Orienting to Probable Stimuli Affects Early Perception: Modulating the 'C1' Visual Evoked Potential in an Orientation Estimation Task
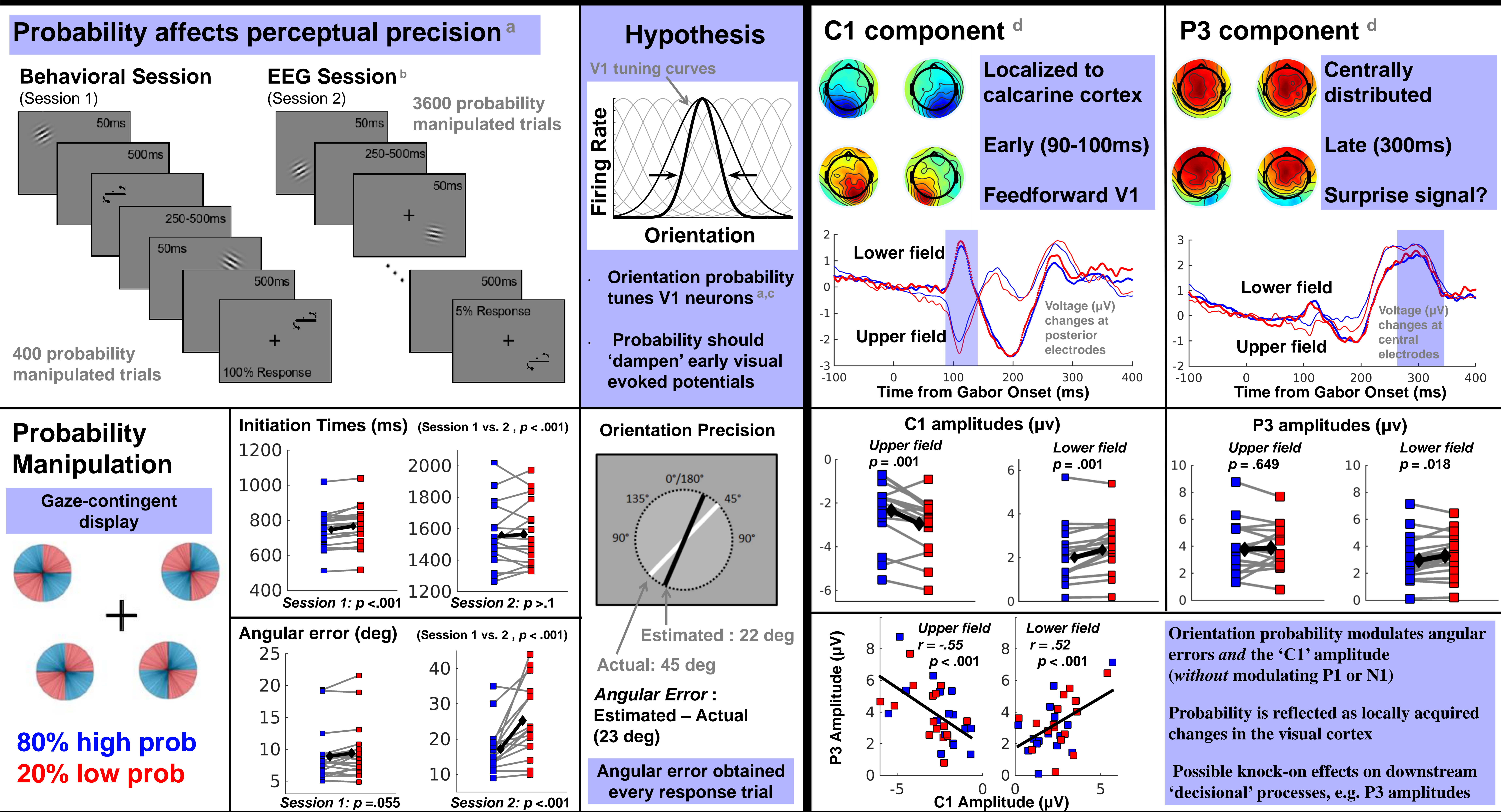
Syaheed B. Jabar[1], Alex Filipowicz[1] & Britt Anderson[1,2]

[1]Department of Psychology, University of Waterloo, [2]Centre for Theoretical Neuroscience, University of Waterloo

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Probability affects perceptual precision [a]

Behavioral Session (Session 1)

50ms
500ms
250-500ms
50ms
500ms
100% Response

400 probability manipulated trials

EEG Session [b] (Session 2)

50ms
250-500ms
50ms
500ms
5% Response

3600 probability manipulated trials

Probability Manipulation

Gaze-contingent display

+

80% high prob
20% low prob

Initiation Times (ms) (Session 1 vs. 2 , p < .001)

1200
1000
800
600
400
Session 1: p < .001

2000
1800
1600
1400
1200
Session 2: p > .1

Angular error (deg) (Session 1 vs. 2 , p < .001)

25
20
15
10
5
Session 1: p = .055

40
30
20
10
Session 2: p < .001

Hypothesis

V1 tuning curves

Firing Rate vs Orientation

- Orientation probability tunes V1 neurons [a,c]
- Probability should 'dampen' early visual evoked potentials

Orientation Precision

0°/180°
135° / 45°
90° / 90°

Estimated : 22 deg
Actual: 45 deg

Angular Error : **Estimated – Actual (23 deg)**

Angular error obtained every response trial

C1 component [d]

Localized to calcarine cortex

Early (90-100ms)

Feedforward V1

Lower field / Upper field

2
1
0
-1
-2
-3
-100   0   100   200   300   400
Time from Gabor Onset (ms)

Voltage (μV) changes at posterior electrodes

C1 amplitudes (μV)

Upper field *p = .001*
0
-2
-4
-6

Lower field *p = .001*
6
4
2
0

P3 Amplitude (μV) vs C1 Amplitude (μV)

Upper field *r = -.55 p < .001*
8
6
4
2
-5   0

Lower field *r = .52 p < .001*
8
6
4
2
0   5

P3 component [d]

Centrally distributed

Late (300ms)

Surprise signal?

Lower field / Upper field

3
2
1
0
-1
-2
-100   0   100   200   300   400
Time from Gabor Onset (ms)

Voltage (μV) changes at central electrodes

P3 amplitudes (μV)

Upper field *p = .649*
10
8
6
4
2
0

Lower field *p = .018*
10
8
6
4
2
0

Orientation probability modulates angular errors *and* the 'C1' amplitude (*without* modulating P1 or N1)

Probability is reflected as locally acquired changes in the visual cortex

Possible knock-on effects on downstream 'decisional' processes, e.g. P3 amplitudes

[a1] Anderson (2014: *JOV*); [a2] Jabar & Anderson (2015: *JEP HPP*)
[b] Locations and timings based on Di Russo et al. (2002: *HBM*)
[c] Found with orientation training in monkeys (Ringach, et al., 1997: *Nature*)
[d] Scalp activation as a function of stimulus location. Red = Positive, Blue = negative
[e] Linked-mastoid referenced Low-pass filter @ 80Hz

syaheed.jabar@uwaterloo.ca