6. FIGURES

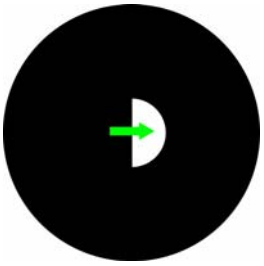
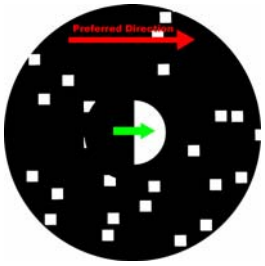
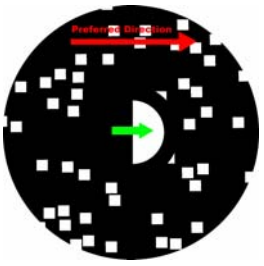
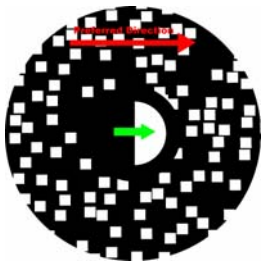
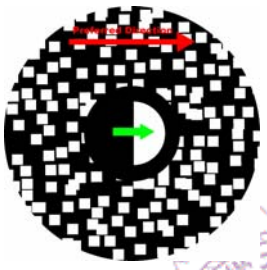
Visual Stimulus			
Coverage Percentage	0	6.25	12.5
			
25	37.5	50	62.5

Figure 1. Spatial coverage stimulus used in this study.

The center was stimulated by a square wave grating at 1 cycle per receptive field center diameter in the preferred direction and velocity of 4 deg/sec. Center diameter was determined according to DSGC's receptive field size. A black annulus in the immediate surround with annulus width of 1/4 center diameter was used to prevent the surround stimulus effect. Surround coverage percentage is defined by the total area of the dots divided by the total surround area. Surround annulus outer diameter was four times the center diameter throughout the experiments. Dots size was 1/8 the diameter of the center area circle. Dots density was modulated to fit the coverage percentage used in

this experiment: 0, 6.25, 12.5, 25, 37.5, 50, and 62.5 %. Random Dots was moving in 100% coherence, same speed as center grating, and in the same direction with the preferred direction of the DSGC.

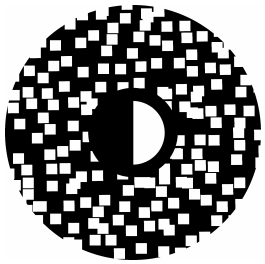
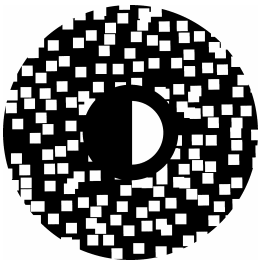
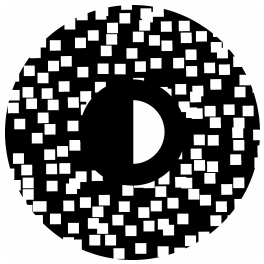
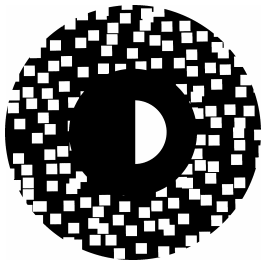
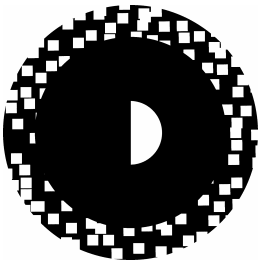
Visual Stimuli		
Black Annulus Width	1/5 D	1/4 D
		
1/3 D	1/2 D	1 D

Figure 2. Immediate surround extending areas.

The center stimulus is the same as Figure 1, a square wave grating in preferred direction with 4 deg/sec velocity and 1 cycle per receptive field center diameter. The surround area was stimulated by random dots of 1/8 center diameter size, 100% coherence and 37.5% spatial coverage. Different black annulus widths were used to examine the surround extent effect. "D" indicates the center diameter.

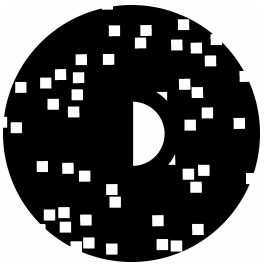
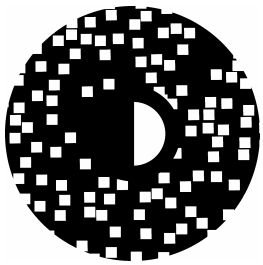
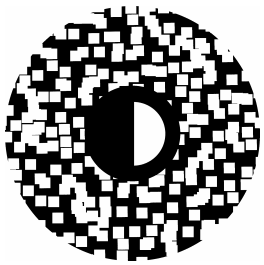
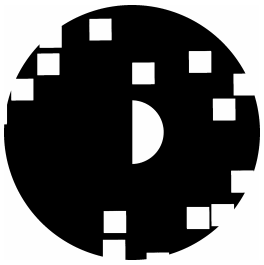
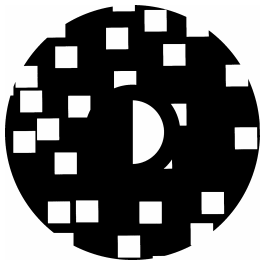
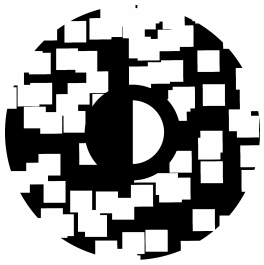
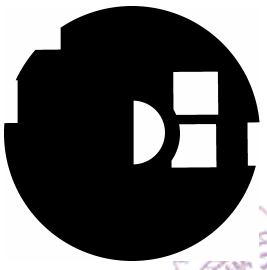
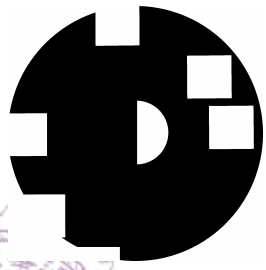
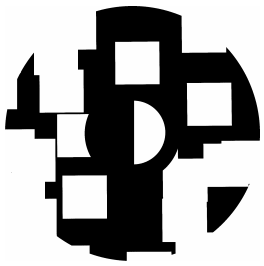
1/8 Center Diameter			
1/4 Center Diameter			
1/2 Center Diameter			
Coverage Percentage	12.5	25	50

Figure 3. Different spatial scale in the surround.

Different dot sizes were used under the same spatial coverage percentage. Center was always stimulated by a preferred direction moving grating, 4 deg/sec velocity and 1 cycle per center diameter. One-quarter of center diameter width of black immediate surround annulus was set in this experiment. Surround random dots sizes were set 1/8, 1/4 and 1/2 of center diameter.

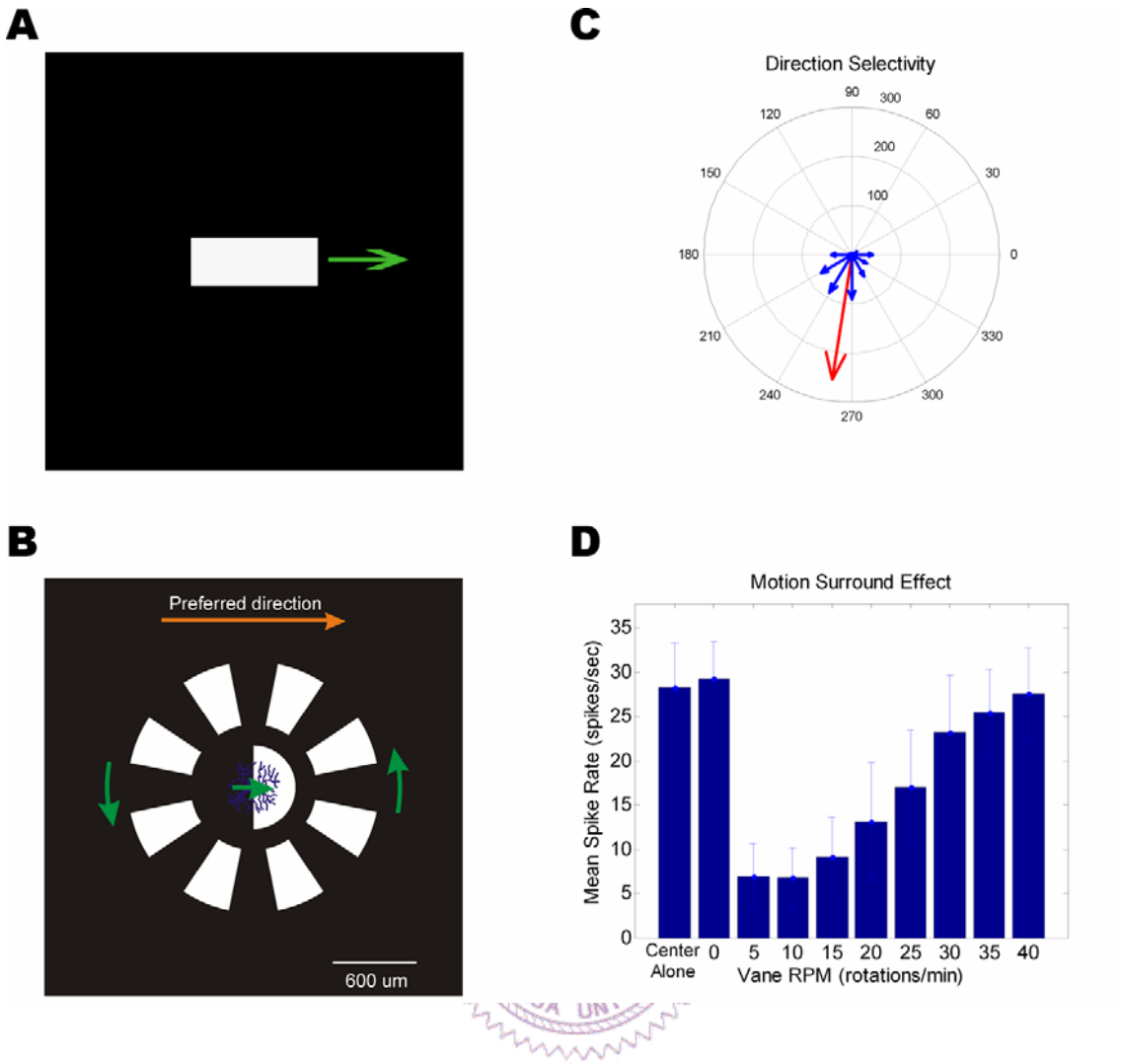


Figure 4. DSGC basic properties.

(A) A 12 directional moving bars were used to determine the preferred-null axis of a DSGC. The blue arrows (B) are vectors pointing in the direction of the moving stimulus and having length equal to the averaged number of spikes recorded during that stimulus direction. The red arrow indicates vector sum of 12 directions, pointing to the preferred direction. (C) A windmill stimulus. A preferred direction moving square wave grating was applied in the center and a 16 vanes of windmill was rotating in the surround, separated by a black annulus of 1/4 center diameter width. (D) The DSGC exhibited a

strong suppressive surround when the vane rotated in low speed but gradually recovered as the vane rotated faster.

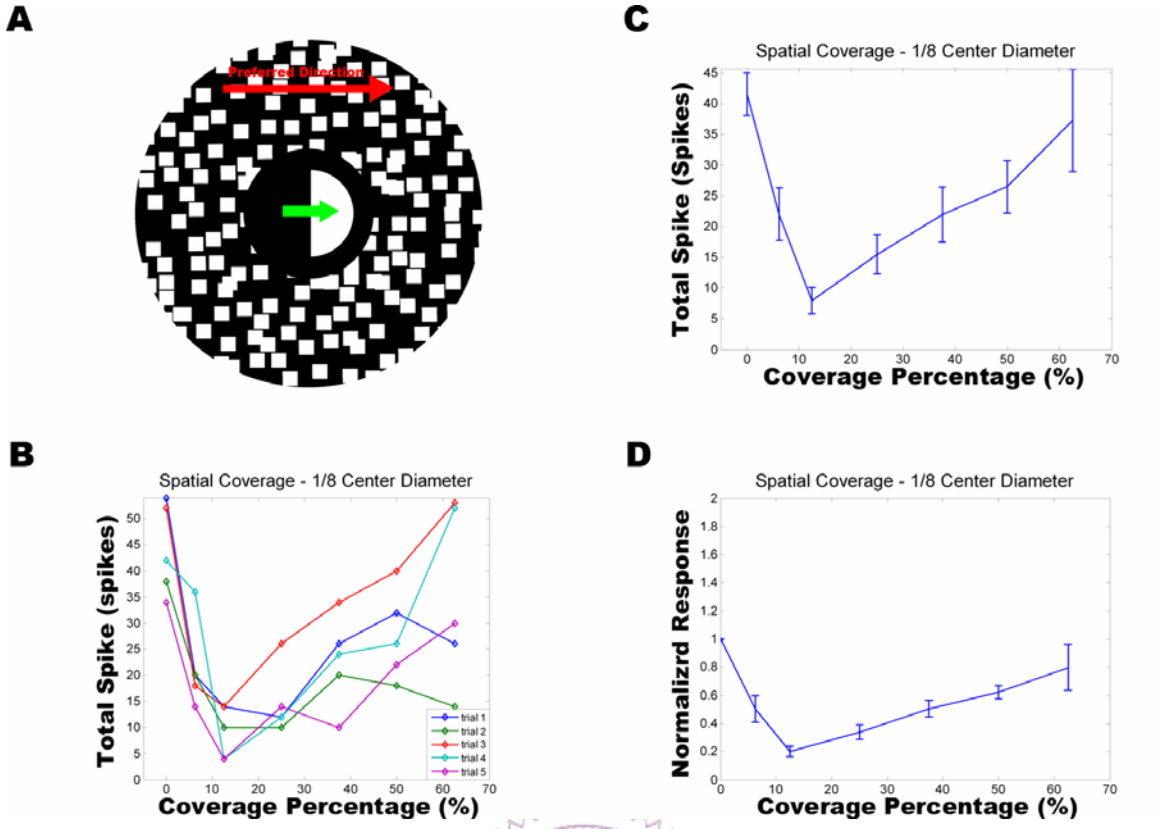


Figure 5. Three different plots present the cell's response.

(A) The stimulus. (B) Each stimulus was repeated 5 times and a trial-by-trial plot was shown. (C) The response plot averaged over five trials (mean ± s.e.m.). (D) All responses are normalized to the control (center alone) and averaged over five trials.

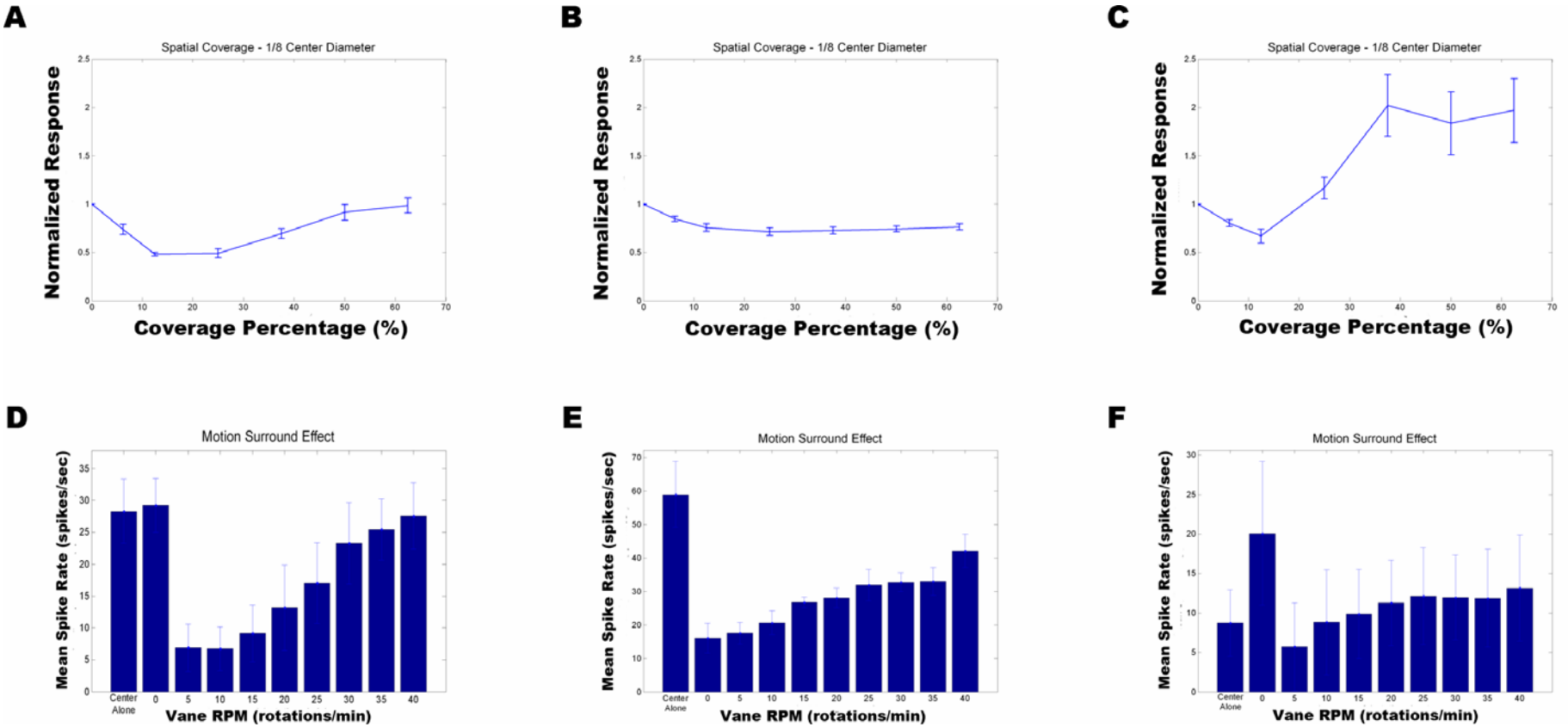


Figure 6. Three different types of DSGCs classified according to the response curve to a spatial coverage stimulus.

(A) A normalized response plot of type I cell. This cell had a suppressive surround when the spatial coverage was low and gradually recovered as the spatial coverage was higher. This character was also found in a windmill experiment (D). (B) Type II cell exhibited a sustained suppressive surround in all spatial coverage conditions. Even the rotating vane surround reflected this phenomenon (E). (C) Surprisingly,

type III cell had excitatory surround at high spatial coverage even though there was still suppressive at low spatial coverage. The windmill experiment plot displayed a very different curve compared to others (F).

	Type I (normal)	Type II (inhibitory)	Type III (excitatory)	Others
Percentage	37.5 (6/16)	25.0 (4/16)	31.25 (5/16)	6.25 (1/16)
DSI	0.6756 ± 0.037	0.5690 ± 0.034	0.5720 ± 0.076	-
T.I.	0.718 ± 0.13	-	1.364 ± 0.07	-
C.P.	-	-	28.79 ± 3.1	-

Table 1 Comparison among three distinct cell types.

Generally, type I cell had the most population in the retina DSGCs(37.5%) and one-quarter of DSGCs is the type II cells (25%). About one-third is type III cells (31.25%), respectively. Among all 16 cells, there was one cell could not be classified into any one of three types of cells. DSI values had no significant difference among cell types, ranging between 0.56 and 0.68. T.I., which is used to classify type I and type III cells, had an obvious divergence between them. By definition, type III cells may have higher TI values and type I cell may have lower ones. It is not necessary to distinguish type II cells from others because of they have very different response curves that lack of TI values. A Critical Point (CP) indicates the specific coverage percentage that type III cells had excitatory response. For type III cells, excitatory surround started to dominate as the background coverage exceeds 30%.

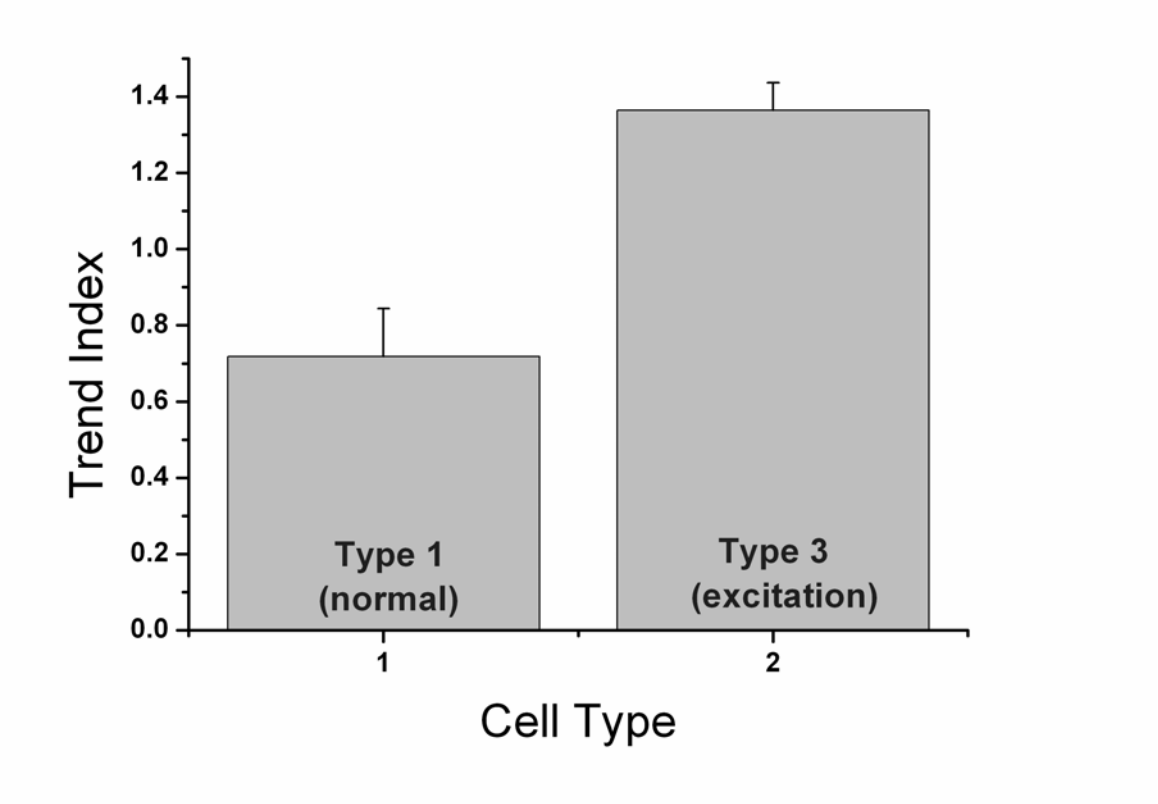


Figure 7. Type I and type III can be separated by Trend Index.

Manually classified cell types are in accordance with the classification using Trend Index. By definition, type III cells should have higher TI values than type I cells, since TI emphasizes the behavior at higher spatial coverage.

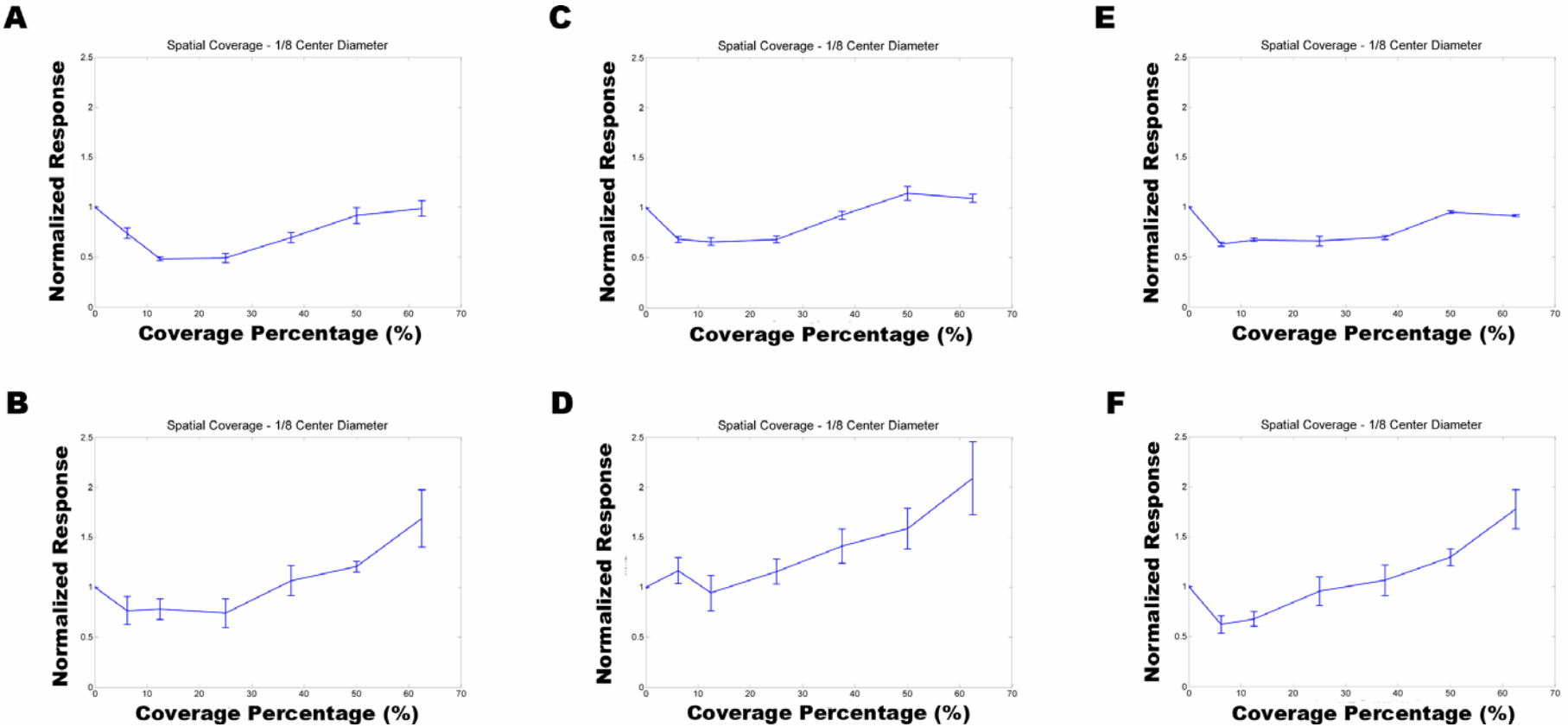


Figure 8. Same test or random sequence does not affect the response curve when compared to a norm.

A typical type I cell can be recognized in (A), stimulated by sequential stimulus and random patterns across repeats. Same stimulus applied to a type III cell was presented in (B). (C) The plot of type I cell responded to stimulus presented in the same patterns across repeats. (D) The plot of type III cell responded to stimulus presented in the same patterns across repeats. (E) The plot of type I cell responded to stimulus presented

in random sequence of spatial coverage percentages. (F) The plot of type III cell responded to stimulus presented in random sequence of spatial coverage percentages.

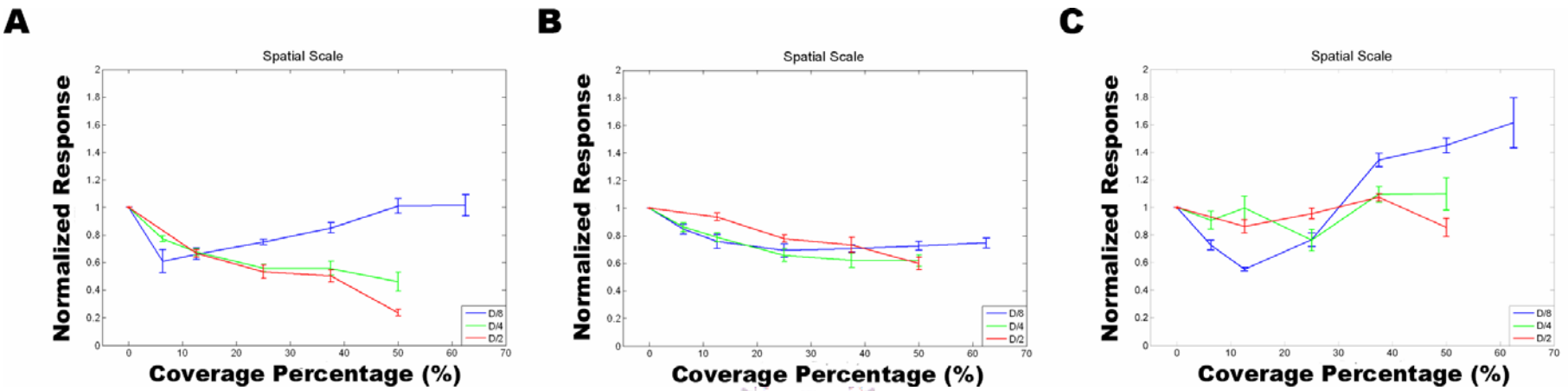


Figure 9. Spatial scale alters the response of DSGCs.

(A) A type I cell responded to three different spatial scales. Blue line indicates that the dot size was 1/8 of center diameter, green line for 1/4 of center diameter and red line for 1/2 of center diameter. "D" in the legend indicates the center diameter. Although type I cell had typical responding curve under 1/8 D, it exhibited a sustain inhibition in all spatial coverage percentages when the dot size was 1/4 D or 1/2 D. (B) A type II cell showed sustained suppressive surround effects in three different spatial scales. (C) In spite of the excitatory responding curve under 1/8 D condition, type III cell had reduced inhibitory and excitatory surrounds when stimulated by 1/4 D or 1/2 D random dots.

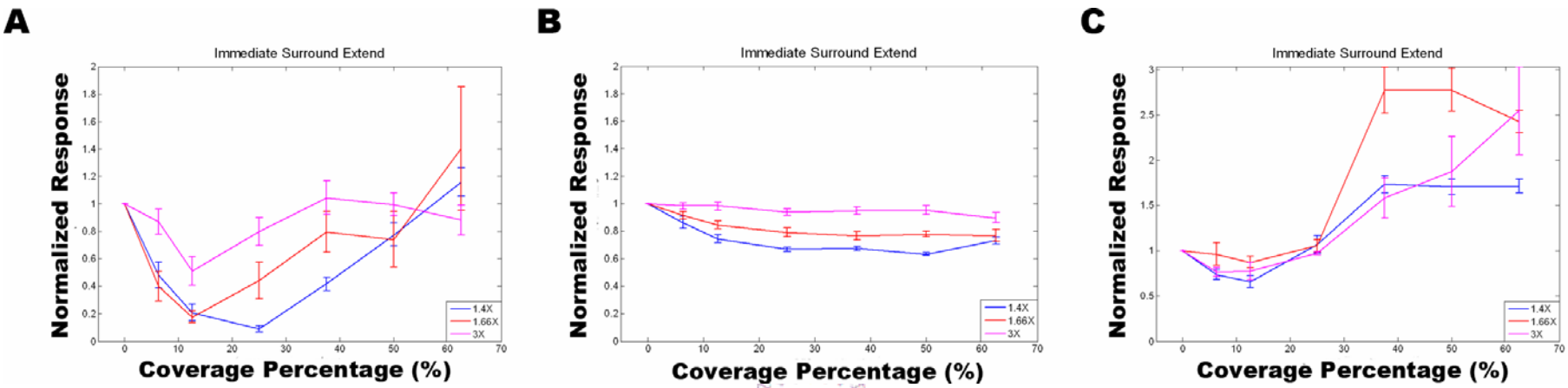


Figure 10. Different types of DSGC respond to different spatially extending surround.

(A) A type I cell responded to different spatial extending stimuli, exhibited typical behaviors. Blue line refers to the stimulus with 1/5 center diameter width of immediate surround black annulus. Red line refers to 1/3 center diameter width and pink refers to 1 fold of center diameter width of black annulus. The result shows that as the immediate surround area shrank gradually , the surround inhibition weakened. (B) A type II cell had a consistent result that the strength of surround inhibition followed the spatial extent in a typical manner. (C) Type III cell had the weakest surround inhibition and a magnified surround excitation in the high spatial coverage percentages as the surround area reduced.

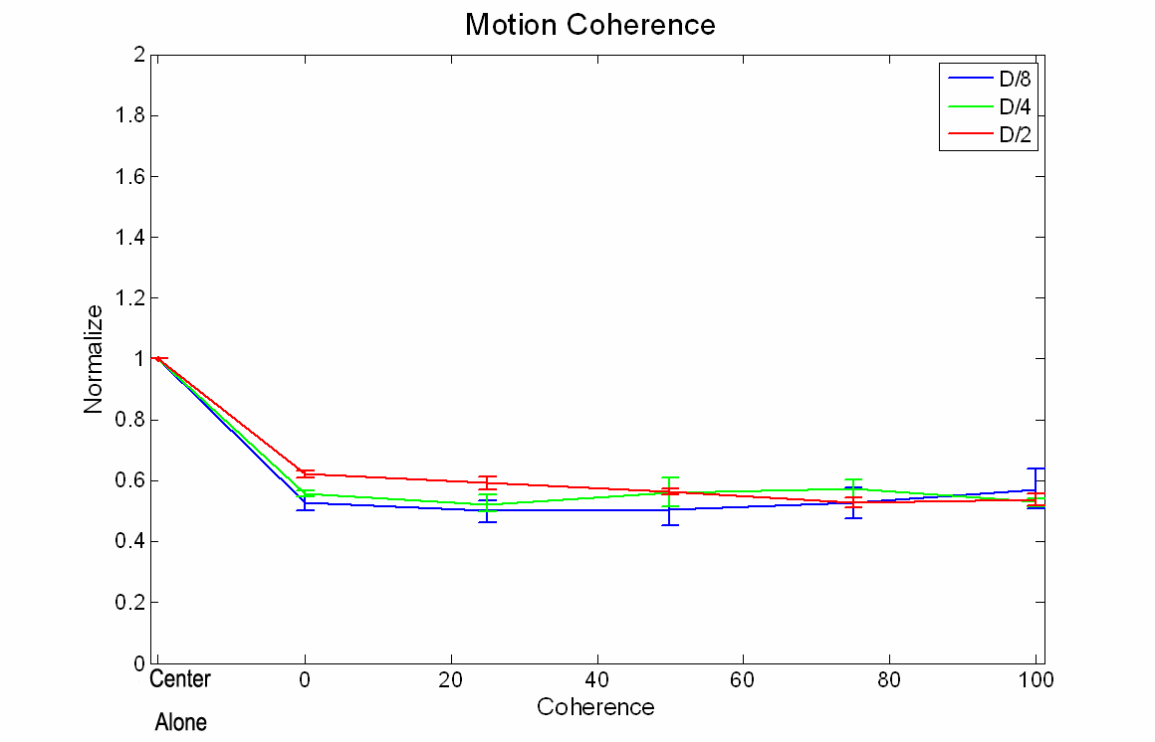


Figure 11. Motion coherence does not affect the center response.

Different background motion coherence gives the same inhibition to the DSGC in all three different spatial scales.

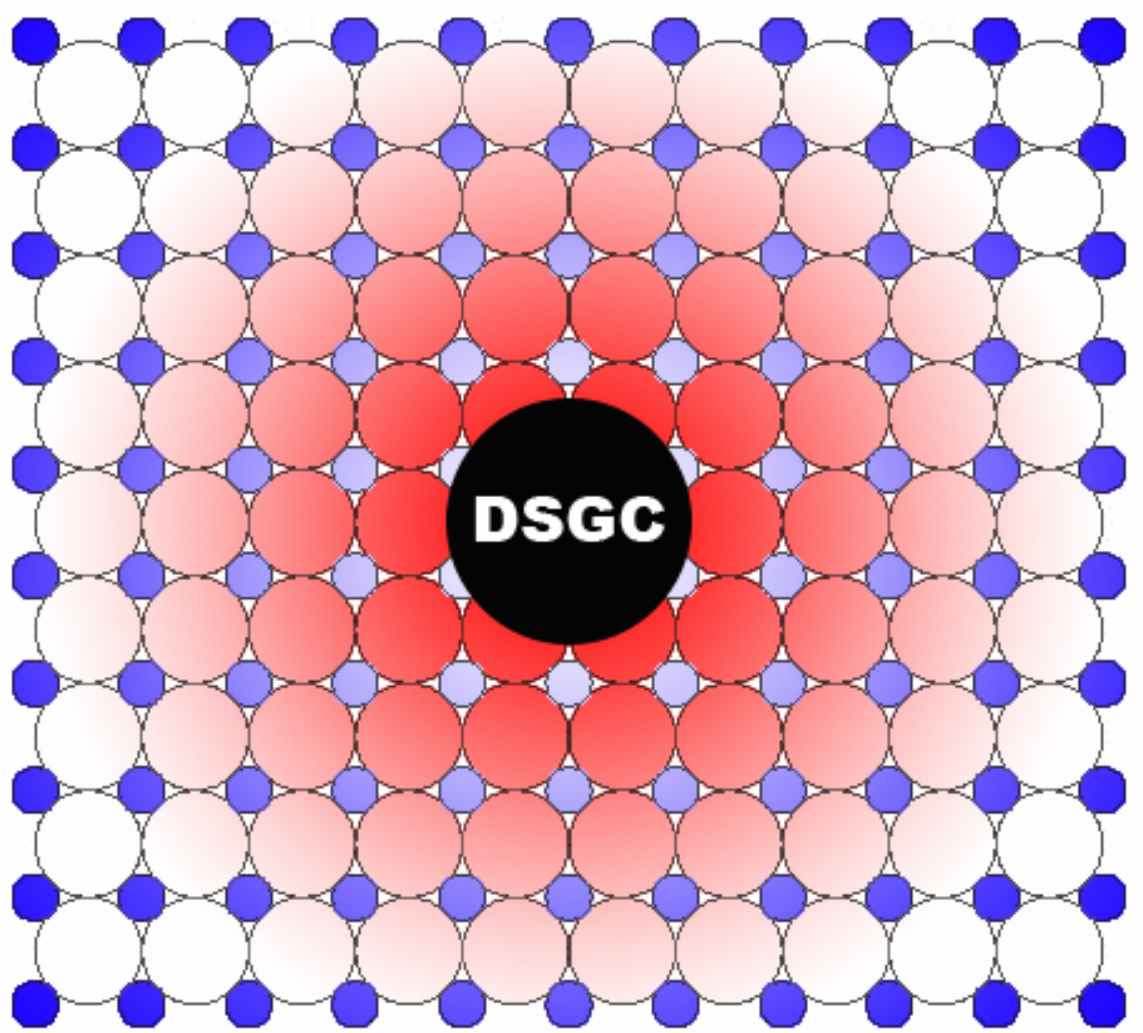


Figure 12. An Excitation-Inhibition competing model for explaining background contextual effect of the DSGC .

The big black circle indicates the DSGC's receptive field. The medium circle indicates the inhibitory subunit and the smallest circle indicates the excitatory subunit. The gradually varied red color presents the strength of inhibition. The more saturated the color, the stronger the inhibition. Similarly, blue color presents the excitation surround. In this model, , the inhibition dominates the inner surround area and the excitation

dominates the outer surround area.