FMRI STUDY OF PERCEPTUAL GROUPING OF A BISTABLE TARGET

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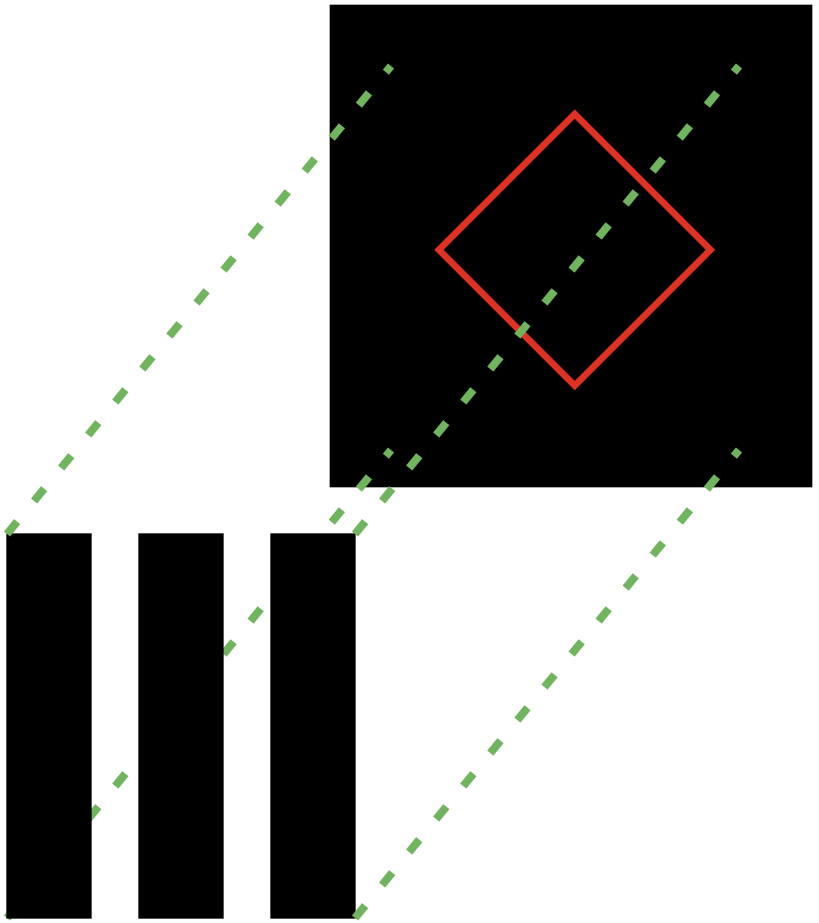
http://vision.psych.umn.edu

Program #:4319

1. The stimulus

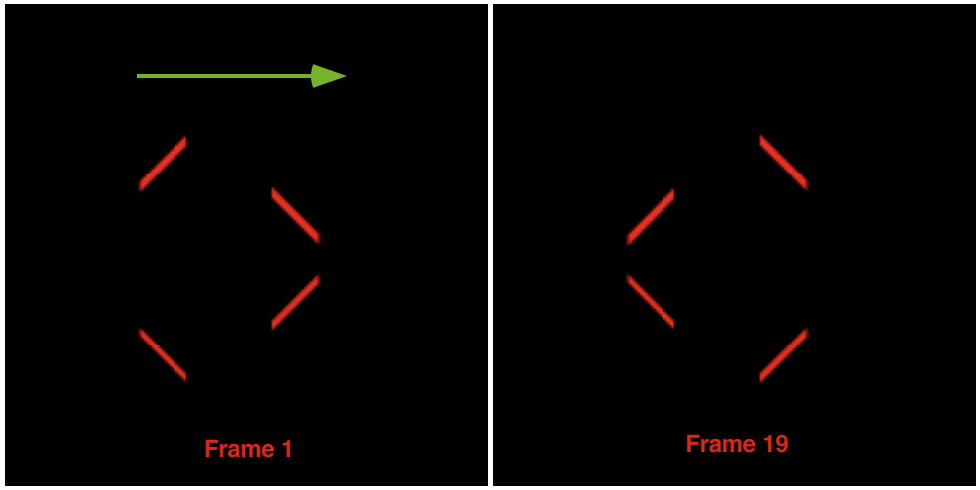


A red diamond was covered by three black bars which hid the four vertices.

We used two stimulus conditions, each with corresponding bistable percepts.

2.

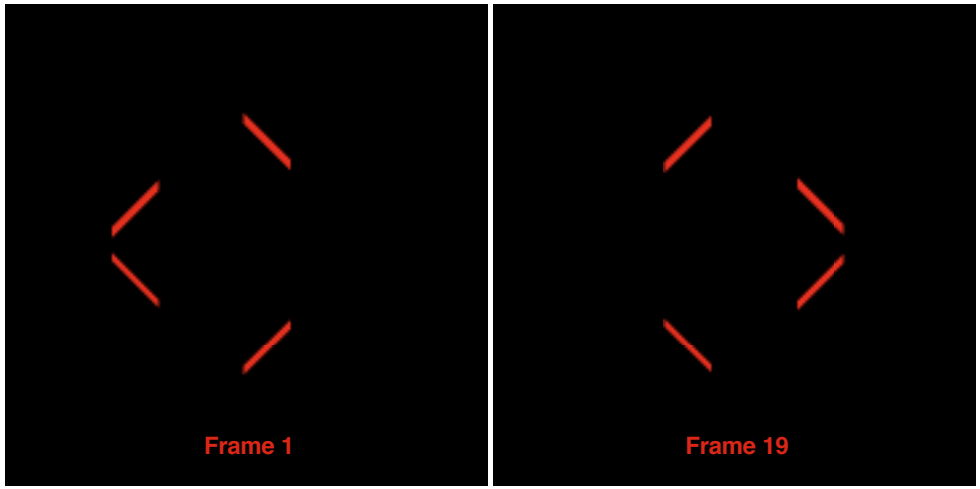
“Diamond moves”



~7 deg

Red diamond moves horizontally, right and then back left

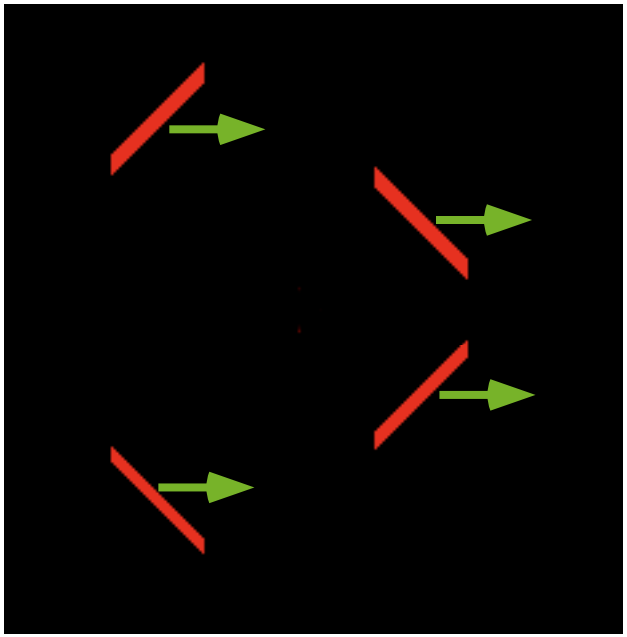
“Bars move”



Black occluding bars move

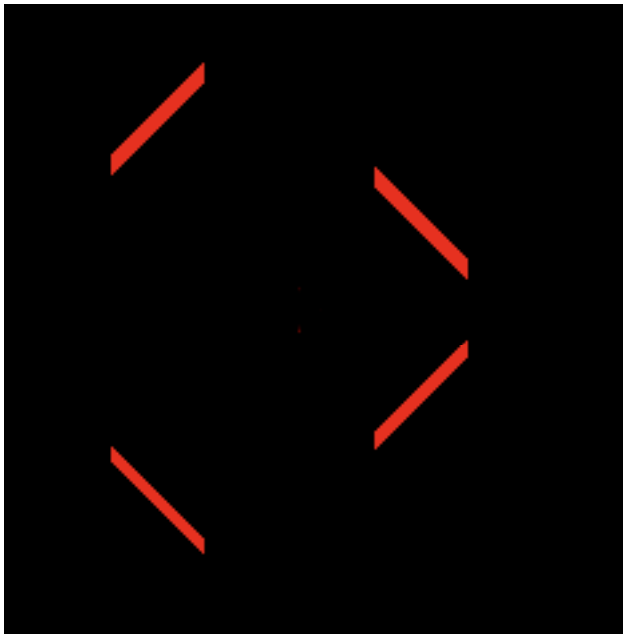
3. The “diamond” percepts

Diamond moves: "Coherent" dia-mond percept



Coherent segment motion: Diamond appears to translate rigidly

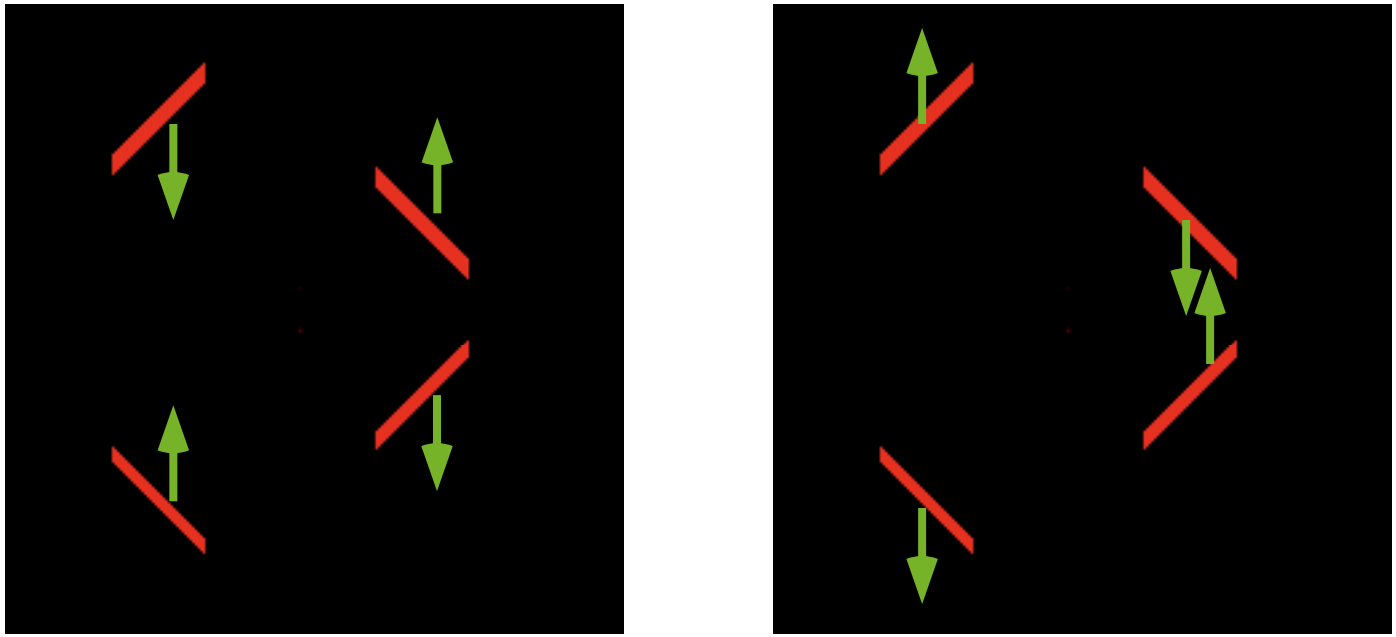
Bars move: Stationary diamond percept



The diamond appears stationary, and the three bars move

4. The incoherent “non-diamond” percepts

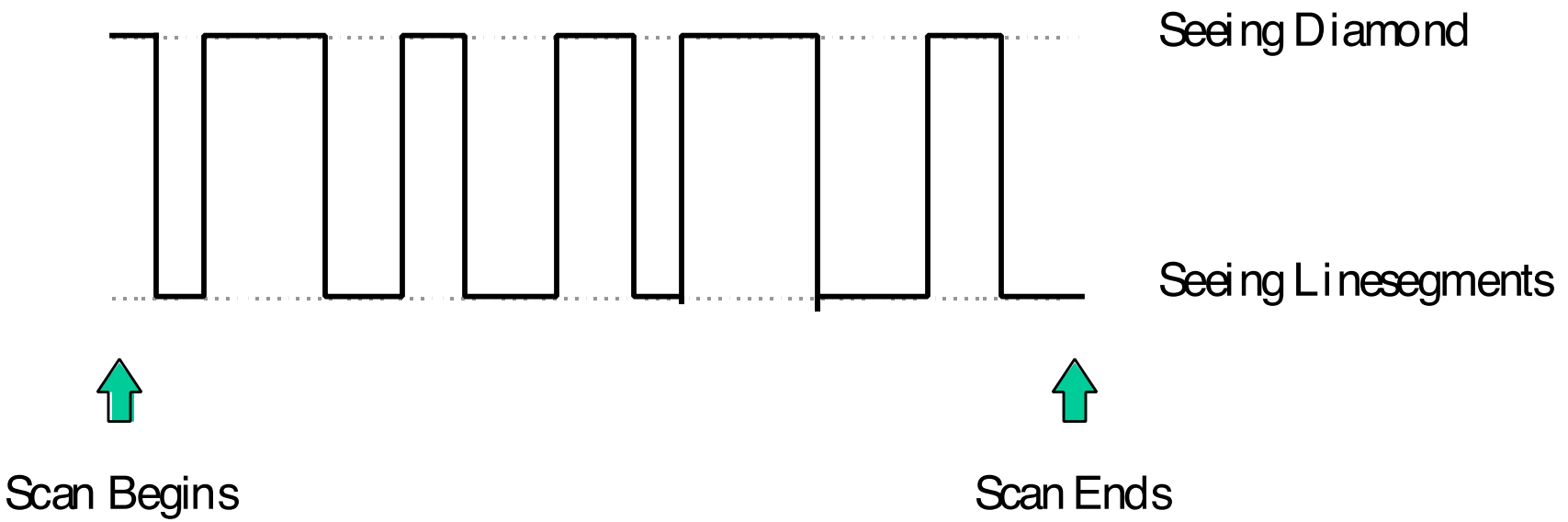
Two of several "incoherent" percepts



Incoherent segment motion:
Lines appear to move independently or in pairs with opposing velocities

5. The task & measurements

Subjects pushed a button to indicate percept

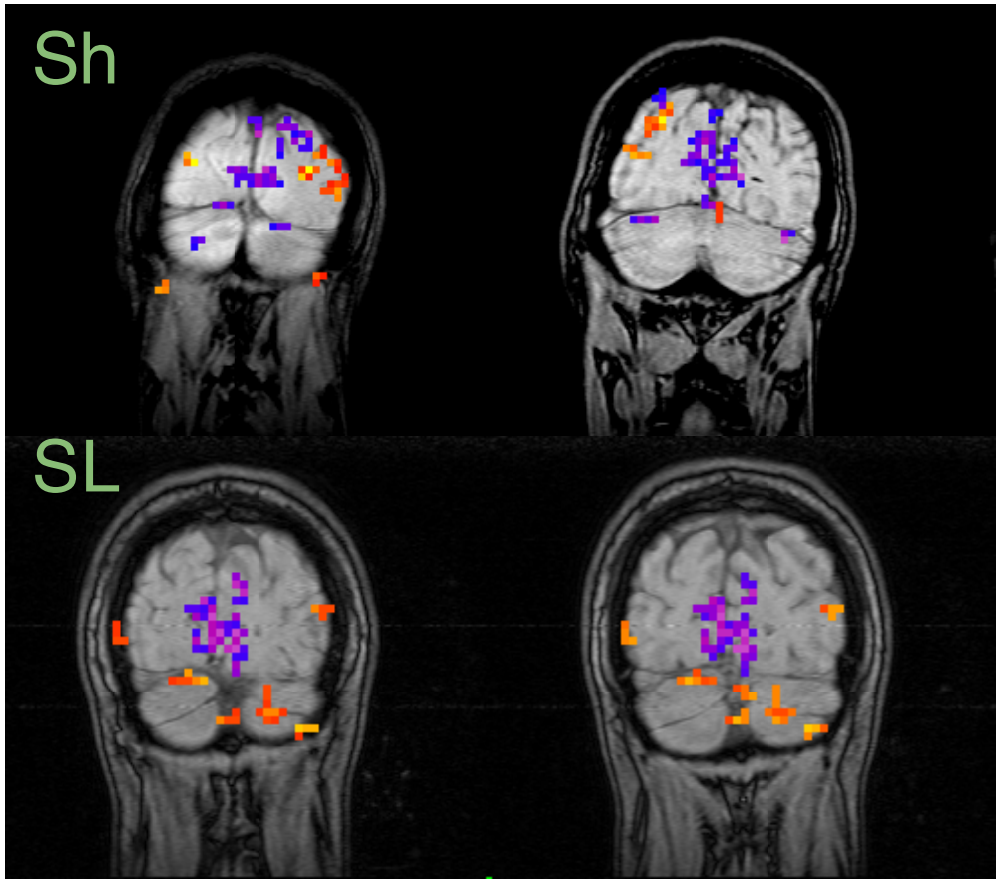


Subjects were scanned in a Siemens Vision 1.5 T scanner using an EPI sequence, TR/TE = 1000/60 ms, 64x64 matrix at FOV = 22x22 cm, 7 one centimeter thick oblique coronal slices were scanned, covering a 7 cm thick slab. Each scan was 300 time points long. Two scans were performed for each task conditions.

Task related BOLD response were detected using correlation analysis. There were mainly two issues to resolve. One was the relatively small signal to noise ration (signal was about 0.5% to 1%, noise about 2% to 3%), the other was that the template was unknown, it depended on subjects behavior. Event-triggered average was used to enhance signal to noise ration and simulated templates were used for cross correlation.

EPI time series were first filtered digitally to remove drift and high frequency noise. Two event-averaged data set were then derived from each of the original scan, one was averaged on the transition from seeing diamond to not seeing the diamond, the other on the transition from not seeing diamond to seeing diamond.

6. The results



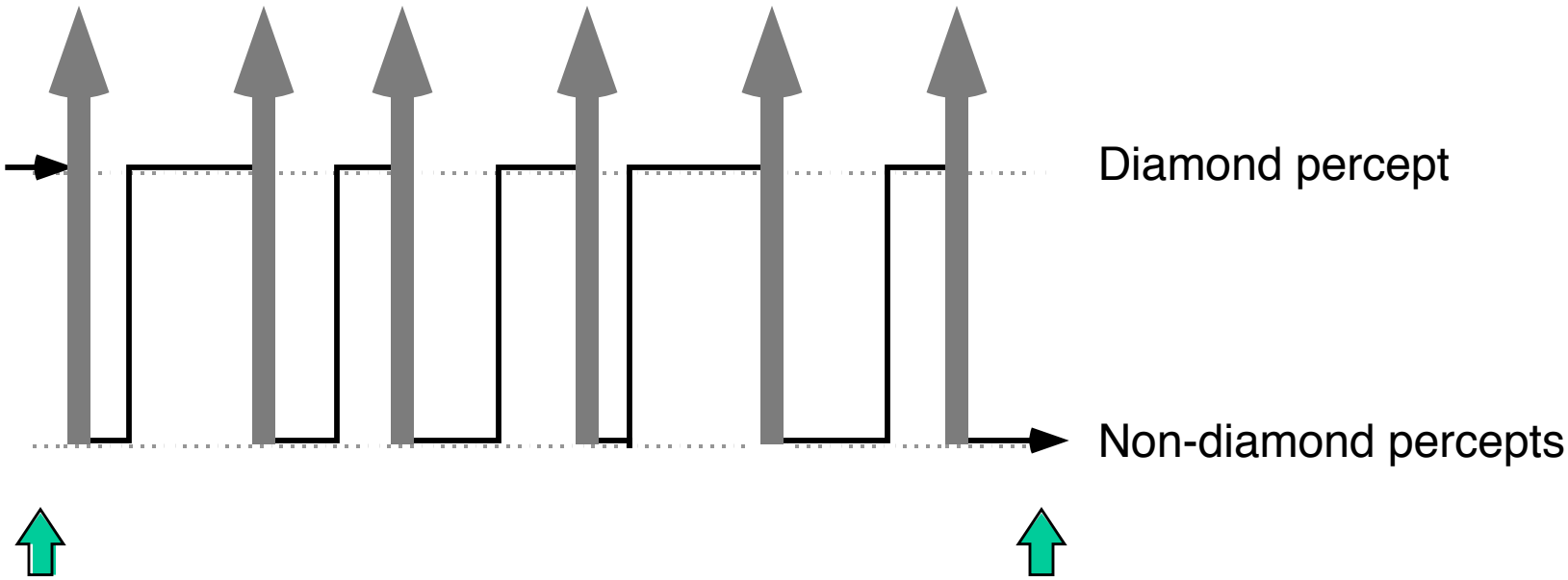
Pixels activated when a diamond was perceived, were colored in red through yellow, in ascending order of cross correlation coefficient; those activated when the diamond was not perceived, were colored in blue through purple. Two subjects shown.

7. V1 activity decreases for coherent diamond percept

Significant modulation of fMRI signals was detected in and around the calcarine sulcus, as well as in other higher-level regions, in accordance with the percepts of the subjects.

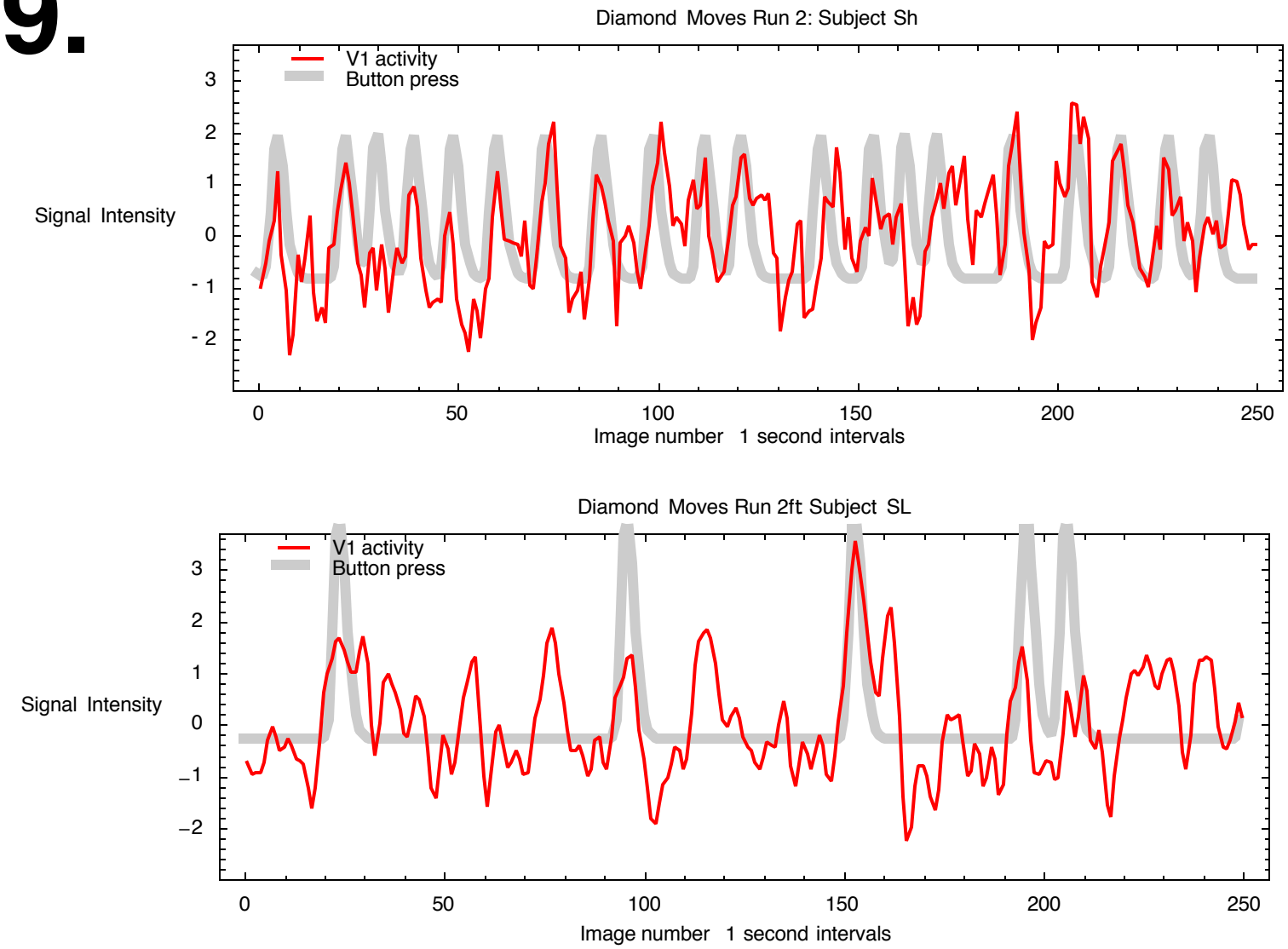
Activity in V1 was less when a coherent diamond was perceived, and more when incoherent pecepts were perceived.

8. Modeling the time-series



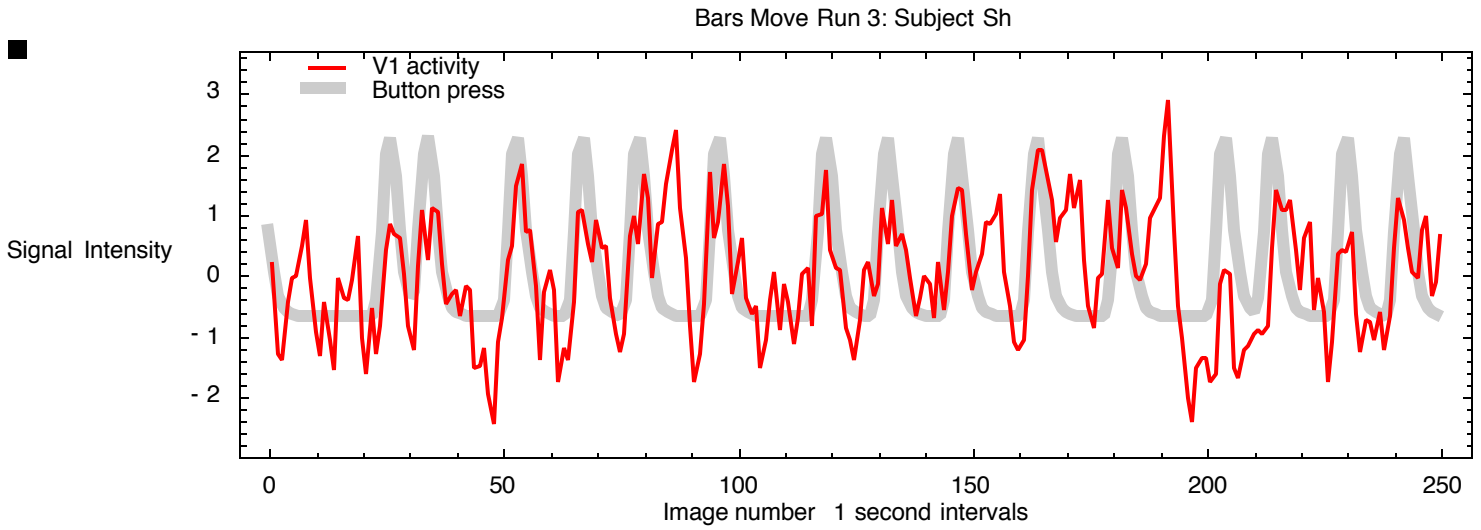
To compare cortical activity with the perceptual response, we convolved the perceptual transient corresponding to “no diamond” with a model transient BOLD impulse response function: $h(t)=t^{\alpha}e^{-t/\beta}$, α = 8.6, β=0.55 (Friston et al., ??).

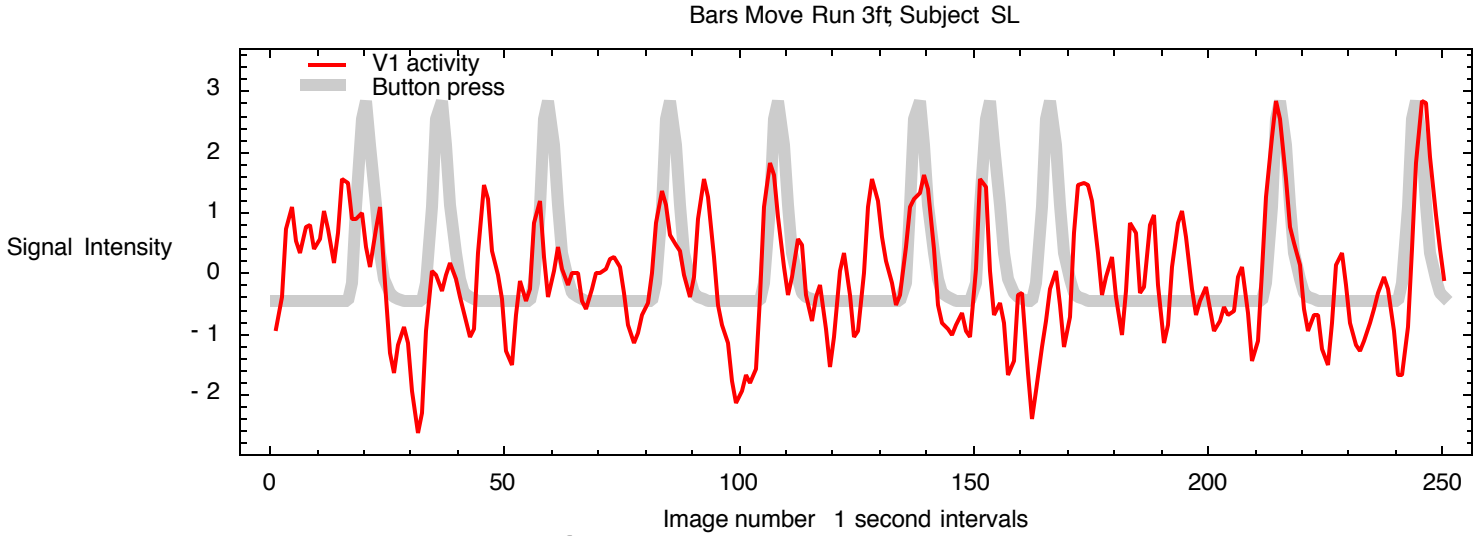
9.



Time course of pixels in V1 and the superimposed simulated response (thick gray lines) based on subjects' percepts. In a given run, predicted time course, assuming transient positive BOLD response to 'incoherent, no diamond percepts'.

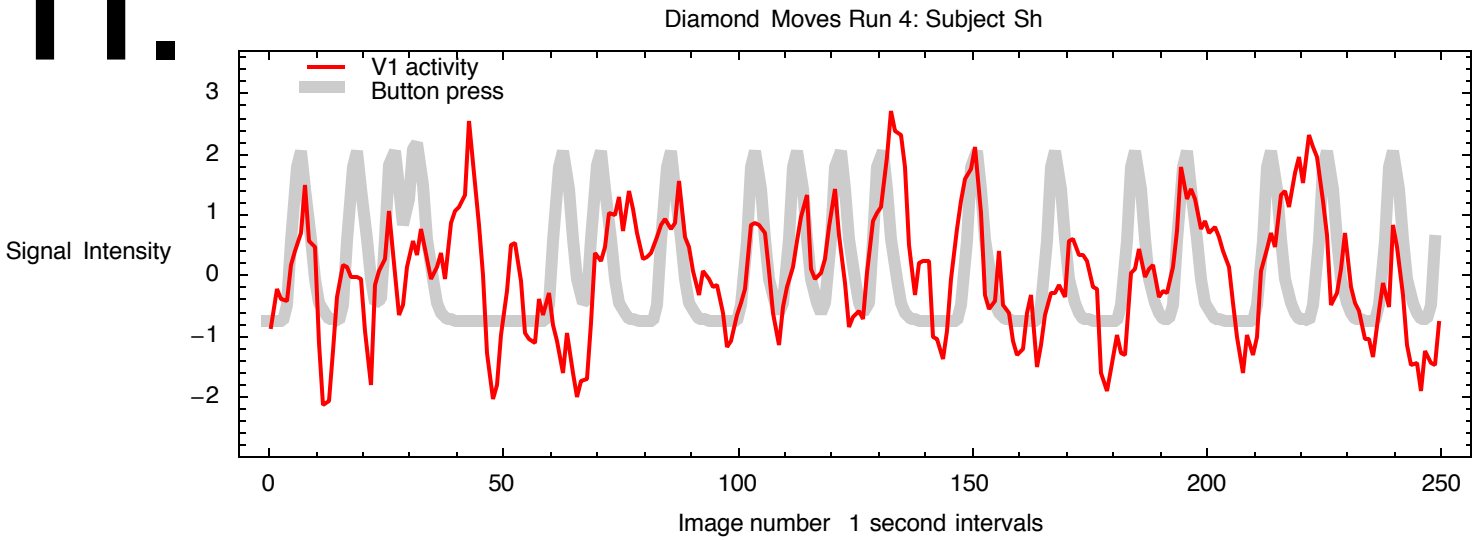
10.

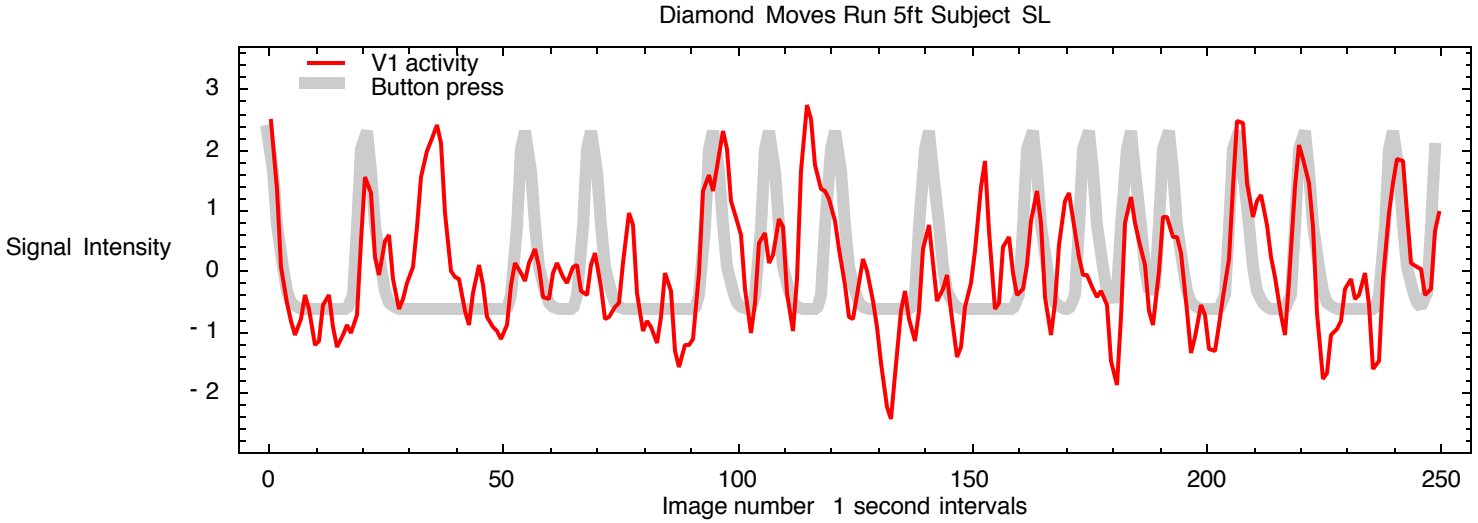




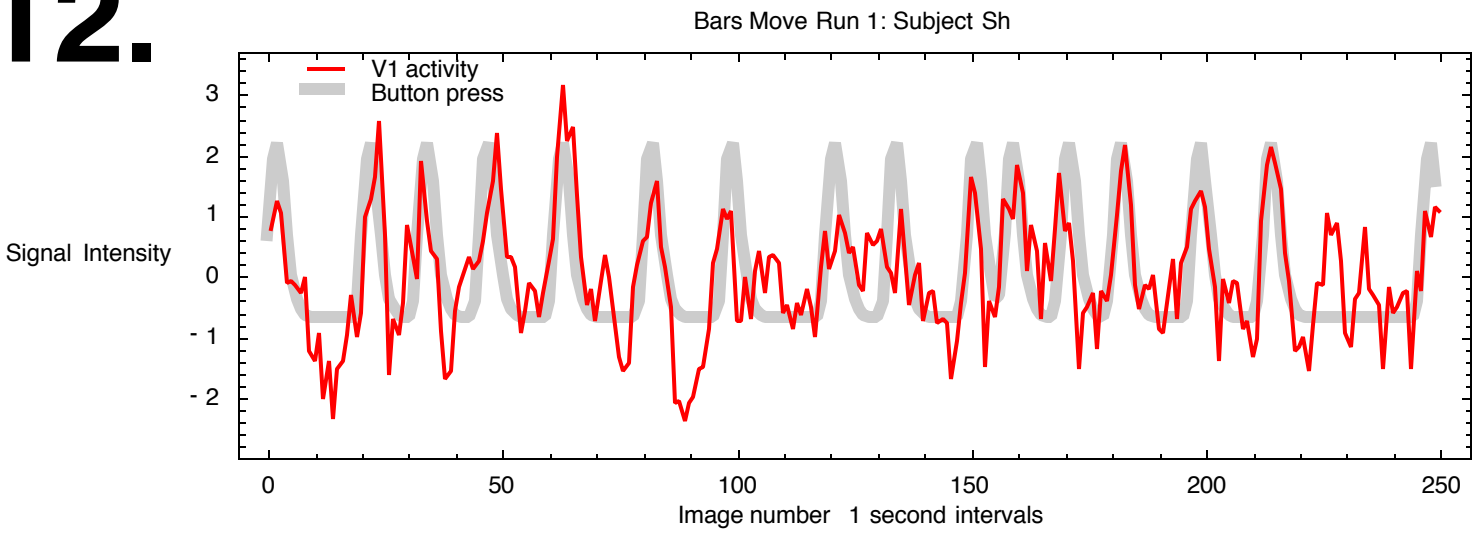
Active pixels detected from one scan could be used to predict subjects response in other scans.The above plots, and the rest to the right show that the response of the same pixels (in run 3 for Sh, run 5 for SL) predict the percepts.

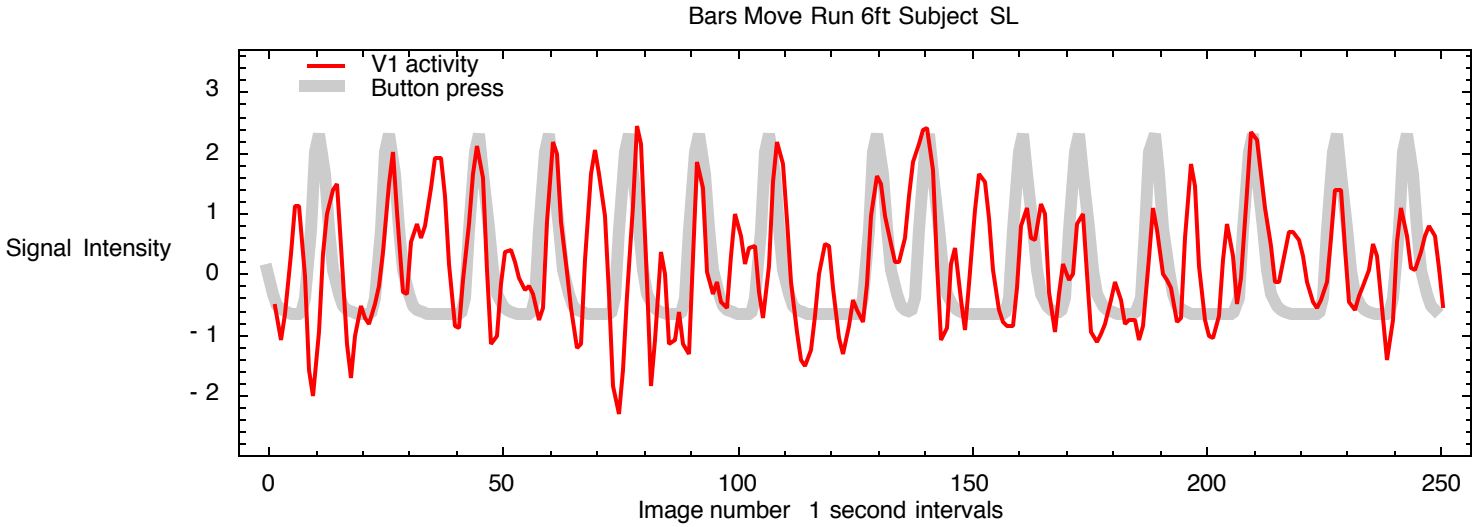
11.


Diamond Moves Run 4: Subject Sh
V1 activity
Button press
Signal Intensity
3
2
1
0
−1
−2
0
50
100
150
200
250
Image number 1 second intervals

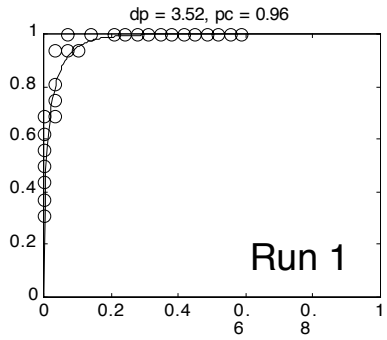

Diamond Moves Run 5ft Subject SL
V1 activity
Button press
Signal Intensity
3
2
1
0
- 1
- 2
0
50
100
150
200
250
Image number 1 second intervals

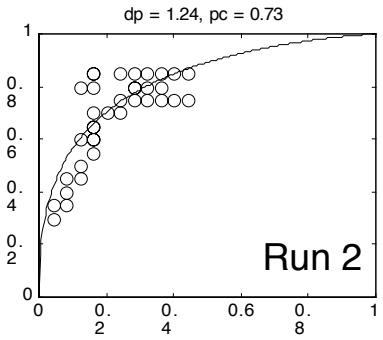
12.

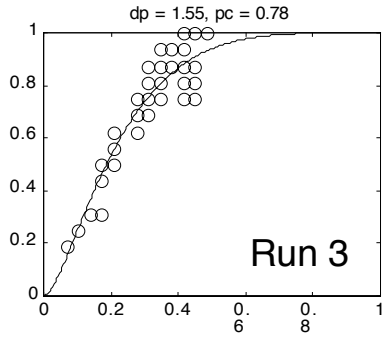

Bars Move Run 1: Subject Sh
V1 activity
Button press
Signal Intensity
3
2
1
0
- 1
- 2
0
50
100
150
200
250
Image number 1 second intervals

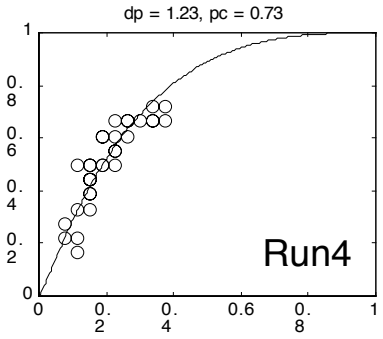

Bars Move Run 6ft Subject SL
V1 activity
Button press
Signal Intensity
3
2
1
0
- 1
- 2
0
50
100
150
200
250
Image number 1 second intervals

13. How well does V1 activity predict percept change?

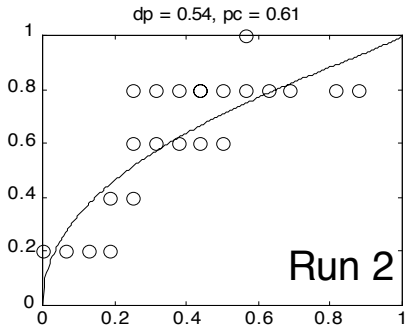


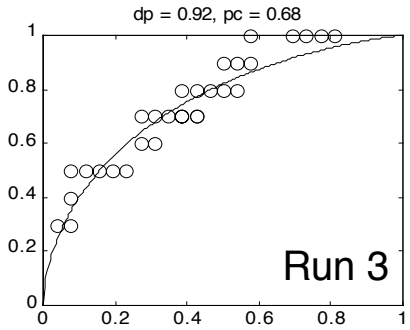


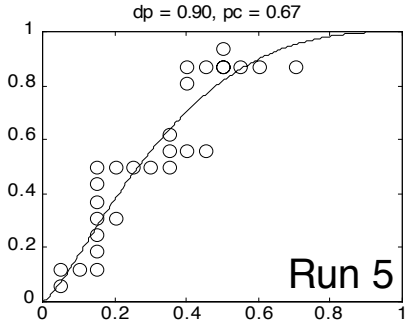


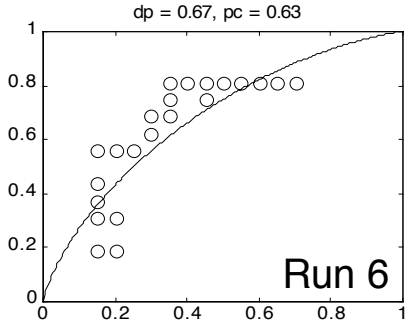


ROC curves, Subject Sh









ROC curves, Subject SL

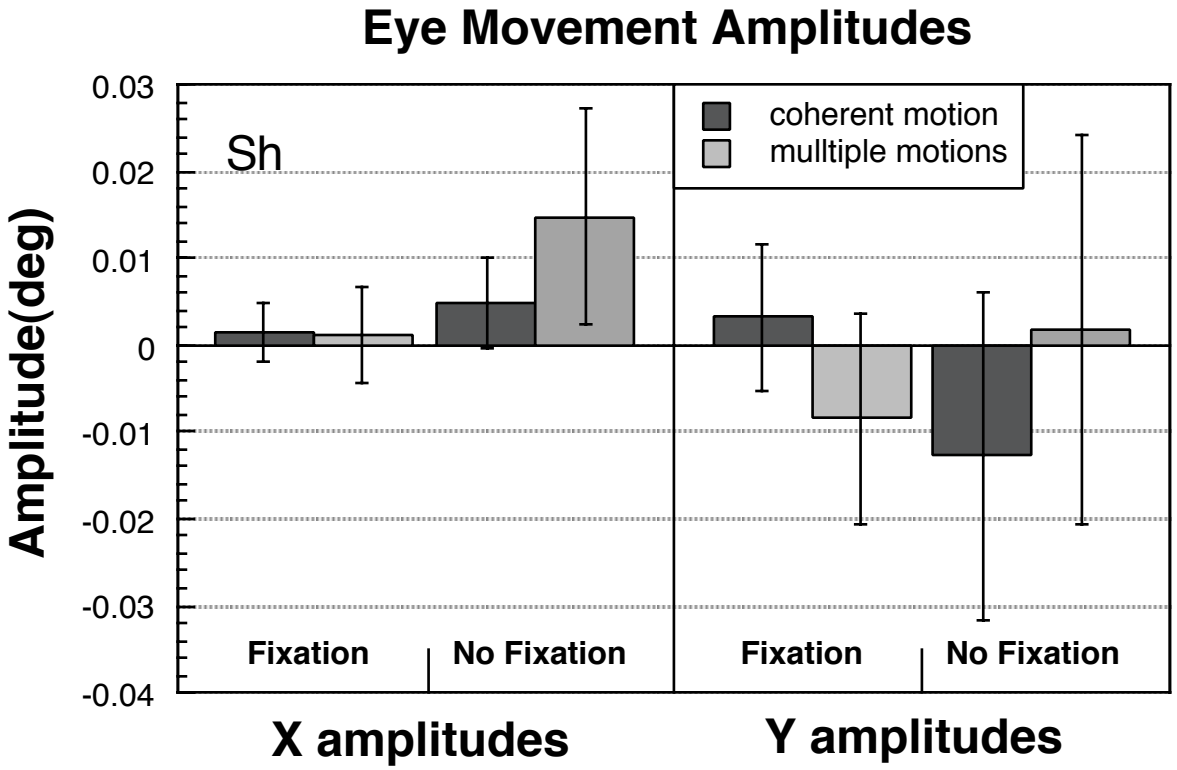
14. V1 time-series fluctuations predict percept changes

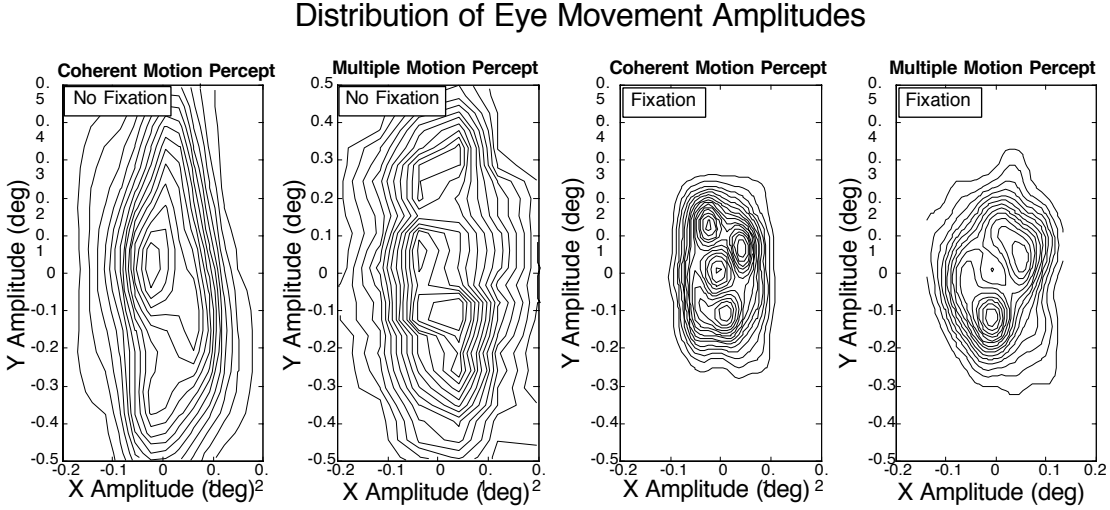
One explanation for the decrease in activity is that perceptual grouping for the diamond percept corresponds to a more accurate prediction of local line segment motion than the incoherent, no diamond percepts.

Another explanation is that the retinal stimulation differs due to different eye movement patterns for the two percept classes.

15. Eye movements

We found no significant difference in the pattern of eye movements between coherent “diamond” percept and the “no diamond” percepts. Data are shown for one subject (Sh) for the Diamond moves stimulus.





16. Conclusions

Activity level in visual areas as early as the primary visual cortex can be modulated by high-level percepts in the absence of changes in the physical features of the visual stimuli.

Furthermore, the sign of the modulation is consistent with the idea that neurons in these areas are engaged in predictive coding of visual information.

References

Friston, K. J., Jezzard, P., & Turner, R. (1994). Analysis of functional MRI time-series. Human Brain Mapping, 1, 153-171.

Acknowledgments

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