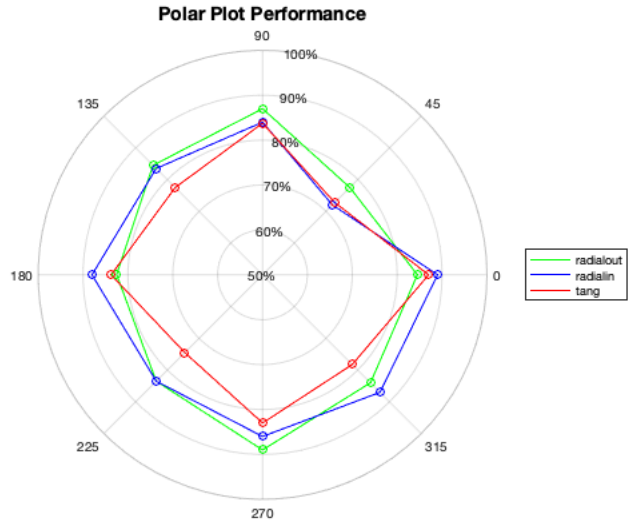


Figure 3: Polar plots by performance (range 50-100%). Each point is 400 trials (collapsed across blocks).

2.3 Quality Control & Misc.

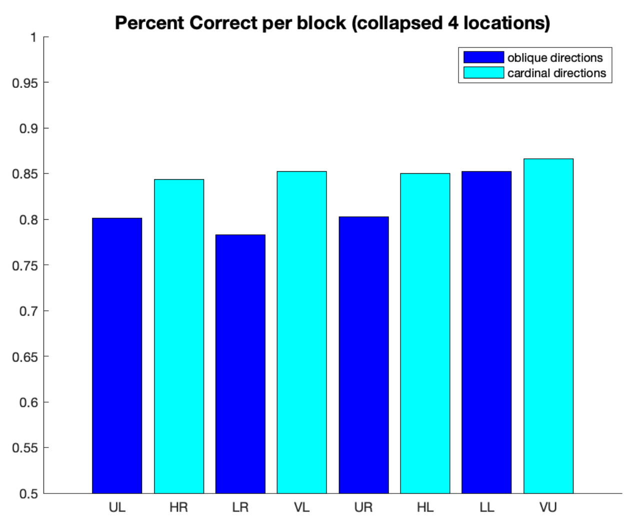


Figure 4: To check that performance does not vary too much between blocks. Cardinal blocks are interweaved with diagonal blocks, and consistently show better performance.

3 Spatial Frequency Data

3.1 Psychometric Function (Cumulative normal)

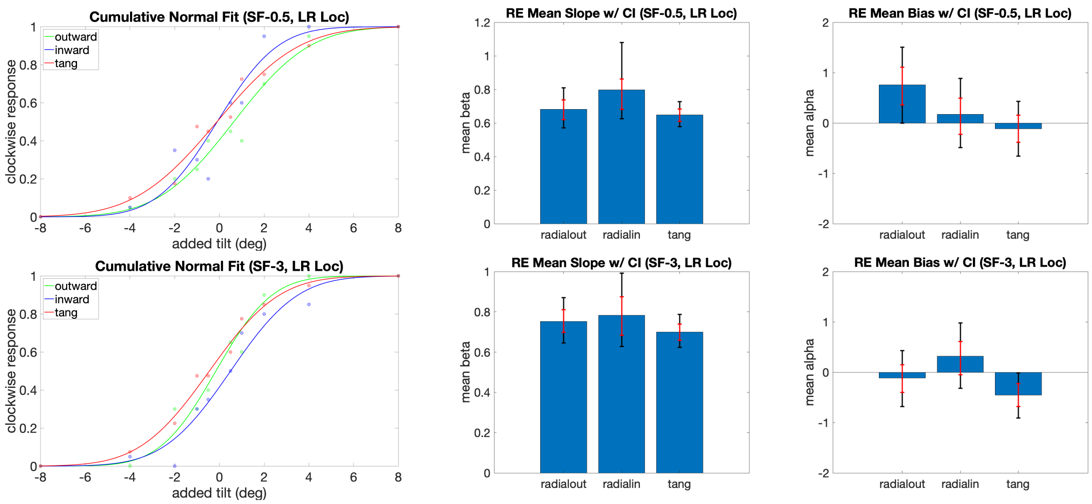


Figure 5: RE new data testing low (SF=0.5) and high (SF=3) spatial frequencies. Only 1 location tested (lower right), which included 200 trials for radialin, 200 for radialout, and 400 tangential.

RE PERFORMANCE
Radial out beta = [Low SF = 0.76, High SF = 0.82]
Radial in beta = [Low SF = 0.825, High SF = 0.82]
Tangential beta = [Low SF = 0.77, High SF = 0.79]
RE SENSITIVIY/SLOPE
Radial out beta = [Low SF = 0.38, High SF = 0.5]
Radial in beta = [Low SF = 0.47, High SF = 0.42]
Tangential beta = [Low SF = 0.35, High SF = 0.41]
RE BIAS
Radial out alpha = [Low SF = 0.65, High SF = -0.16]
Radial in alpha = [Low SF = -0.10, High SF = 0.50]
Tangential alpha = [Low SF = -0.12, High SF = -0.45]

4 Current Goals

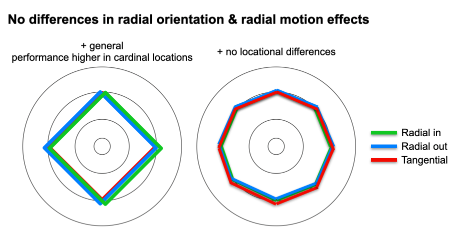
1. Literature reports that sensitivity to radial orientations is greater than tangential orientations; same with radial motion based on random drifting dot stimuli. Orientation and motion direction, with 1D gratings is always orthogonal. Is sensitivity greater for radial motion or radial orientations 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.

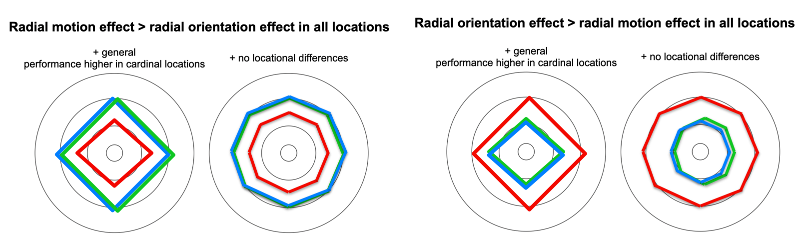
   - Interesting because there is evidence for both in literature, but effects are at odds.
   - So far, data points to radial bias in respect to motion domain (conflict w/ Hong).

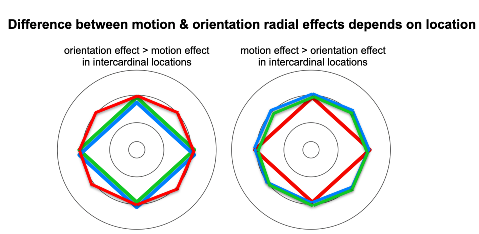
2. Is the difference in radial and tangential sensitivity more pronounced in non-cardinal locations compared to cardinal locations.

3. Is sensitivity greater in cardinal locations compared to non-cardinal locations?

   - Cardinal bias might enhance sensitvity disproportionately for orientation, which minimizes radial bias differences on the cardinal axes.

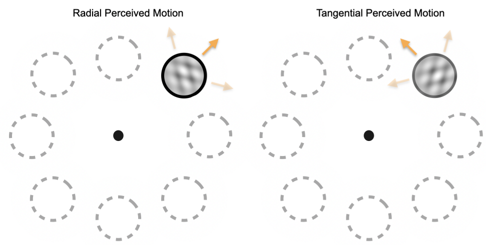






5 Extending to Plaid Stimuli

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

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.

6 Supplemental Questions

1. Is there an HVA or VMA present for any/all of the conditions? (SF in design matters in this case)
2. Maybe abandon question about how these biases change w/ eccentricity.

7 Updates

- Design Related
  - Now running trials using 4 polar angles per block (block 1 = diagonal (e.g. upper left), block 2 = cardinal (upper vertical), block 3 = diagonal (upper left), etc.)
    * Note: For cardinal locations, it feels difficult to not perform task based on orientation
- Analysis Related
  - Running 2 spatial frequencies at one location (to test differences)
  - I feel it's harder to not use orientation to complete task with higher SFs.
- Other improvements
  - n/a
- For discussion
  - **Eye tracker in RM 956**
    * No server connection in that room. Where to store data?
    * Need to calibrate CRT monitor.
  - **Subject payments, grant**
  - **Traveling to AD (July?)**
  - **VSS expenses**

8 To Do

- Feedback from Feb 17, 2021
  - Schematic for plaids; keep top row only but change to 120 deg difference
  - Change all stimuli to 50 % (remove intermediate)
  - Jon: Re-plot polar angle plot with arrows pointing in direction (length indicating performance)
  - Difficulty level is good as is, and block design is ok
  - 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?
- Other
  - Use next meeting to go overall plan conceptually (gratings, plaids etc.)
  - 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)

9 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/)