Radial Bias Pilot 1

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Jan 20, 2021

Contents

1 Goal of Pilot 1

To measure radial direction bias with 1D drifting gratings at 2-4 polar angle locations at a given eccentricity. A total of 4 directions of motion will be tested, 2 radial (inwards and outwards) and 2 tangential (clockwise, counterclockwise), 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): Upper left (45 deg) and lower right (225 deg)
Stimulus: sine wave gratings w/ 0.4 deg sigma gaussian mask
Stimulus spatial frequency: 1 c/deg
Stimulus drift speed: 4 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

1.2 Experimental Design

The pilot uses a 2AFC paradigm, where each trial includes a drifting grating presented at 1 of 2 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 [-1.5, -1.25, -1, -0.75, -0.5, 0.5, 0.75, 1, 1.25, 1.5]. 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 at one location is depicted below:

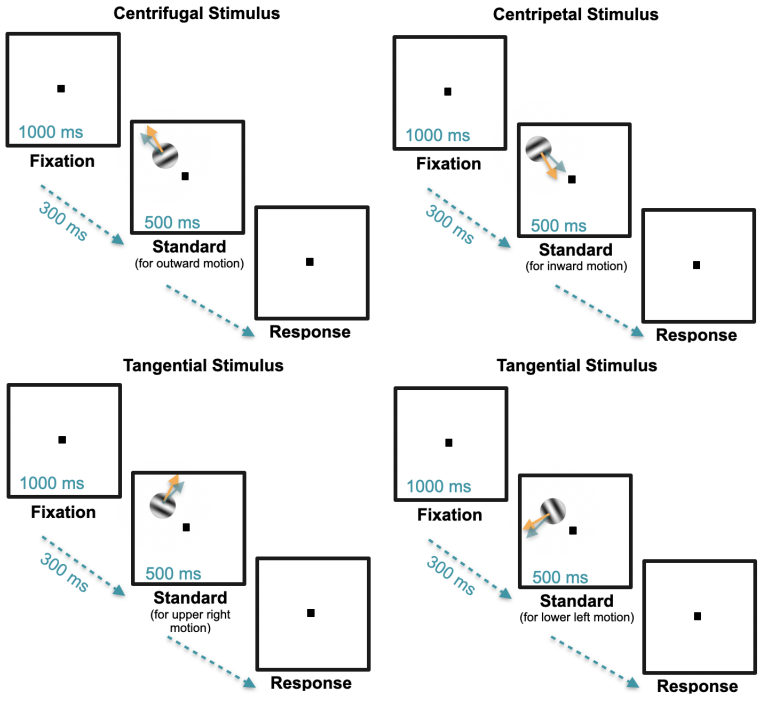
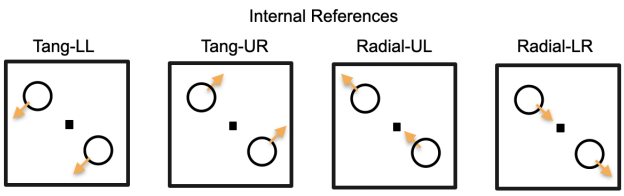


Figure 1: Blue arrow represents the internal reference, the orange arrow represents an example of the direction at which the stimulus is presented (can be clockwise or counterclockwise to the blue arrow.

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 experiment, the "standard" motion direction corresponding to that specific block is 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. This was tested using radial motion only, and 1.5 degrees was the estimated angular value to add/subtract to the standard to achieve 75% performance of the clockwise/counterclockwise discrimination task. Constants [-1.5, -1.25, -1, -0.75, -0.5, 0.5, 0.75, 1, 1.25, 1.5] were chosen to roughly center around this value for all 4 conditions. Note positive and negative values for clockwise v. counterclockwise tilt.
Each condition (radial-in, radial-out, tang) contained 2 locations x 9 tilt values x 2 (clock v cc) x 20 repetitions = 720 trials. Each full-block takes 35 min; all 3 full-blocks took 105 min.
Sequence of partial-blocks tested (re-test was in reverse order):

1. radial-UL [angles: +- 0.5, 0.75, 1, 1.25, 1.5] (20 min, 40 trials) - BLOCK1a
2. radial-LR [angles: +- 0.5, 0.75, 1, 1.25, 1.5] (20 min, 40 trials) - BLOCK2a
3. tang-UR [angles: +- 0.5, 0.75, 1, 1.25, 1.5] (10 min, 20 trials) - BLOCK3a
4. tang-LL [angles: +- 0.5, 0.75, 1, 1.25, 1.5] (10 min, 20 trials) - BLOCK3b
5. tang-LL [angles: +- 2, 2.5, 3, 4] (8 min, 20 trials) - BLOCK3c
6. tang-UR [angles: +- 2, 2.5, 3, 4] (8 min, 20 trials) - BLOCK3d
7. radial-LR [angles: +- 2, 2.5, 3, 4] (15 min, 40 trials) - BLOCK2b
8. radial-UL [angles: +- 2, 2.5, 3, 4] (15 min, 40 trials) - BLOCK1b

2 Data

2.1 Psychometric Function (Cumulative normal)

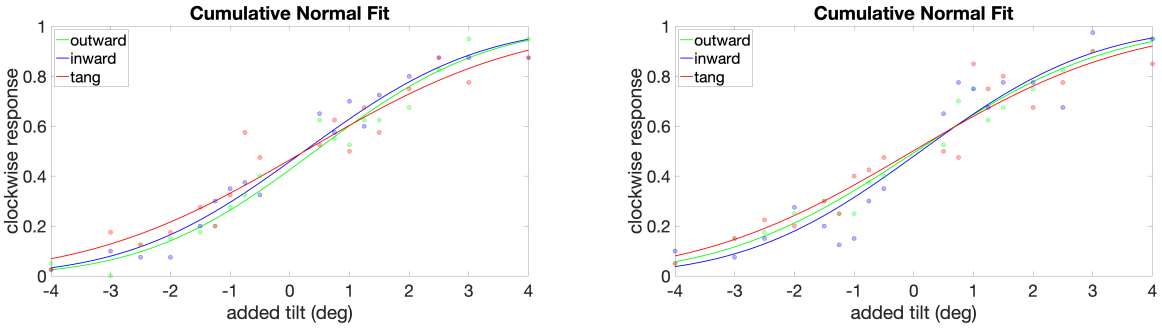


Figure 2: To the left: test data with blocks that contain same reference vector; combines data across locations (40 trials per angle). To the right: re-test with same number of trials.

SENSITIVIY/SLOPE
Radial out beta = [test 0.4441], [re-test 0.3914]
Radial in beta = [test 0.4339], [re-test 0.4324]
Tangential beta = [test 0.3488], [re-test 0.3521]
BIAS
Radial out alpha = [test 0.4225]; [re-test 0.0425]
Radial in alpha = [test 0.242]; [re-test 0.1172]
Tangential alpha = [test 0.2512]; [re-test -0.014]

2.2 Current number of trials

N_Trials is the total number of trials for a particular condition. Ans_clock is the percentage of the observer answering clockwise out of the N_Trials for that condition.

Radial outwards

	-4	-3	-2.5	-2	-1.5	-1.25	-1	-.75	-.5	.5	.75	1	1.25	1.5	2	2.5	3	4
N_Trials:	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Ans_clock:	.05	0	.13	.15	.18	.2	.28	.33	.4	.63	.55	.53	.63	.63	.68	.83	.95	.95
N_Trials:	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Ans_clock:	.05	.15	.18	.25	.3	.25	.25	.38	.4	.53	.7	.75	.63	.68	.75	.83	.9	.95

Radial inwards

	-4	-3	-2.5	-2	-1.5	-1.25	-1	-.75	-.5	.5	.75	1	1.25	1.5	2	2.5	3	4
N_Trials:	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Ans_clock:	.03	.1	.08	.08	.2	.3	.35	.38	.33	.65	.58	.7	.6	.73	.8	.88	.88	.88
N_Trials:	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Ans_clock:	.1	.08	.15	.28	.2	.13	.35	.15	.3	.35	.65	.78	.75	.68	.78	.78	.68	.98

Tangential (combined)

	-4	-3	-2.5	-2	-1.5	-1.25	-1	-.75	-.5	.5	.75	1	1.25	1.5	2	2.5	3	4
N_Trials:	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Ans_clock:	.03	.18	.13	.18	.28	.2	.33	.58	.48	.53	.63	.5	.68	.58	.75	.88	.78	.88
N_Trials:	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Ans_clock:	.05	.15	.23	.2	.3	.25	.4	.43	.48	.5	.48	.85	.75	.8	.68	.78	.9	.85

3 Updates

- Design Related
  - Changed blocks to include vectors of the same direction so the subject does not have to change internal reference frame within block
  - Ran an equal number of trials (sample without replacement).
  - Left out condition with 0 degrees added tilt (not needed).
  - Included feedback for all trials to reinforce knowledge of internal stimulus.
  - Changed stimulus presentation 0.5 sec and fixation period to 1 sec.
  - Tested with new set of constant stimuli -4, -3, -2.5, -2, -1.5, -1.25, -1, -0.75, -0.5, 0.5, 0.75, 1, 1.25, 1.5, 2, 2.5, 3, 4.
- Analysis Related
  - Calculated bias (alpha), and slope for the PFs
  - Ran experiment 2x (once for each block) to a test-retest validation, and plot.
- Other improvements

  - Generalized screen configurations
  - Made trial execution more temporally efficient
  - Added default mode (practice, radial outwards)
  - Made user input non-case sensitive
  - Saves movie/snapshot per trial as png

4 To Do

- Feedback from Feb 3, 2021
  - Prioritize collecting data from a second subject
  - Use some kind of formula to determine spacing of interval (log or use polynomial, etc.) possibly 0.5 to 8?
  - Split first half of radial in and out to rule out any perceptual learning (since num radial trials is greater than for tang)
  - Look into any dynamic staircase methods
  - Ensure that blocks evenly distribute difficulty levels
  - Think more about testing differences statistically (e.g. see if a common slop fits better than 3 different models), maybe use AIC
  - Potentially need to control for the fact that radial condition block requires 2 internal vectors, whereas tangential block requires 2
    * Tangential block performance might be exacerbated by the fact that fixation point does not guide formation of internal reference vector as well
  - Think about how to parse out effects from orientation and motion direction
    * Use dots to confirm effect [problem: will still be hard to differentiate strategies in radial blocks v. tangential blocks]
    * Would lowering contrast or jitter or noise help?
    * Could present reference vector on the screen [maybe task would then be more similar to a vernier alignment]
    * Could we just ask subject to determine orientation [this might just flip the problem so that subject can use motion direction for one block]
    * Any chance we could argue that judging motion direction necessarily entails processing orientation anyway?
    * Keep in mind interesting finding by Yuna on working memory: drifting grating creates a "compression vector of orientation not direction of motion" – [but instructions to subject in this task was to focus on orientation]
- Other
  - Add 95perc confidence intervals to PFs
  - Double check sigma of gaussian (and at what eccentricity contrast drops below 1 perc)
  - Fix crashing error
  - Make beep lower freq
  - Double check speed

5 Extra Figures

5.1 Psychometric Function (Cumulative normal)

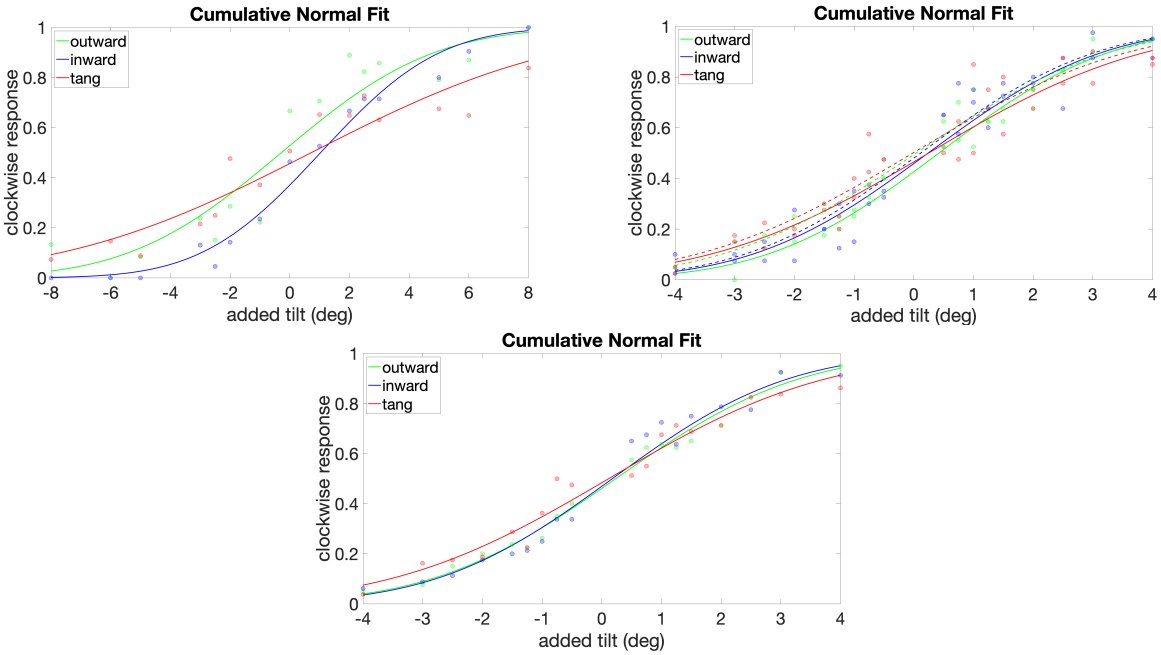


Figure 3: Top left: previous data collected with blocks separated by radial-in, radial-out, tang-c, tang-cc. Top right: new data with blocks that contain same reference vector (e.g. blocks mixing radial-in/radial-out). This combines data across locations (40 trials per angle), and shows test (solid), re-test (dotted). Bottom: new data with test and re-test combined (80 trials per angle).