

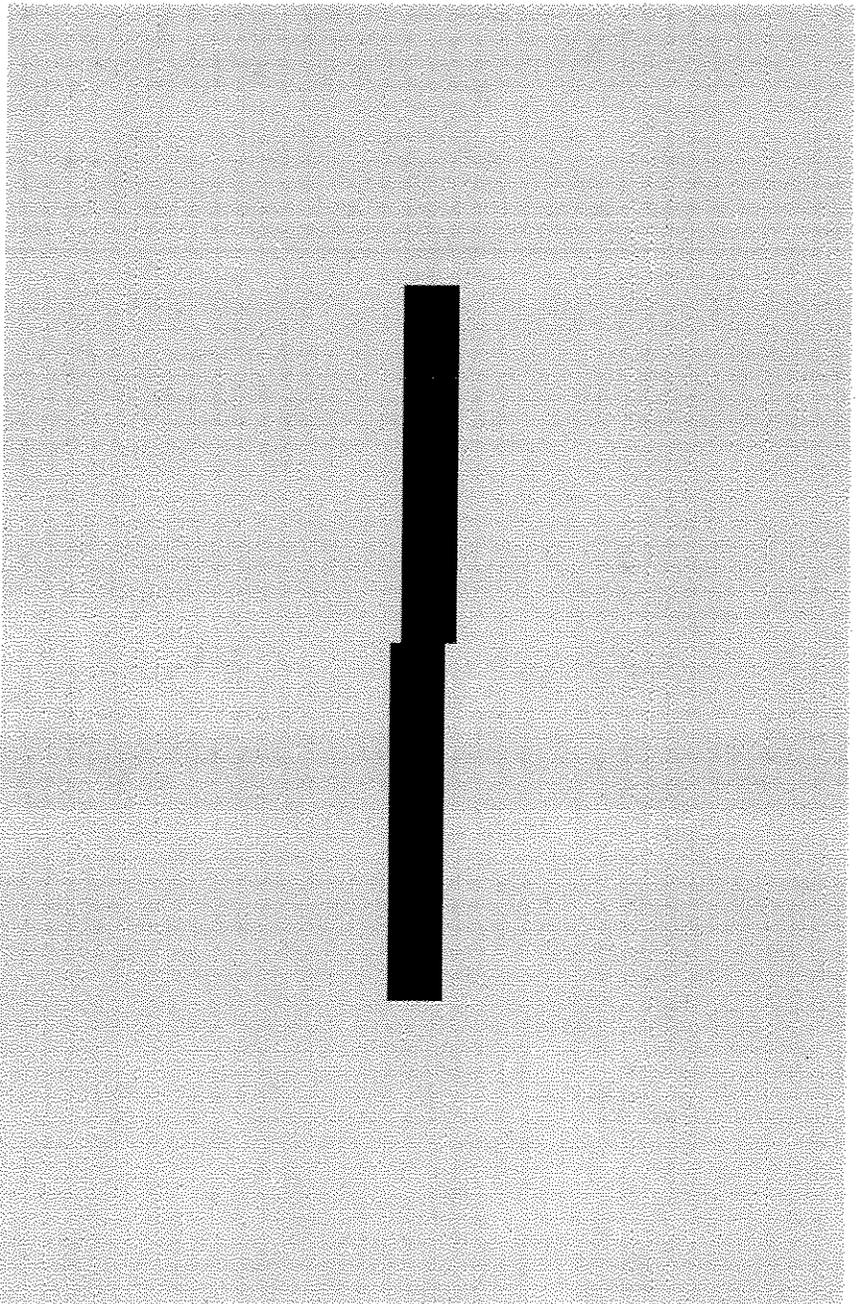
**Stimulus classification images
for Vernier acuity:
the periphery, the oblique effect,
and feature polarity**

Bettina L. Beard

Albert J. Ahumada, Jr.

NASA Ames Research Center

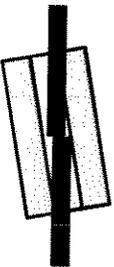
Vernier Acuity



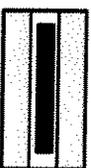
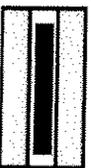
1

What stimulus classification rules are used for alignment discrimination and do they change with line separation?

Beard, B.L. & Ahumada, A.J., Jr. (1998) SPIE Proc., 3299, 79-85.



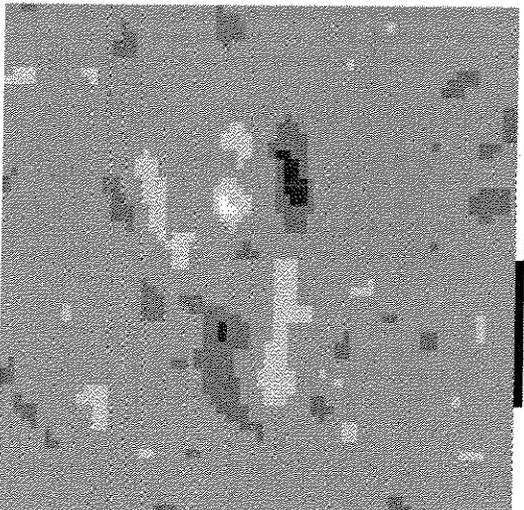
- vernier judgments are limited by the contrast responses of spatial filters sensitive to both stimulus features



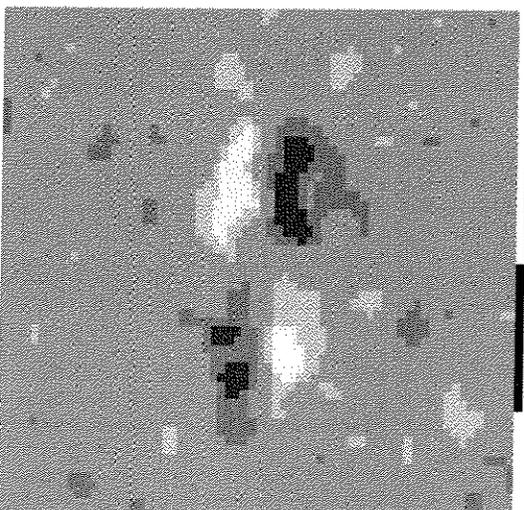
- thresholds may be based on the linear spacing of human cortical functional units referred to as 'local signs'

Abutting Vernier Stimulus Classification Images

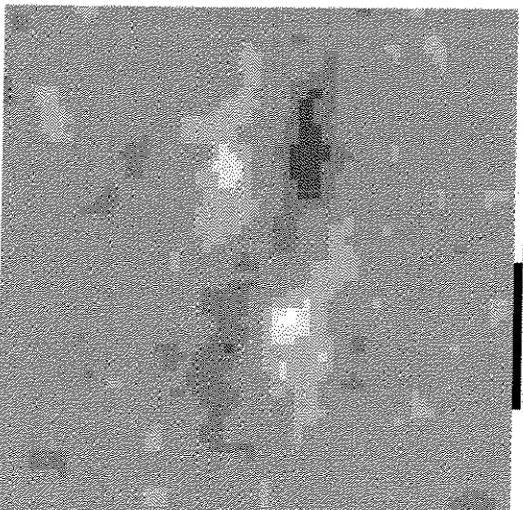
PW (3300 trials)



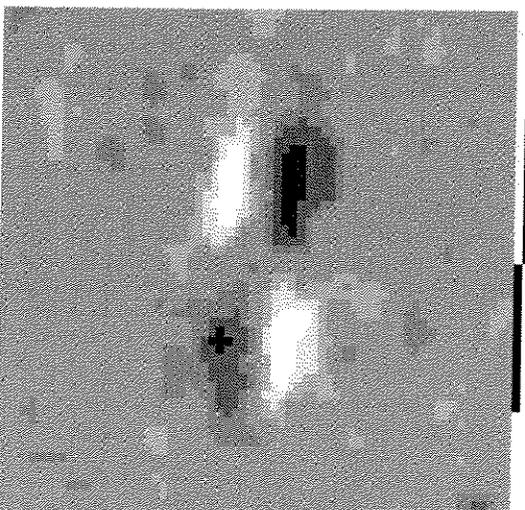
DF (4900 trials)



BLB (3200 trials)

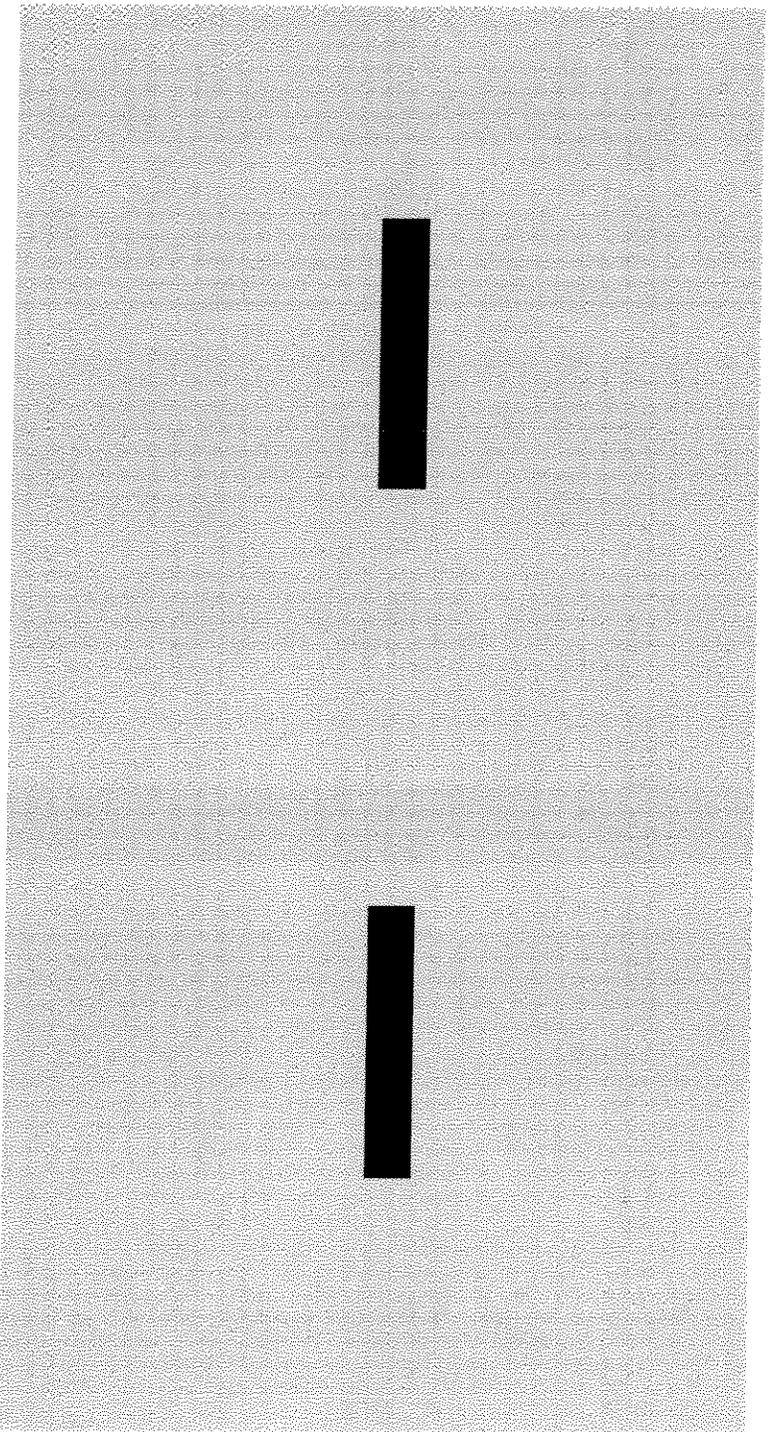


Group



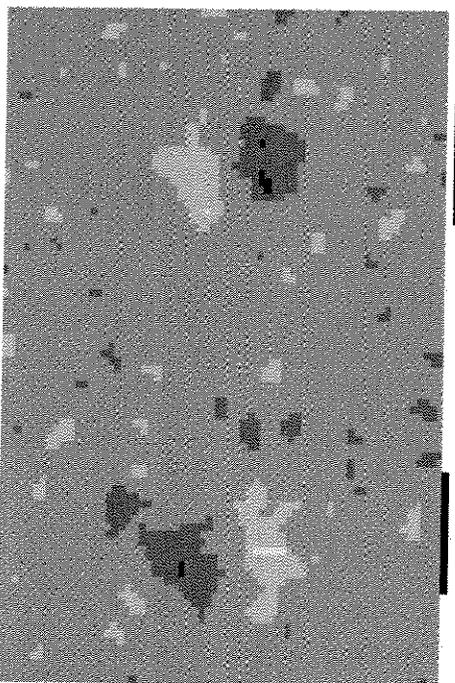
✓

Widely Separated Vernier Features

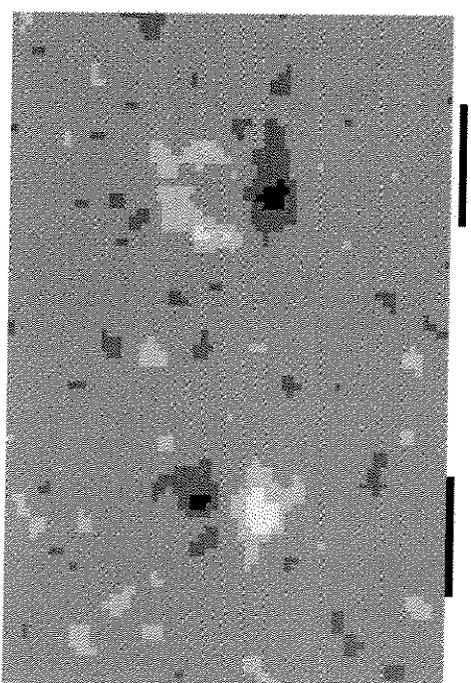


Wide Separation Vernier Stimulus Classification Images

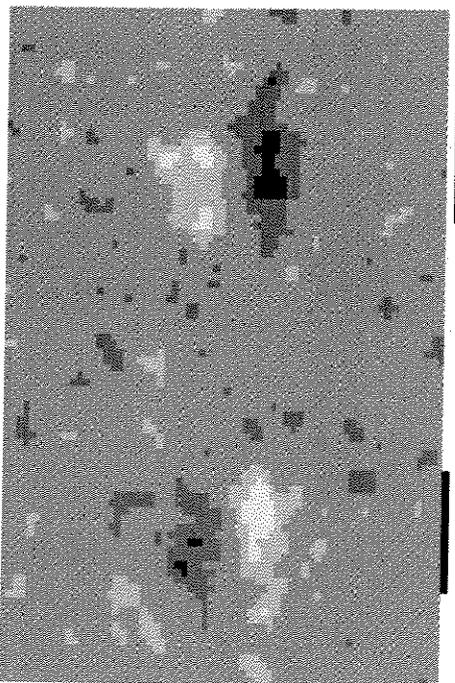
PW (3000 trials)



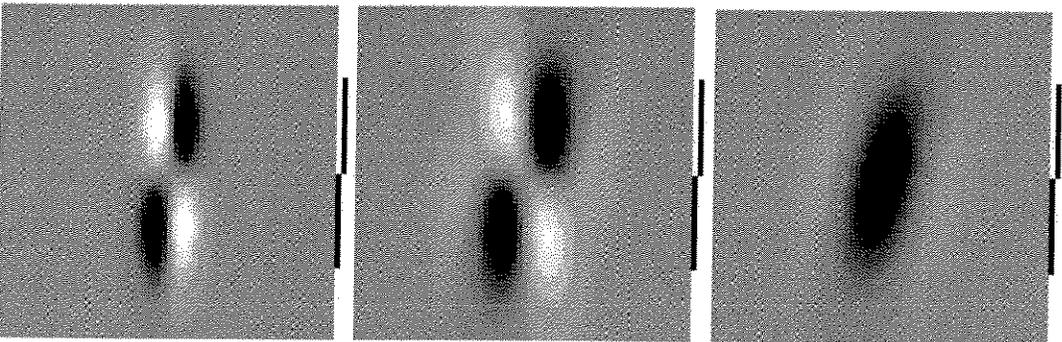
DF (4700 trials)



Group

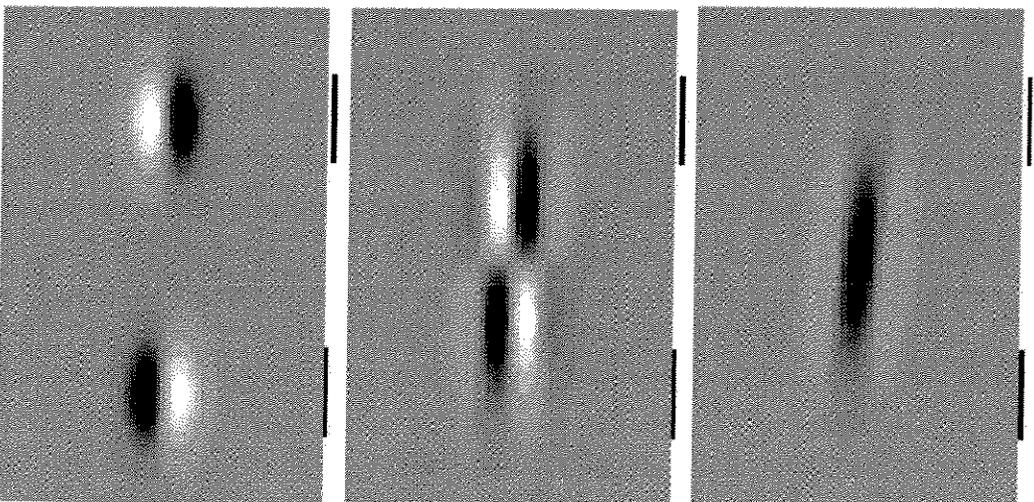


Abutting Vernier Predictions



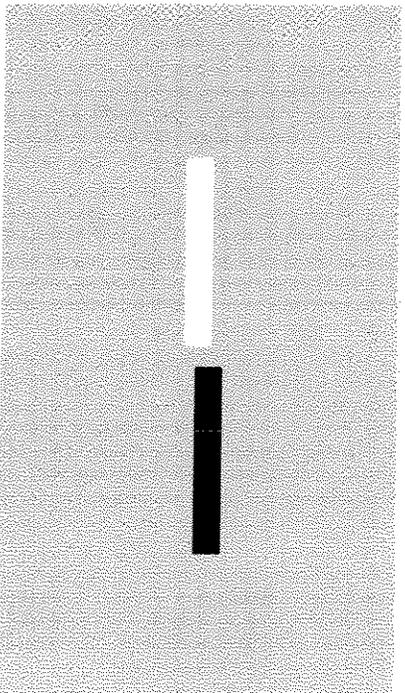
- Gabor filter
- Oriented Gabor filter pair
- Local centroid

Wide Separation Predictions



- Gabor filter
- Oriented Gabor filter pair
- Local centroid

**Use the response classification technique
to reveal the stimulus features for :**



- opposite polarity

✓

Response Classification Technique

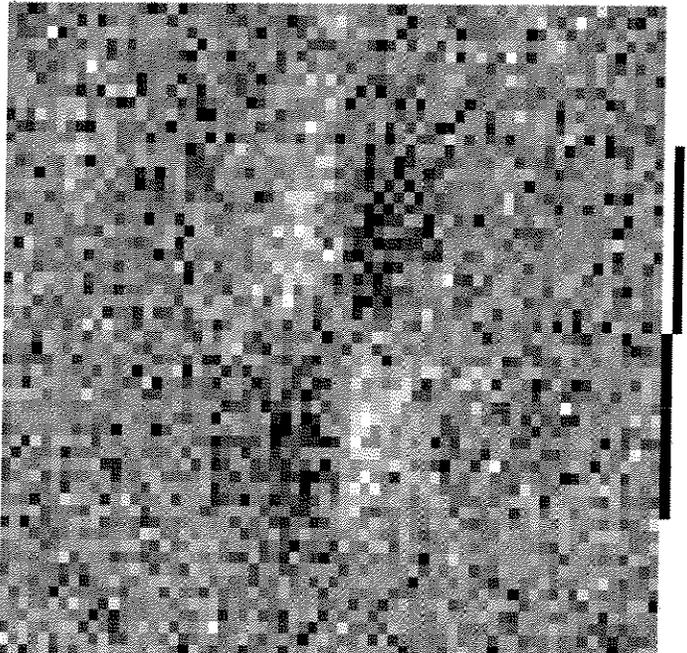
	Response	
	0	1
0		
1		

Stimulus

- On each trial tabulate
 - observers response
 - stimulus type
 - particular noise sample
- Noises averaged separately for four stimulus-response trials
- S0 - stimulus is aligned
- S1 - stimulus is offset
- R0 - response “aligned”
- R1 - response “offset”

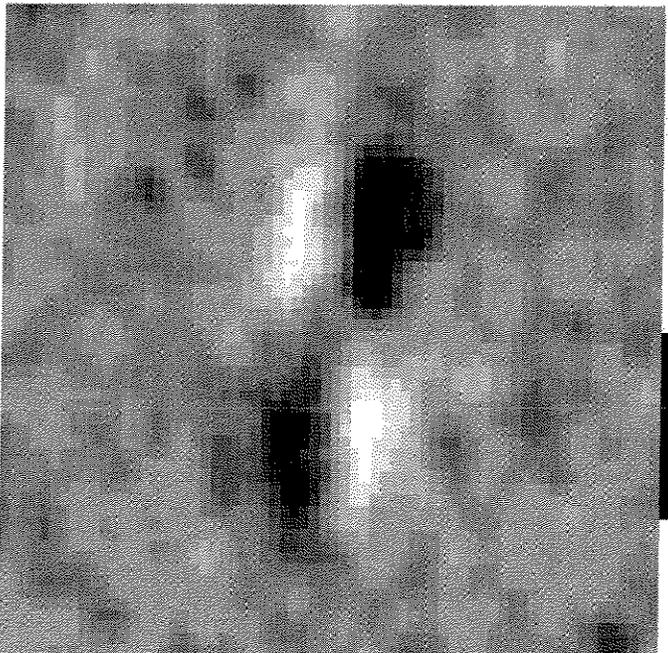
✓

Response Classification Technique



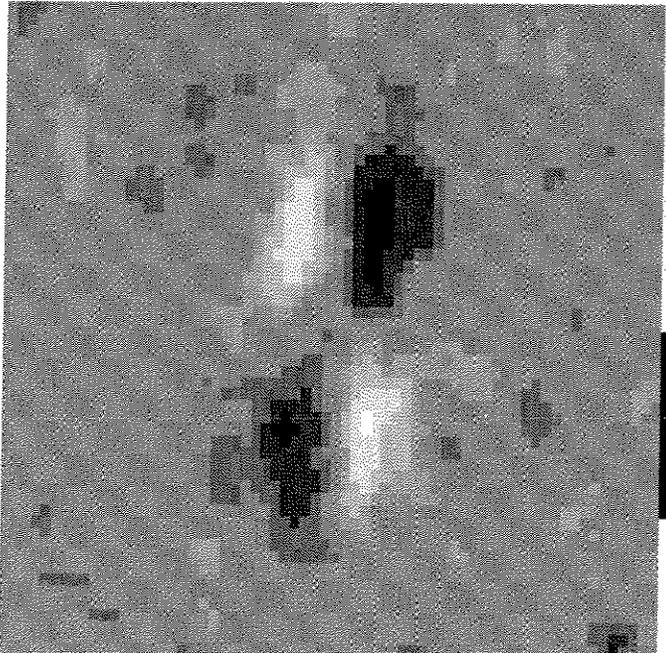
- **Raw Classification Image**
 $(-S_0 R_0) + S_0 R_1 + (-S_1 R_0) + S_1 R_1$

Response Classification Technique

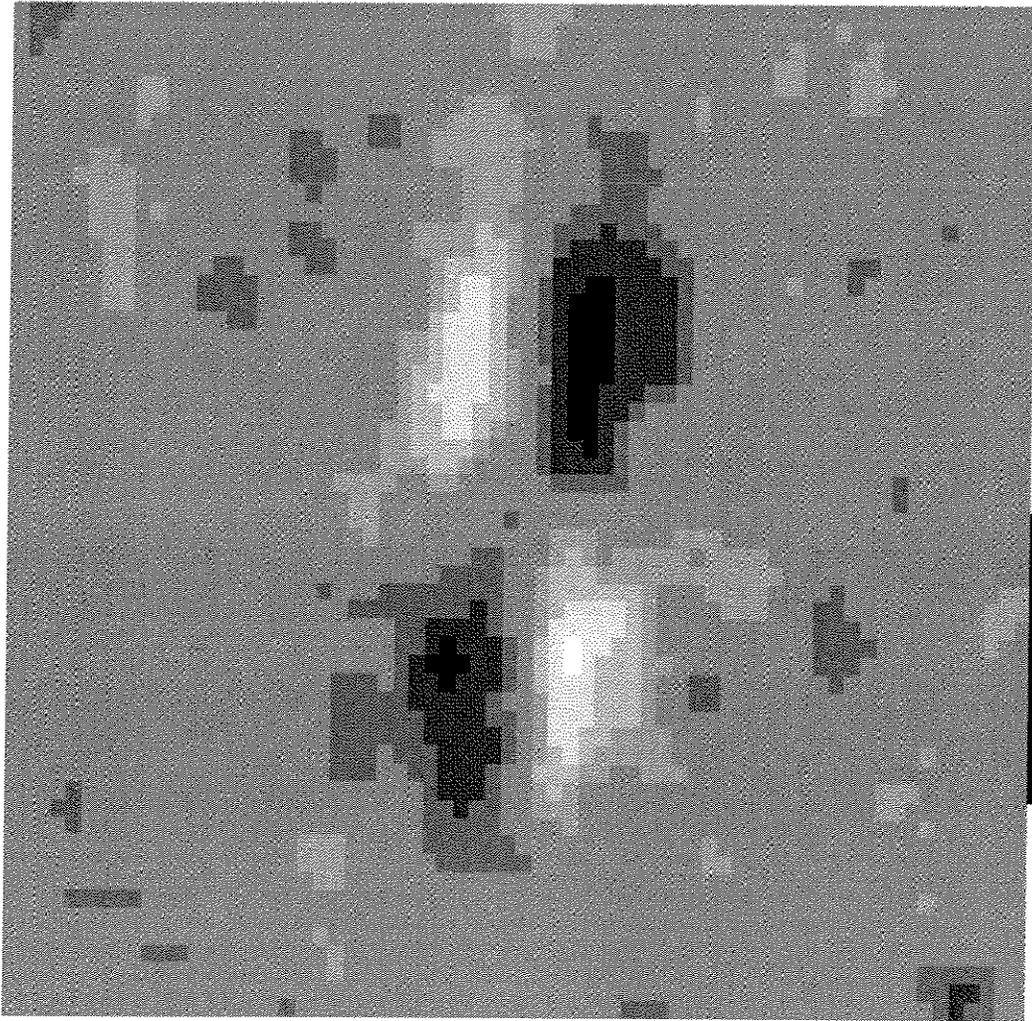


- **Smoothed Image**
the image is then smoothed by
a 5 x 5 convolution kernel

Response Classification Technique



- **Statistical significance** quantized in 2 standard deviation steps



Response Classification Technique

- On each trial tabulate
 - observers response
 - stimulus type
 - particular noise sample
- Noises averaged separately for six stimulus-response trials
 - S0 R0 S0 R1 S0 R2 S1 R0 S1 R1 S1 R2
 - S0 - stimulus is aligned
 - S1 - stimulus is offset
 - R0 - response “aligned”
 - R1 - response “offset”
 - R2 - response “offset” twice to same noise sample
- **Raw Classification Image:**
 - Aligned image: (S0) = AveNoise(S0 R2) - AveNoise(S0 R0)
 - Offset image: (S1) = AveNoise(S1 R2) - AveNoise(S1 R0)

Methods

- Obs: DCH CSS MPE BLB
- Noise level 0.25 0.25 0.25 0.25
- Sig. Amp. 90 50 90 50
- Gap 3 pixels 3 3 3
- Offset 1 pixel 1 1 1
- Length 26 pixels 16 16 16
- Width 3 pixels 3 3 3
- Duration 1000 msec 500 500 500
- Task: “aligned” or “offset”
- 50 random noise samples appeared twice in the same block with the same “aligned” or “offset” stimulus
 - To see internal noise calculation and estimates visit
 - <http://vision.arc.nasa.gov/~al/talks/99arvo/outline.htm>
 - <http://vision.arc.nasa.gov/~tina/vita.html#talks>

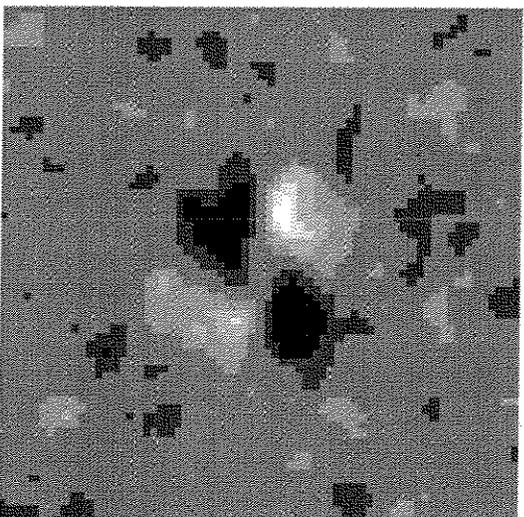
Methods

	-45 deg	45 deg	0 deg	0 deg
• Obs:	<u>NA</u>	<u>BLB</u>	<u>NA</u>	<u>BLB</u>
• Noise level	0.25	0.25	0.25	0.25
• Sig. Amp.	50	50	50	50
• Gap	3 pixels	3	3	3
• Offset	1.2 pixel	1	1	1
• Length	16 pixels	16	16	16
• Width	3 pixels	3	3	3
• Duration	500 msec	500	500	500

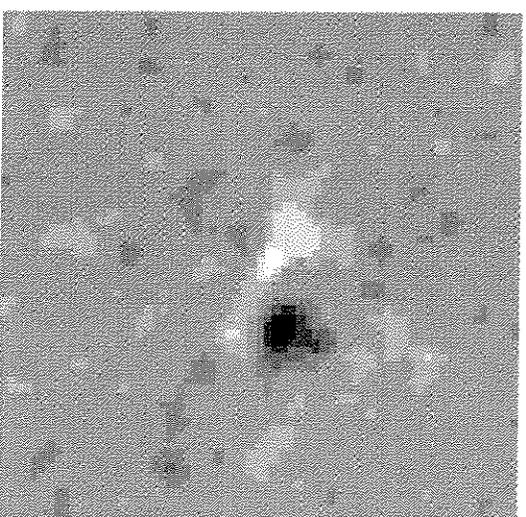
- Task: “aligned” or “offset”
- 50 random noise samples appeared twice in the same block with the same “aligned” or “offset” stimulus
 - To see internal noise calculation and estimates visit
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 - <http://vision.arc.nasa.gov/~tina/vita.html#talks>

Same Polarity

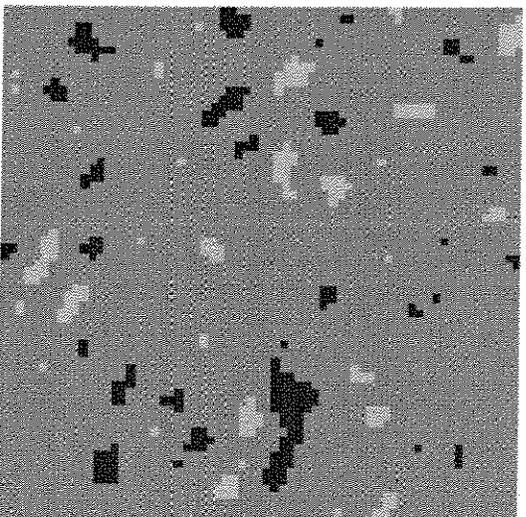
MPE (7200 trials)



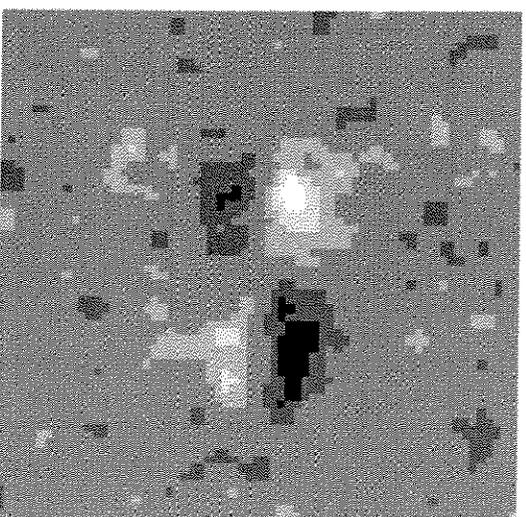
CSS (4800 trials)



DCH (6000 trials)

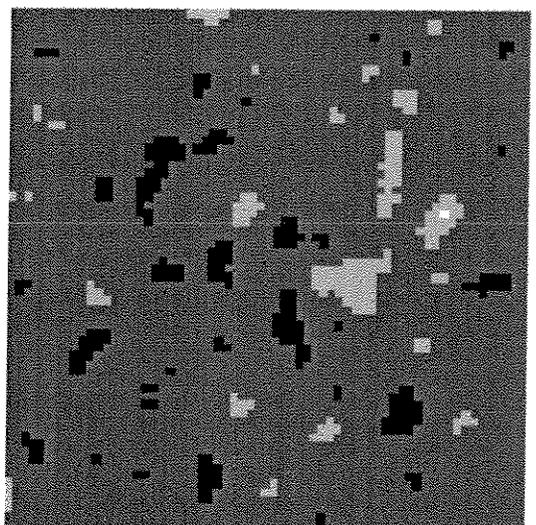


BLB (4000 trials)

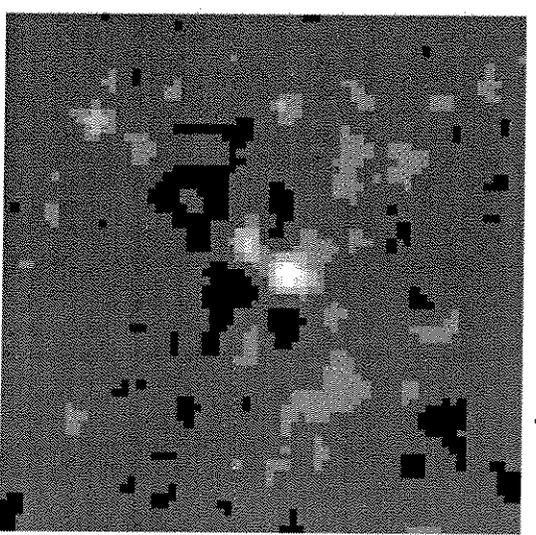


Opposite Polarity

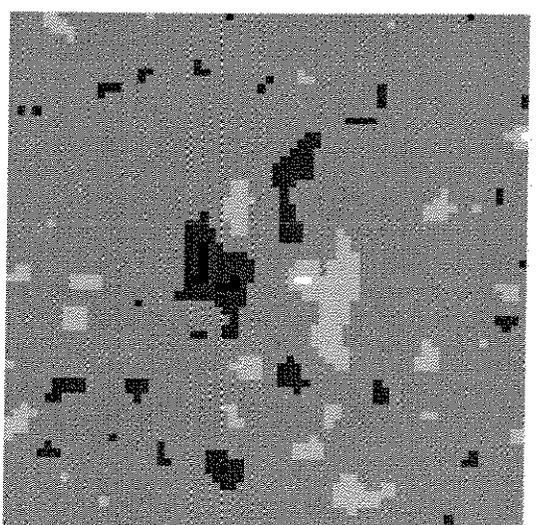
MPE (7300 trials)



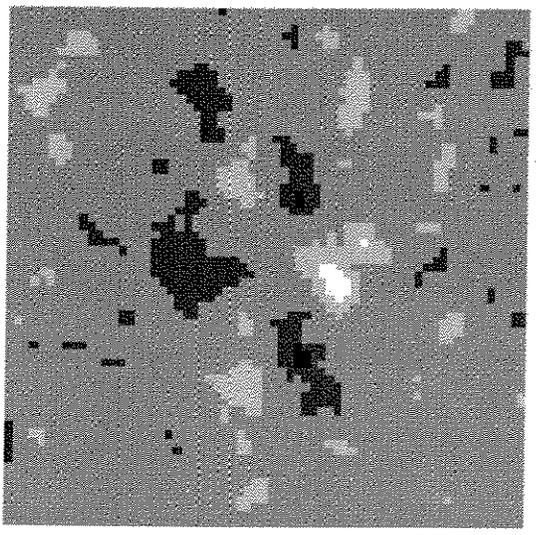
CSS (12000 trials)



DCH (8600 trials)

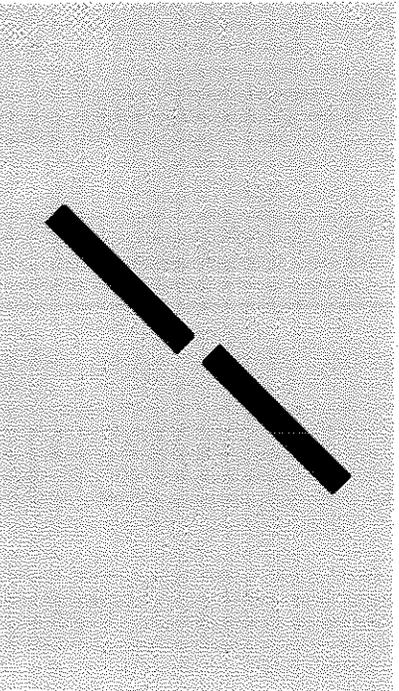


BLB (7100 trials)



V

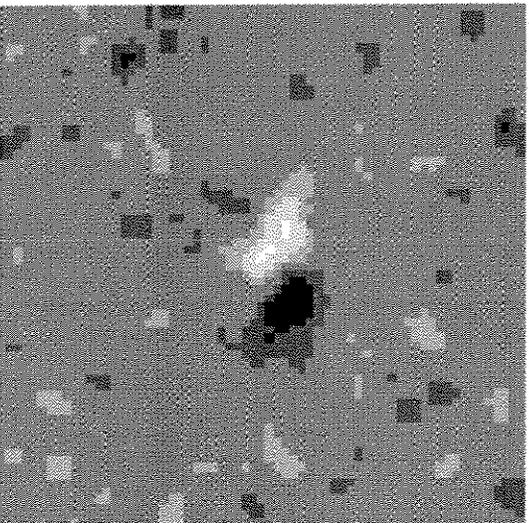
Use the response classification technique to reveal the stimulus features for :



- oblique orientation

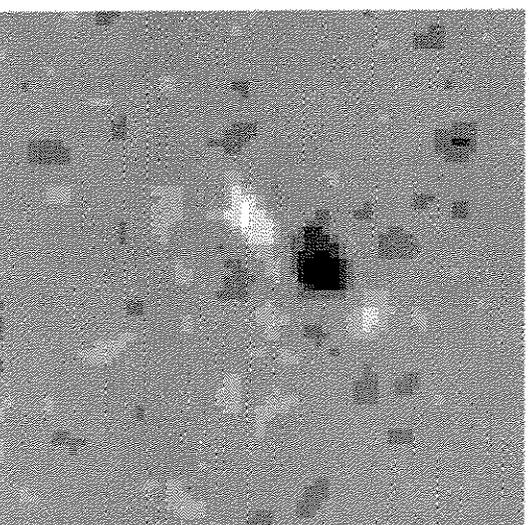
0 deg

NA (4000 trials)

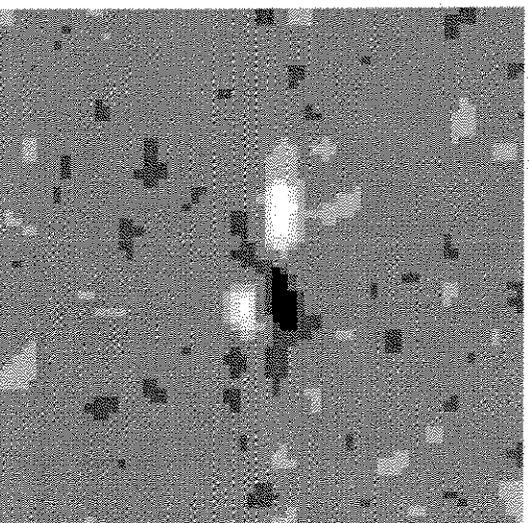


45 deg

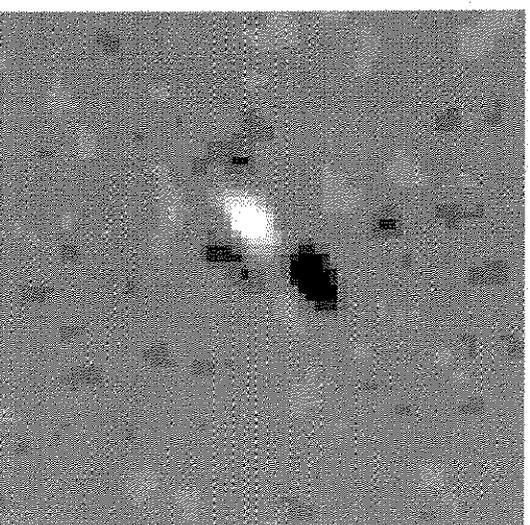
NA (5300 trials)



BLB (2400 trials)



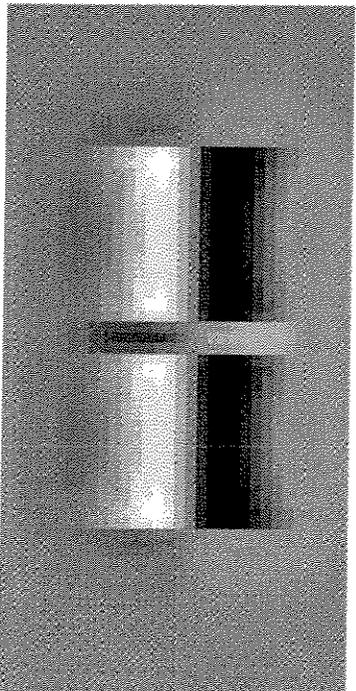
BLB (4300 trials)



Conclusions

- There are additional light and dark areas in the classification images for opposite polarity vernier features near the edges of the features suggesting that these transitions are important to the classification scheme.
- Response classification images for obliquely oriented vernier acuity show a weak lower portion of the bipolar distribution.
- Response classification images may reveal changes in classification schemes or strategy as a result of prior experience.

Model Predictions



- convolve stimulus with a DOG filter
- take vertical position estimate