

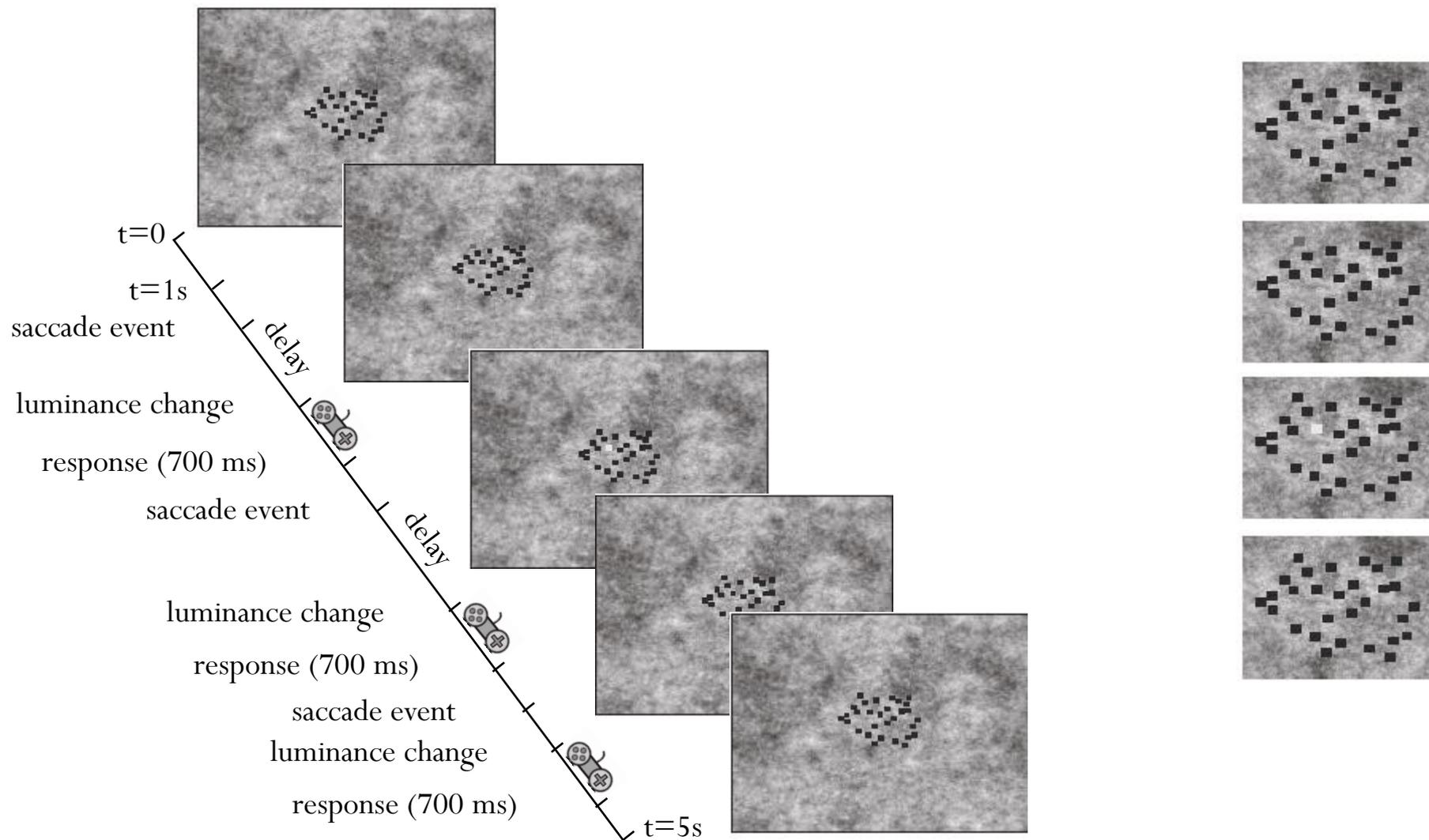
Peri-microsaccadic vision

11-25-15

Study objectives:

- Examine the Spatiotemporal profile of peri-microsaccadic contrast sensitivity.
- Examine the homogeneity of contrast sensitivity across the fovea and perifovea.
- Study the dynamics of saccadic suppression phenomena across the fovea and perifovea.

Experimental design



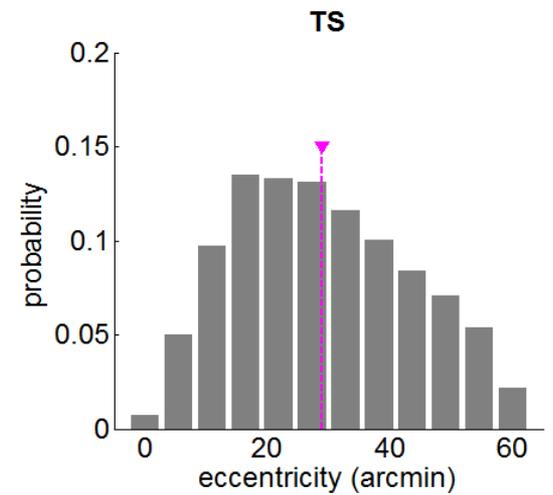
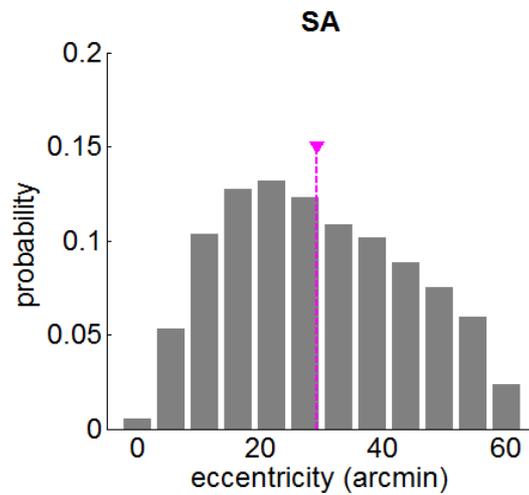
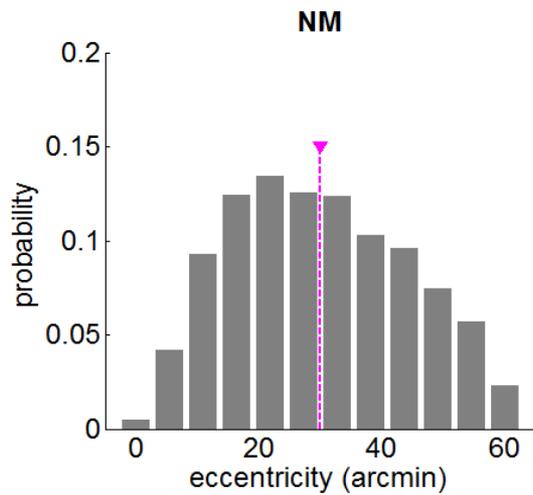
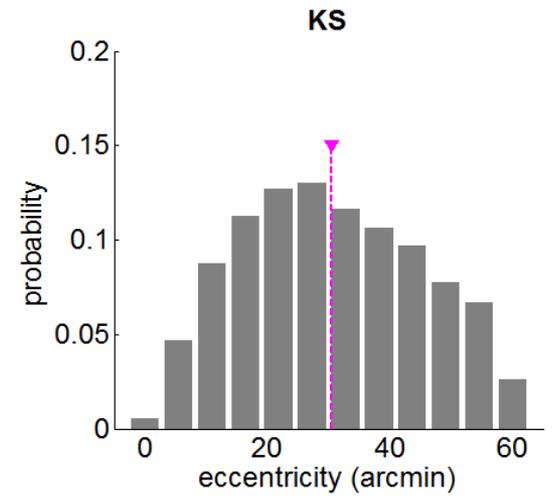
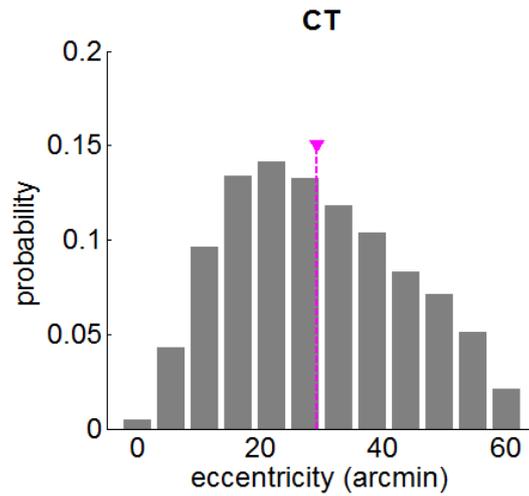
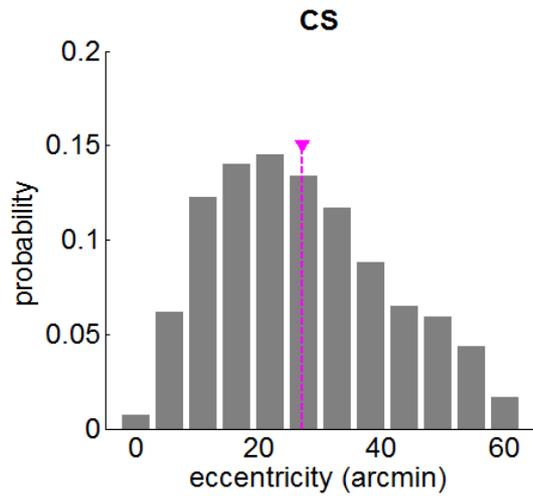
Data analysis:

- The “notrack” and “blink” trials have been discarded.
- The changes have been segmented into different spatial and temporal bins.
- The spatial bins are centered at the center of gaze.
- Only changes associated with small saccades, i.e. saccades smaller than 60 arcmin have only been included in the data analysis.
- Only changes within 60 arcmin distance from the center of gaze have been included in the analysis.
- Only horizontal changes, i.e. changes that are presented at a cone of ± 45 deg angle from the center of gaze have been included in the data analysis.
- Only changes that are only associated with 1 saccade within ± 200 ms before and after the change have been included in the analysis.
- Hits are considered as the changes that were detected within 300 to 1000 ms.

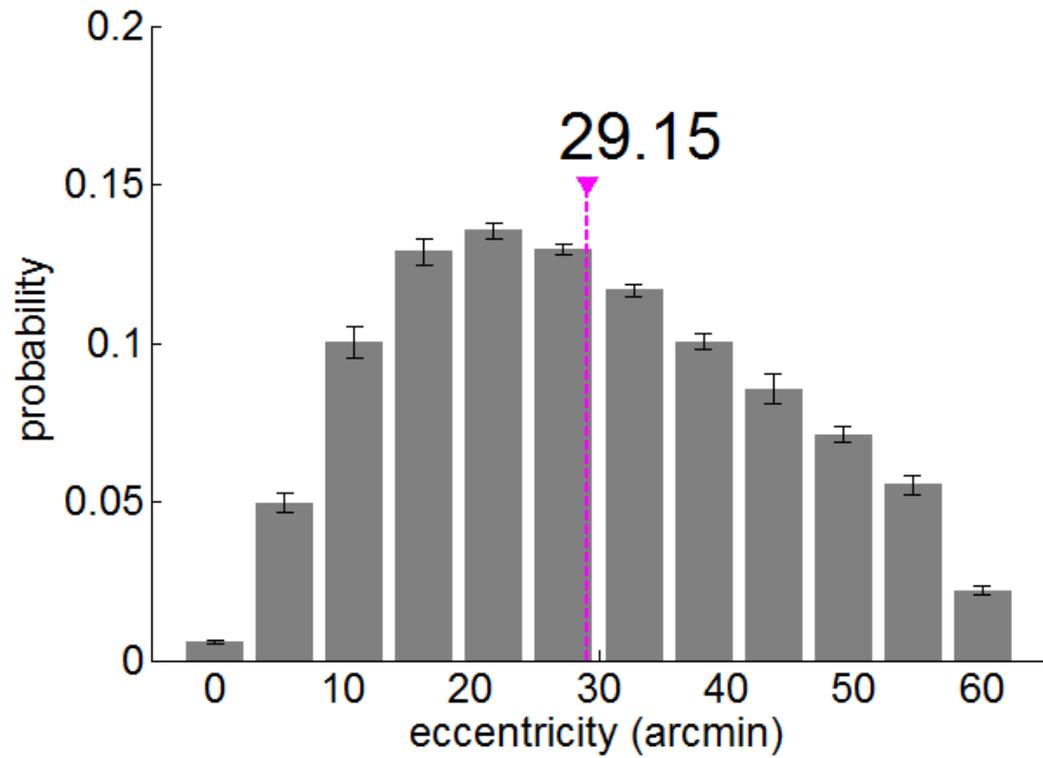
Data summary (saccade onset)

	# chng	# hor chng	#used chng		-200 to -100	-100 to -50	-50 to -25	-25 to 0	0 to 25	25 to 50	50 to 100	100 to 200
CS (20)	12562	12050	8943	0-15	80	122	74	75	214	816	370	256
				15-30	210	193	160	181	367	1426	557	362
				30-60	294	224	135	160	317	1542	507	301
CT (25)	15033	14369	11088	0-15	51	89	50	81	227	860	368	253
				15-30	208	216	137	145	403	1736	801	496
				30-60	338	226	110	148	422	2197	963	563
KS (30)	18666	18069	12880	0-15	123	113	64	69	164	812	475	324
				15-30	254	223	129	128	323	1684	1019	659
				30-60	294	241	154	135	362	2623	1471	937
NM (28)	17868	16870	11856	0-15	51	69	48	64	324	627	490	321
				15-30	144	133	116	126	581	1391	1100	621
				30-60	201	195	130	138	657	1888	1534	907
SA (23)	13079	12468	8053	0-15	99	111	62	56	145	538	291	227
				15-30	251	154	92	105	298	1039	520	395
				30-60	364	183	107	104	318	1407	702	485
TS (25)	12652	11816	7501	0-15	83	124	64	40	139	639	230	79
				15-30	233	195	94	77	279	1289	402	183
				30-60	486	204	86	77	259	1534	452	253

Distribution of change eccentricity

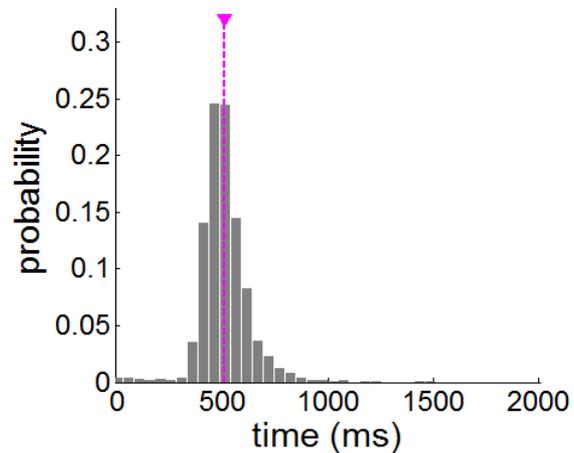


Distribution of change eccentricity

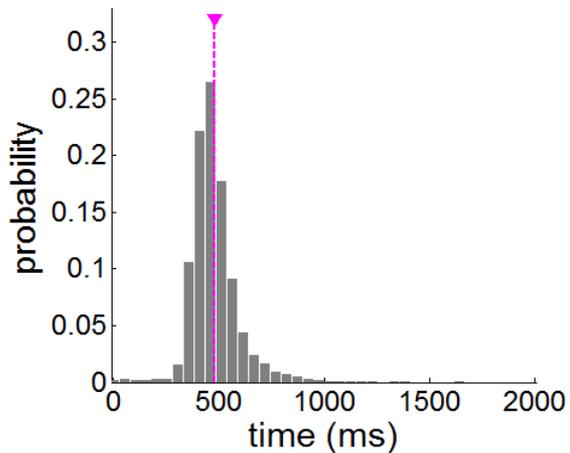


Distribution of reaction times

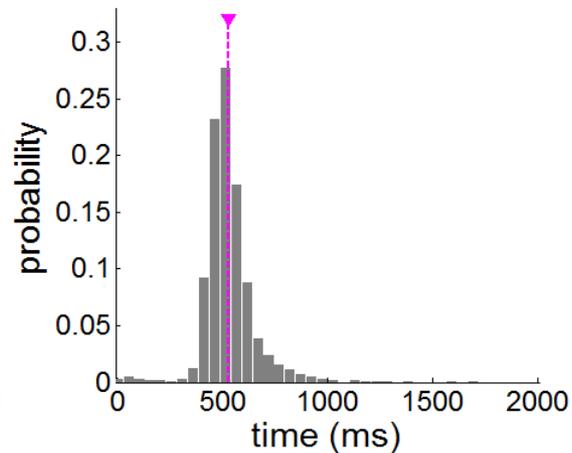
CS



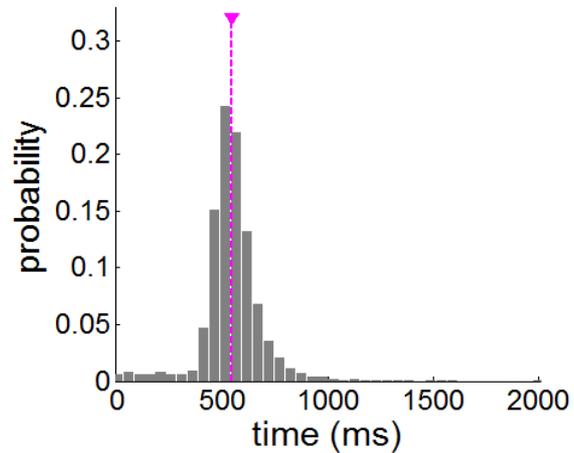
CT



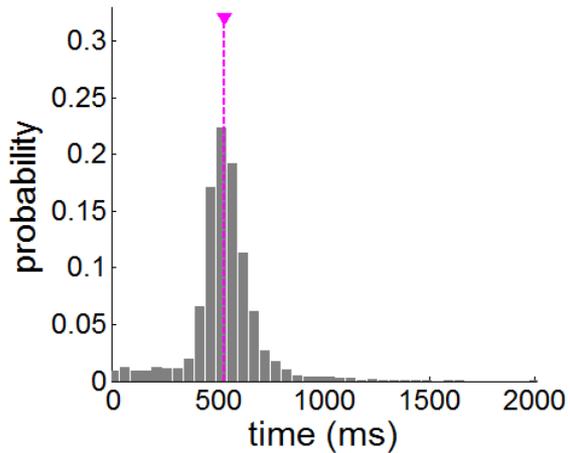
KS



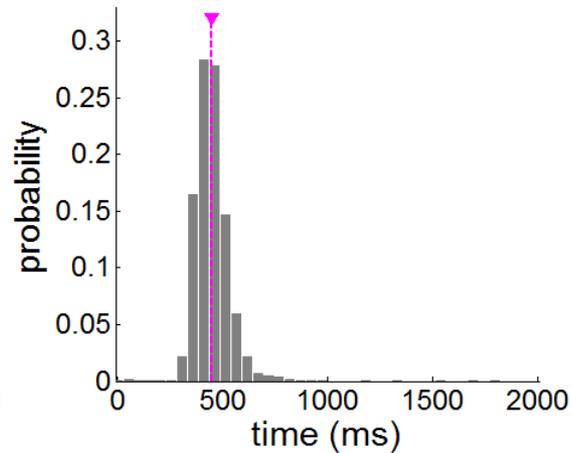
NM



SA

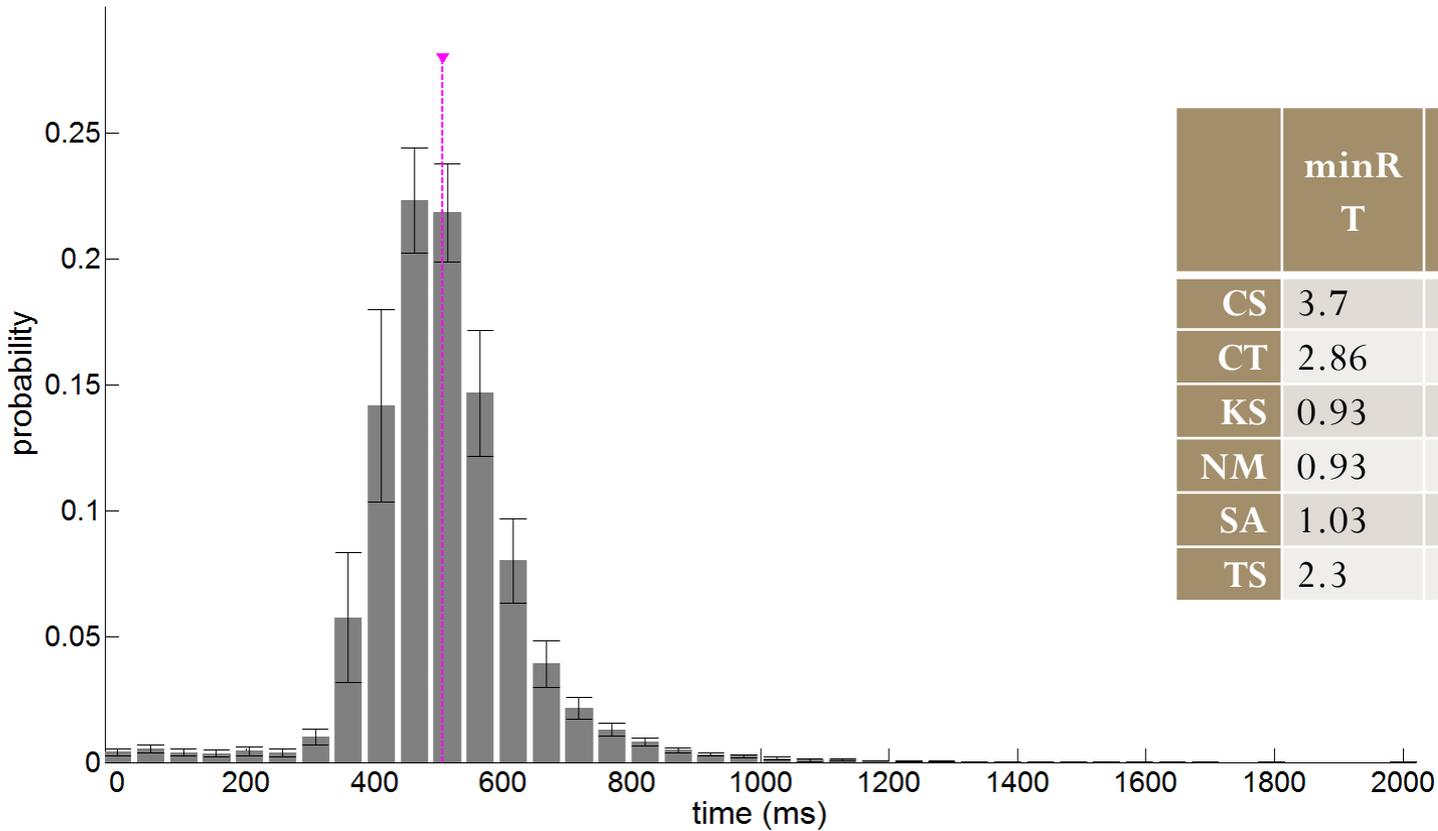


TS



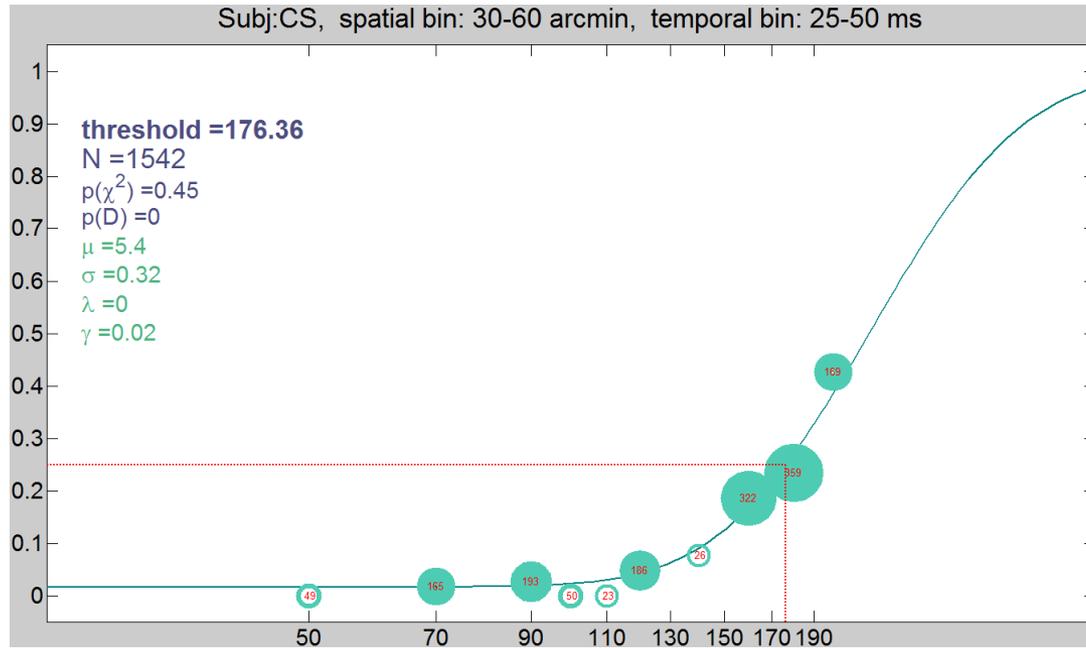
Distribution of reaction times

Reaction time for all button press events



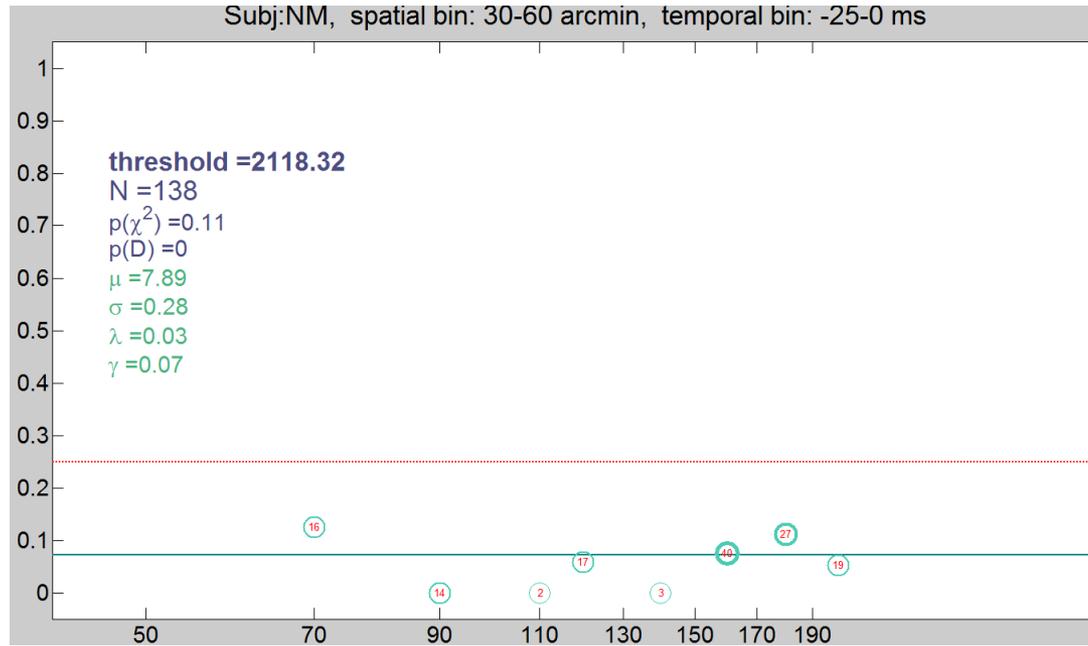
	minR T	maxRT	5 perce ntile	95 perce ntile
CS	3.7	1505.2	382.28	696.55
CT	2.86	1637.7	350.86	681.01
KS	0.93	1707.9	406.78	734.14
NM	0.93	2067.0	372.43	750.89
SA	1.03	1983.1	226.12	751.69
TS	2.3	1793.3	344.29	577.98

Contrast threshold estimation



$$\text{luminance} = 15 * (\text{contrast}/255) + 0.11$$

Contrast threshold estimation

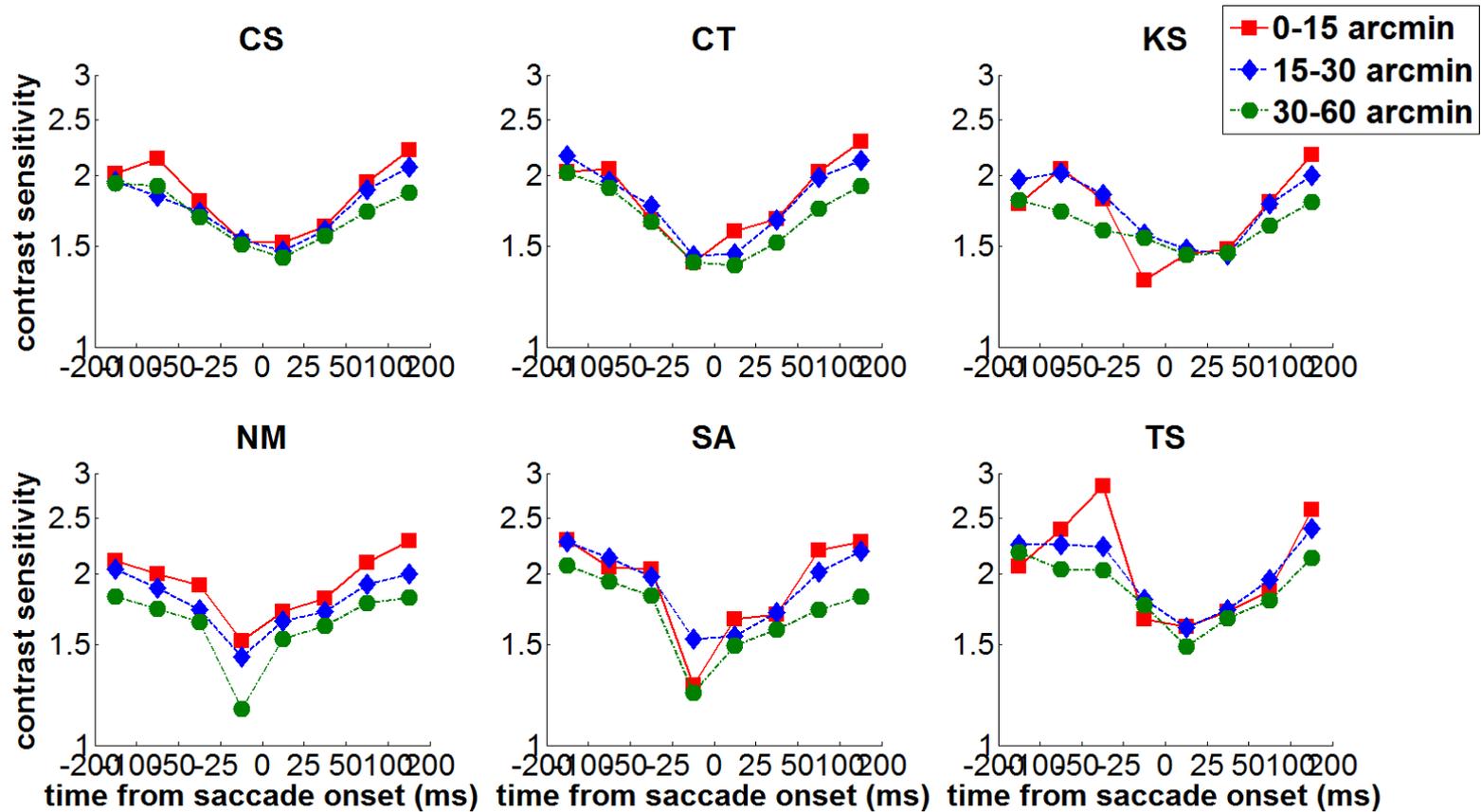


max contrast step threshold = 600

Time course of sensitivity change across the fovea and perifovea

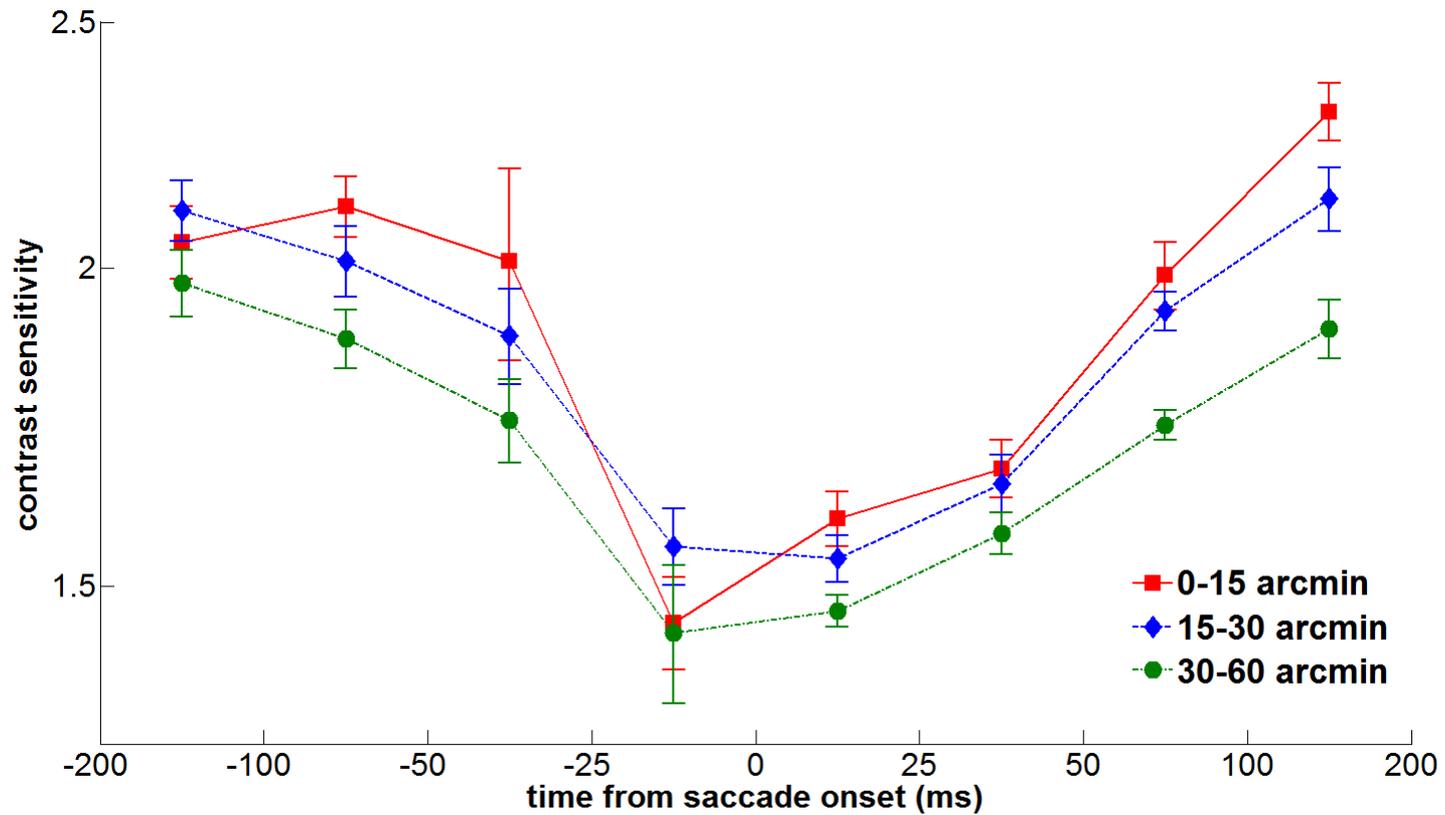
Relative to occurrence of microsaccades and small saccades (Michelson contrast)

$$\text{Sensitivity} = (\text{luminance} + (2 * \text{default luminance level of the flies})) / \text{luminance threshold}$$

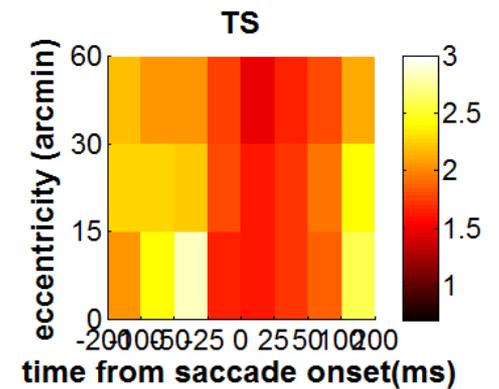
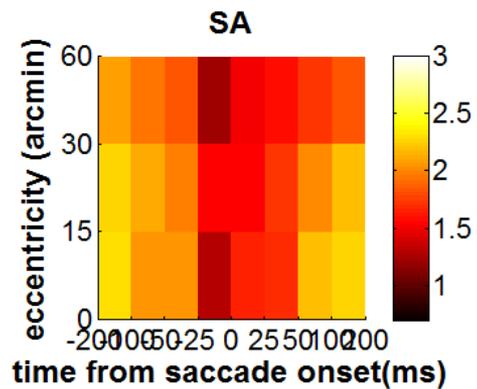
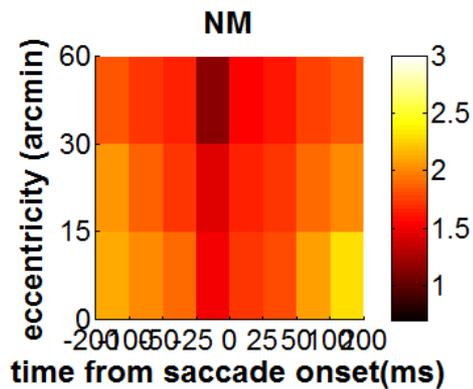
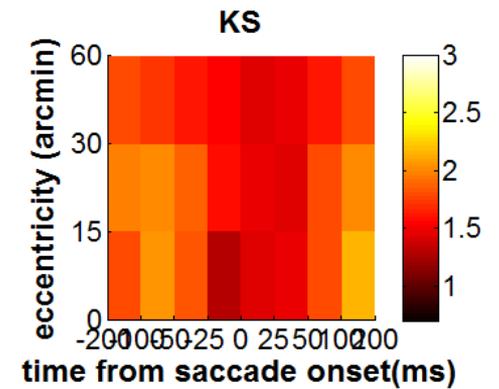
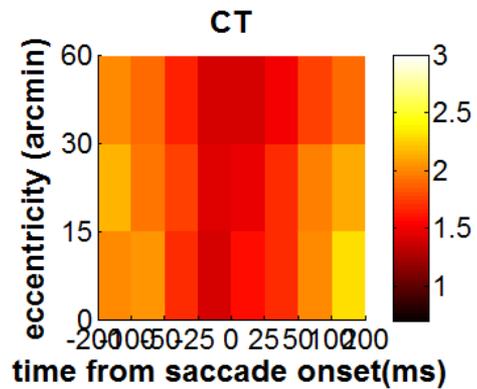
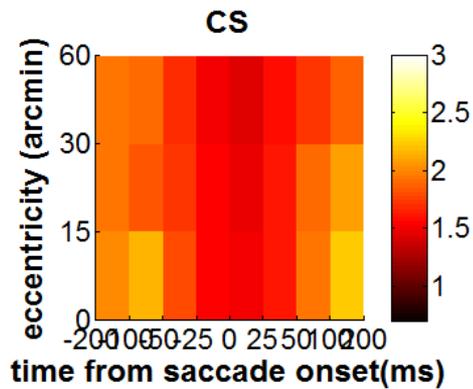


Time course of sensitivity change across the fovea and perifovea

Relative to occurrence of microsaccades and small saccades (Michelson contrast)

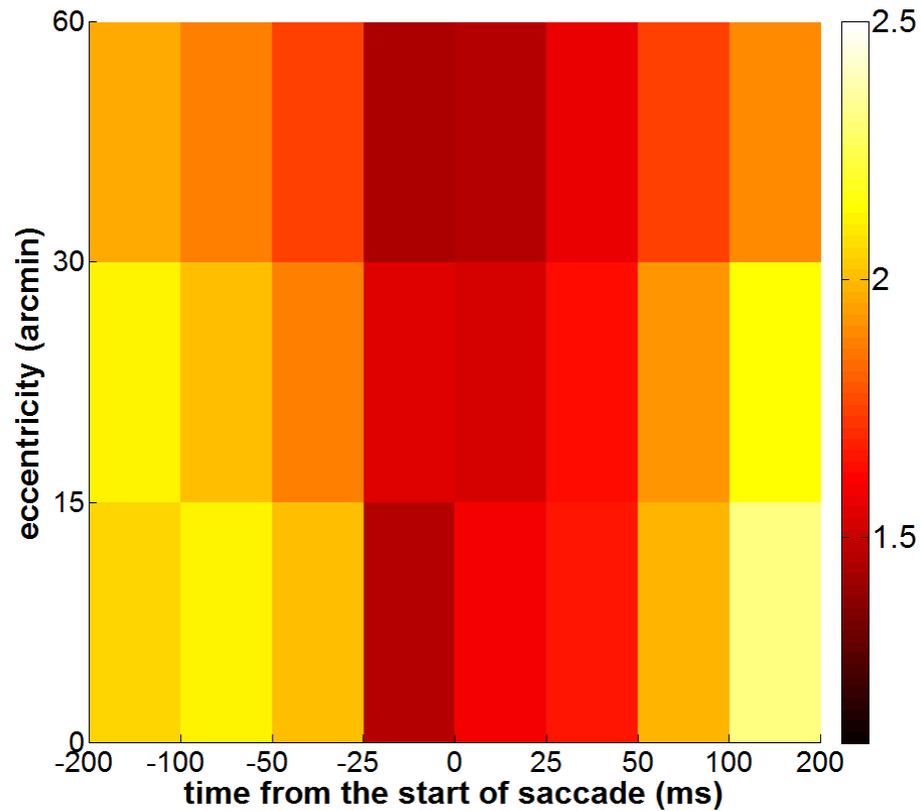


Spatiotemporal contrast sensitivity map.



Spatiotemporal contrast sensitivity map.

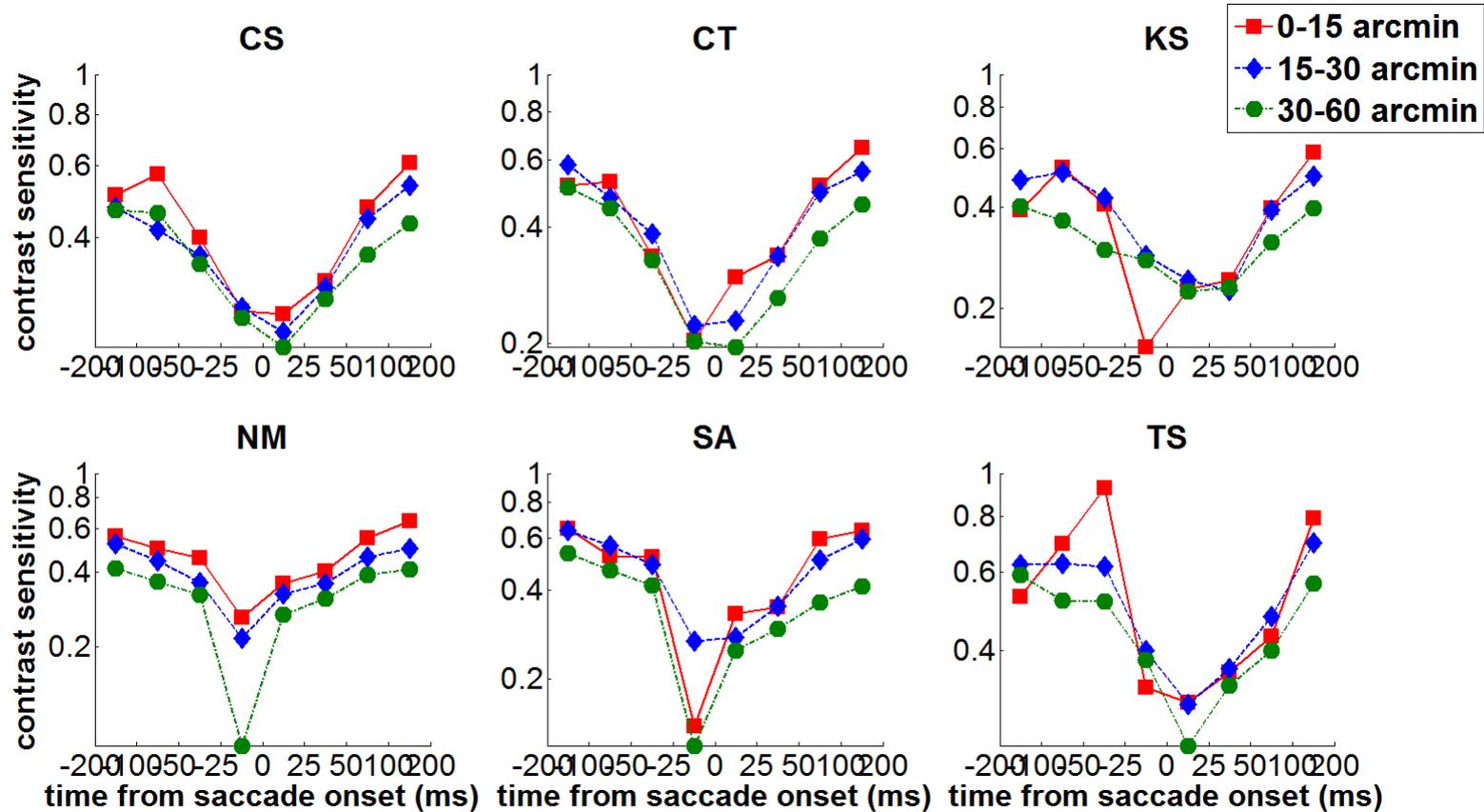
Relative to occurrence of microsaccades and small saccades



Time course of sensitivity change across the fovea and perifovea

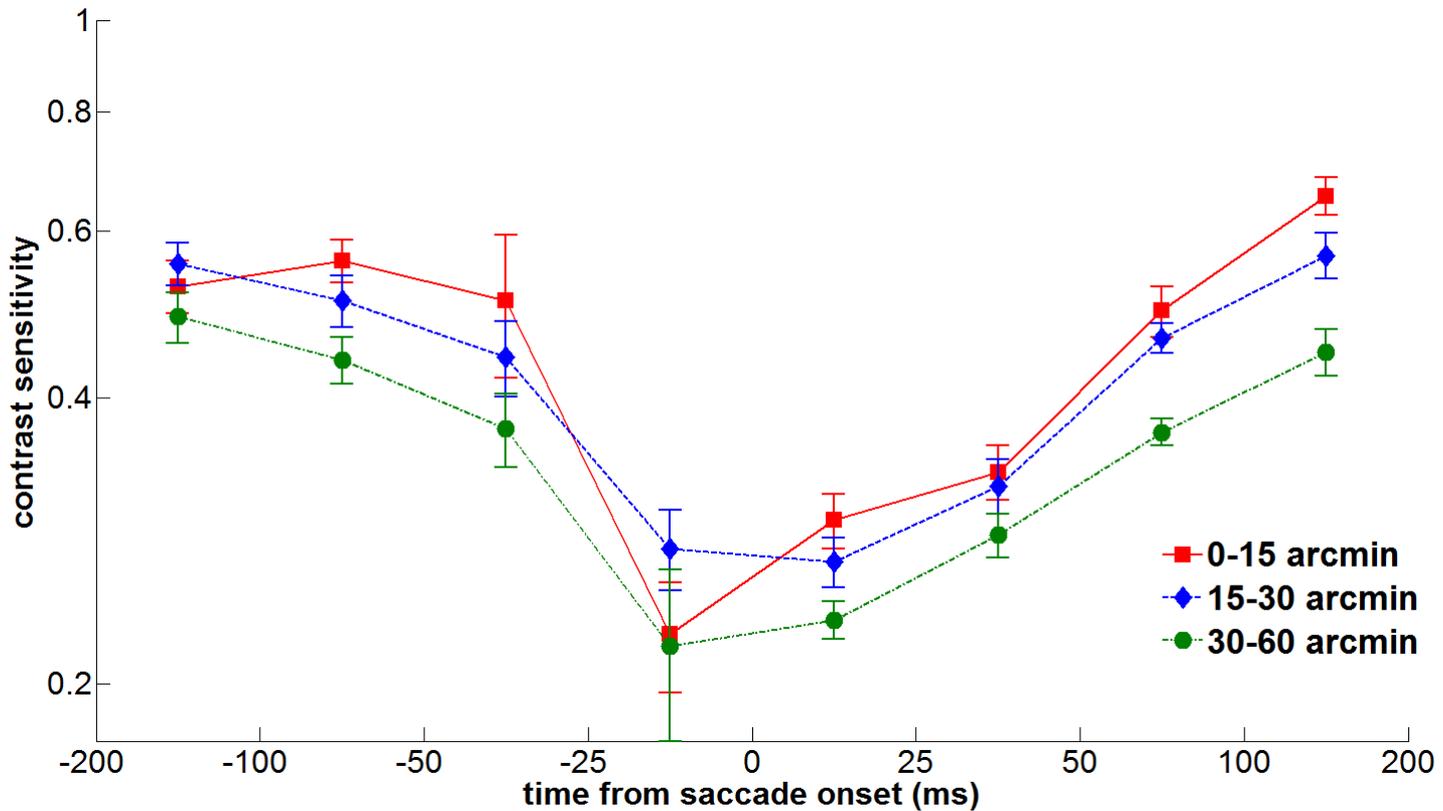
Relative to occurrence of microsaccades and small saccades (Weber contrast)

Weber Sensitivity = default luminance level of the flies / luminance threshold

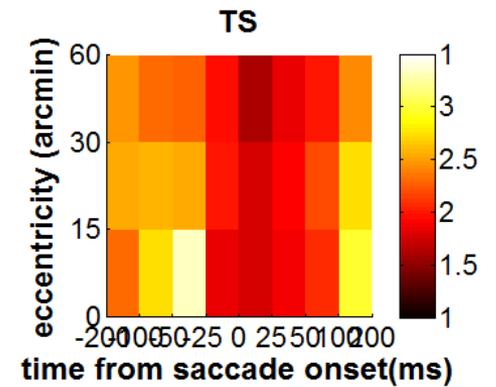
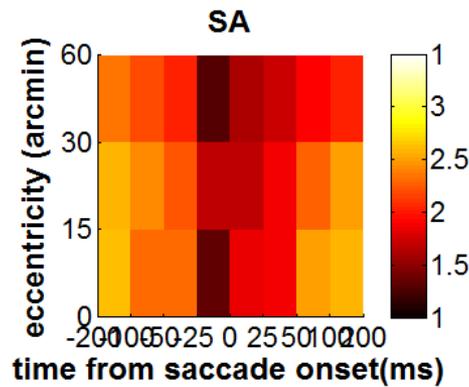
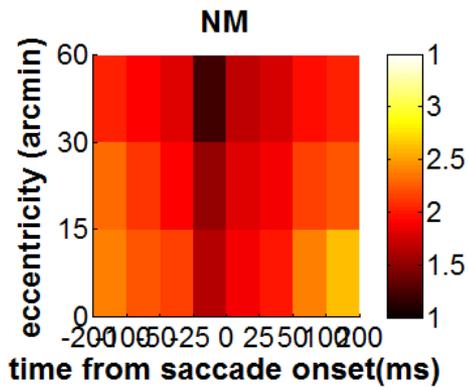
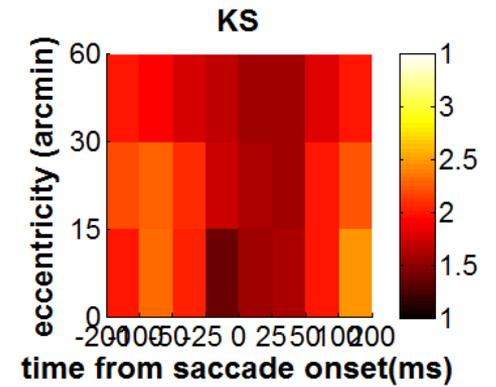
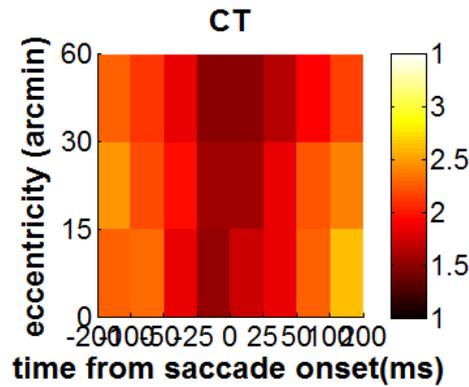
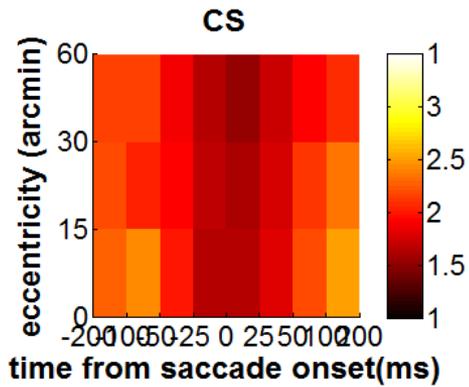


Time course of sensitivity change across the fovea and perifovea

Relative to occurrence of microsaccades and small saccades

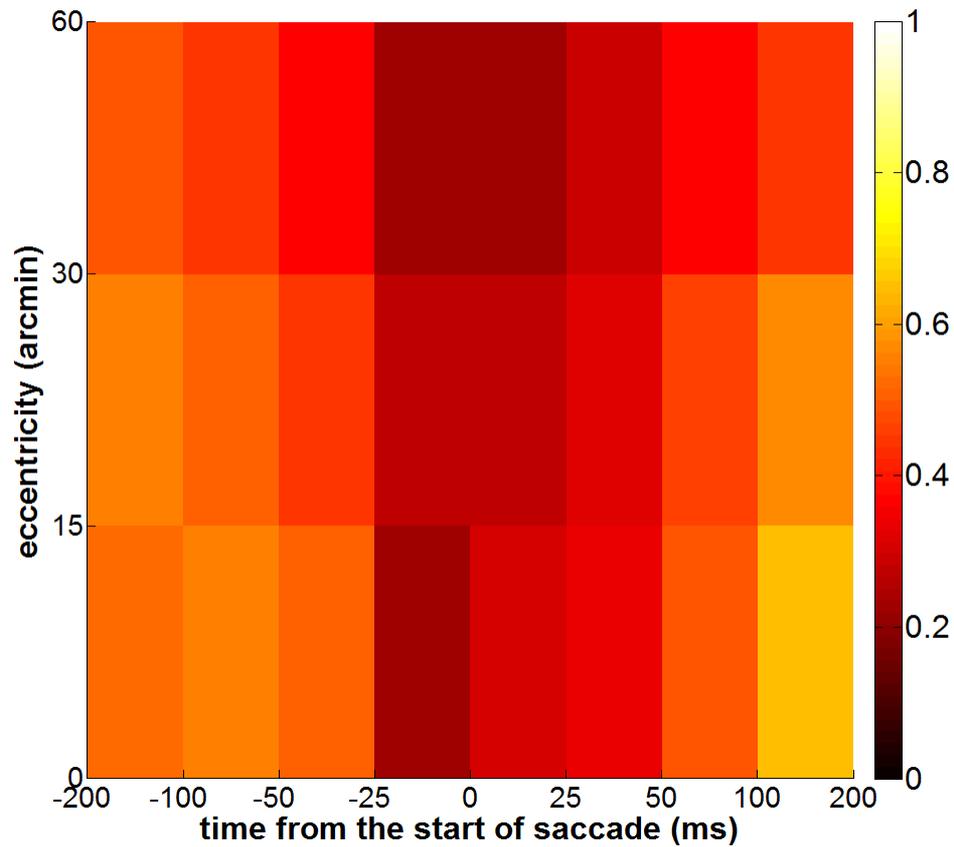


Spatiotemporal contrast sensitivity map.



Spatiotemporal contrast sensitivity map.

Relative to occurrence of microsaccades and small saccades



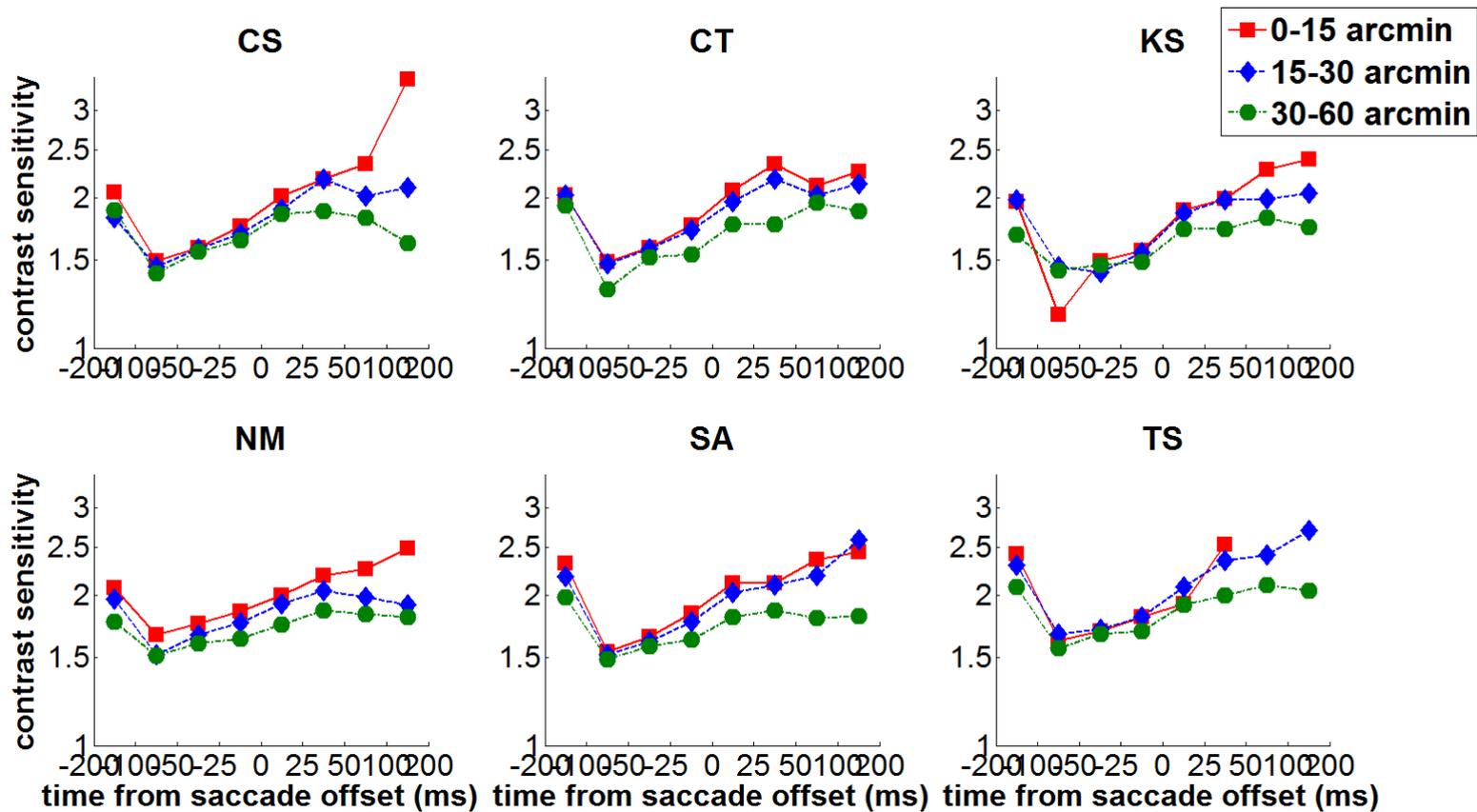
Data summary (saccade offset)

	# chng	# hor chng	#used chng		-200 to -100	-100 to -50	-50 to -25	-25 to 0	0 to 25	25 to 50	50 to 100	100 to 200
CS (20)	12562	12050	8617	0-15	232	193	785	359	125	134	120	32
				15-30	417	424	1314	592	197	177	178	50
				30-60	451	373	1583	433	133	171	111	33
CT (25)	15033	14369	10742	0-15	135	161	601	541	161	155	138	75
				15-30	364	307	1179	1081	333	350	273	146
				30-60	389	301	1730	1027	430	398	319	148
KS (30)	18666	18069	12406	0-15	227	192	686	424	198	155	149	60
				15-30	430	338	1437	824	487	334	279	135
				30-60	499	469	2348	1054	644	499	367	171
NM (28)	17868	16870	11689	0-15	114	142	563	449	247	173	189	98
				15-30	264	281	1223	902	584	381	344	178
				30-60	345	384	1656	1088	763	564	506	251
SA (23)	13079	12468	7592	0-15	189	137	368	359	145	106	104	70
				15-30	291	243	824	602	226	224	188	94
				30-60	357	302	1189	631	340	290	216	97
TS (25)	12652	11816	6981	0-15	228	99	661	248	41	38	29	24
				15-30	376	189	1333	431	91	71	85	51
				30-60	399	198	1652	363	89	114	112	59

Time course of sensitivity change across the fovea and perifovea

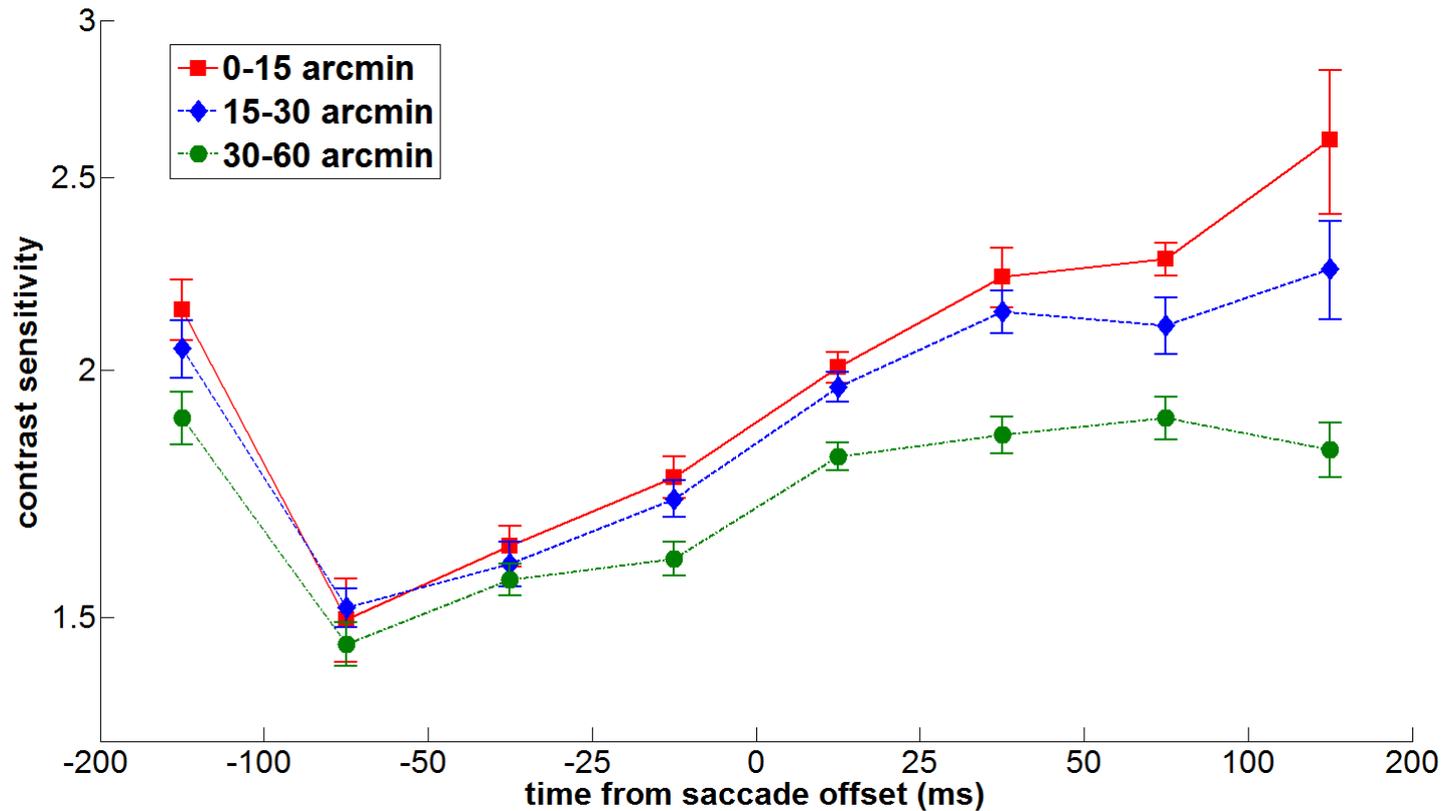
Relative to occurrence of microsaccades and small saccades (Michelson contrast)

$$\text{Sensitivity} = (\text{luminance} + (2 * \text{default luminance level of the flies})) / \text{luminance threshold}$$

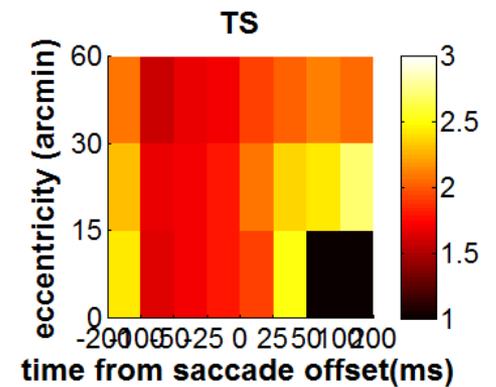
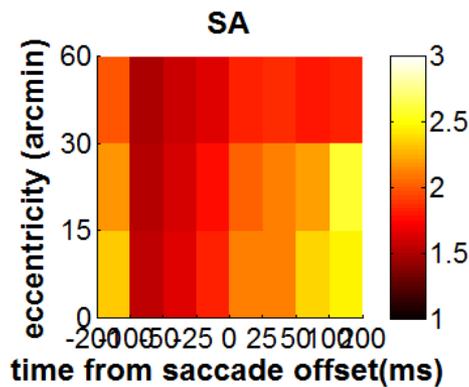
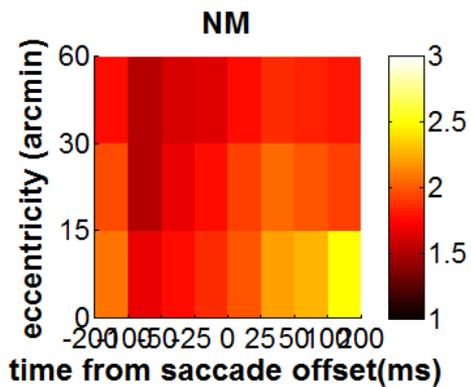
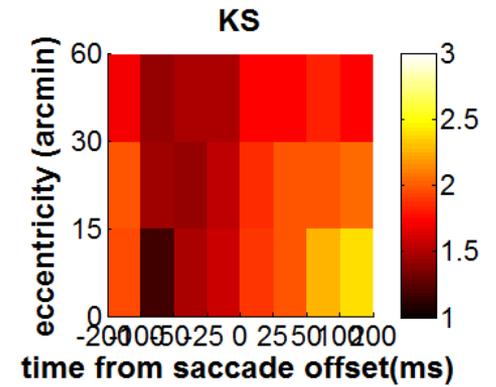
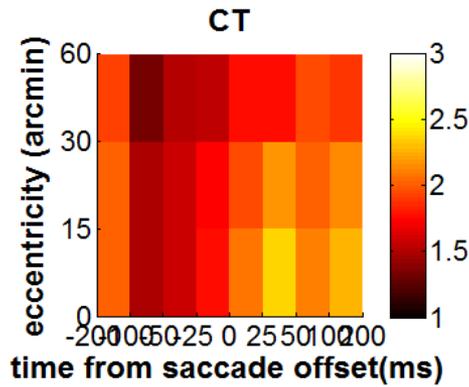
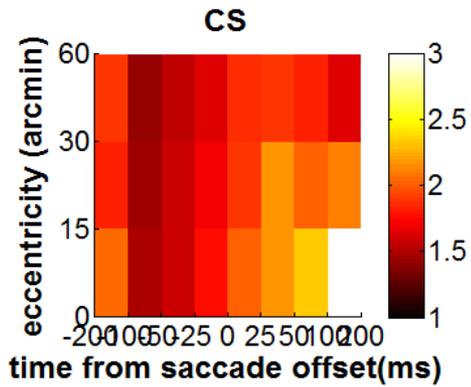


Time course of sensitivity change across the fovea and perifovea

Relative to occurrence of microsaccades and small saccades (Michelson contrast)

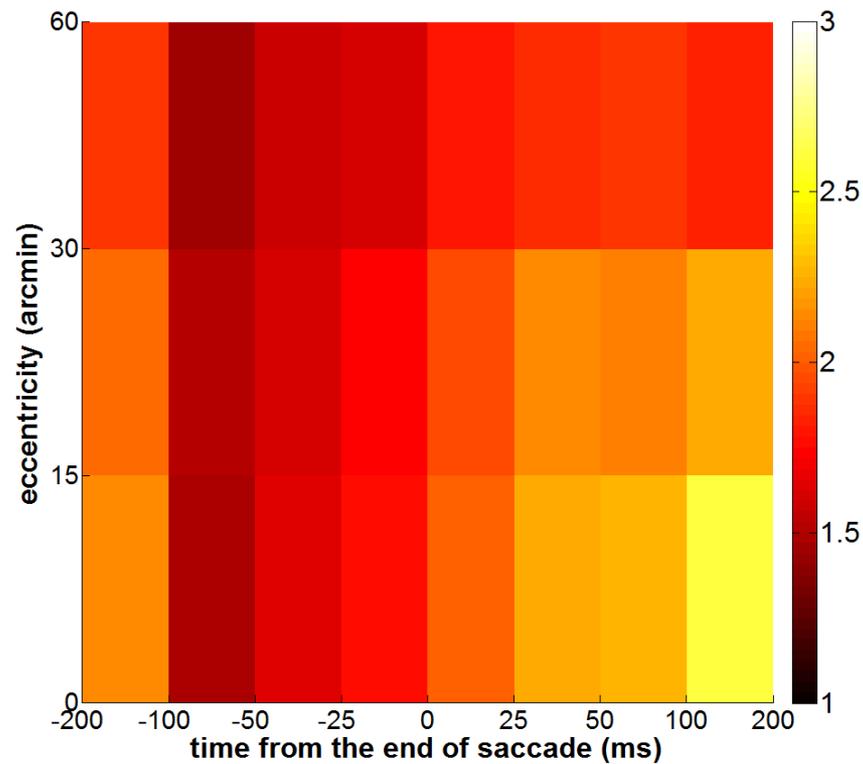


Spatiotemporal contrast sensitivity map.



Spatiotemporal contrast sensitivity map.

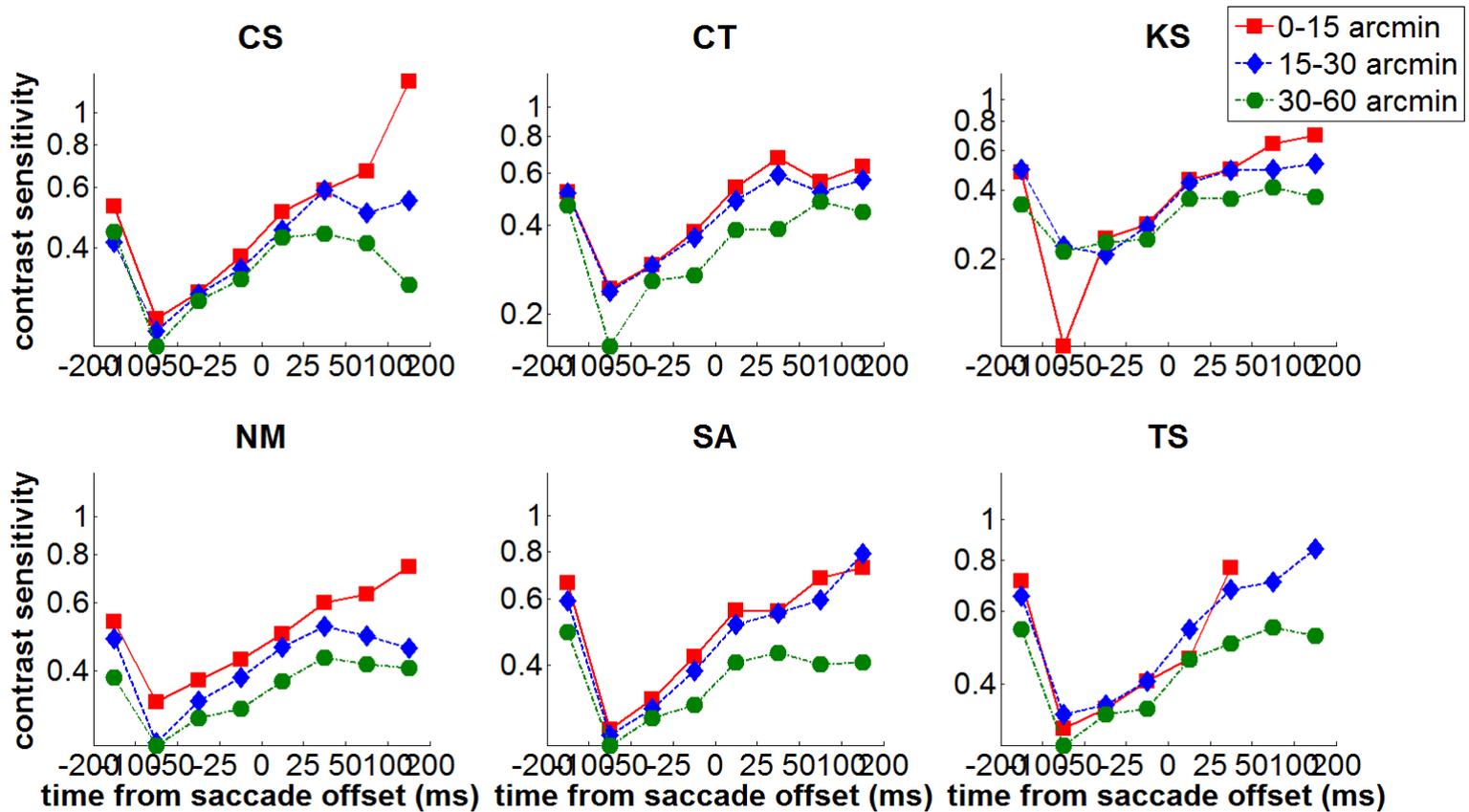
Relative to occurrence of microsaccades and small saccades



Time course of sensitivity change across the fovea and perifovea

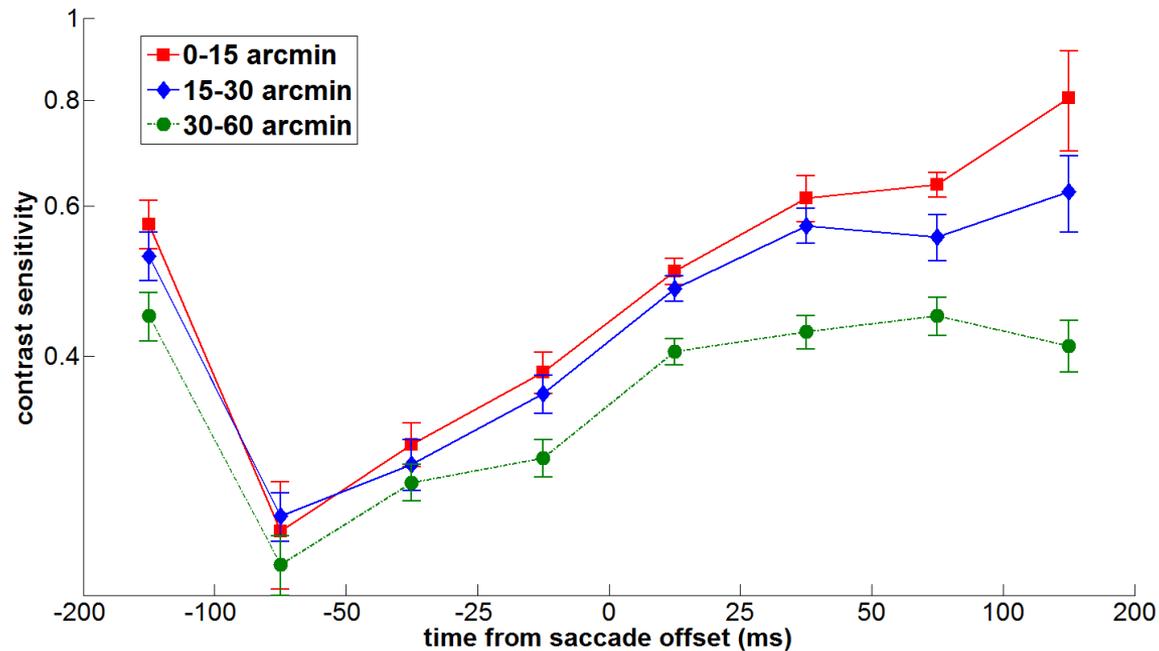
Relative to occurrence of microsaccades and small saccades (Weber contrast)

Weber Sensitivity = default luminance level of the flies / luminance threshold

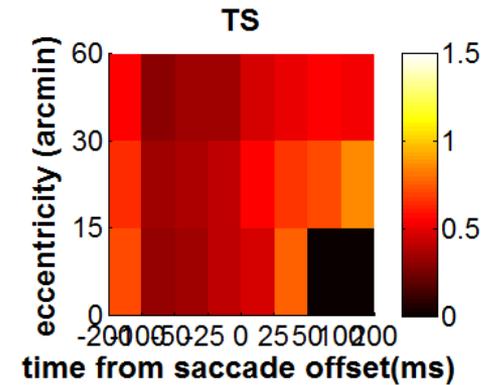
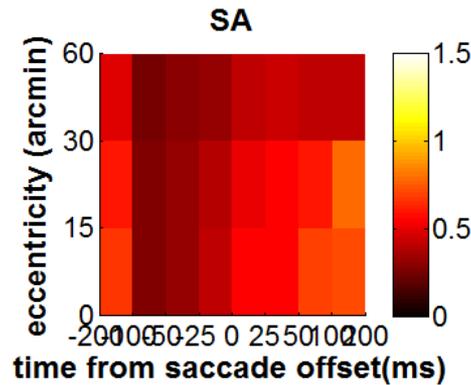
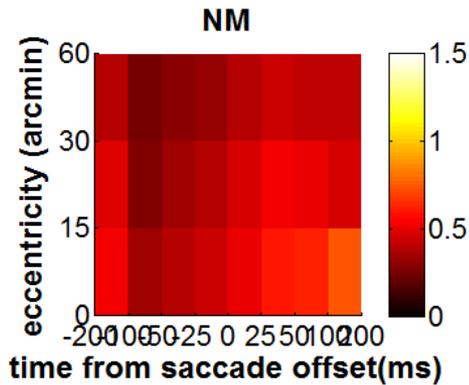
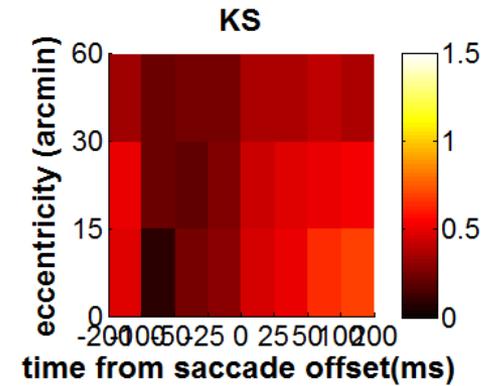
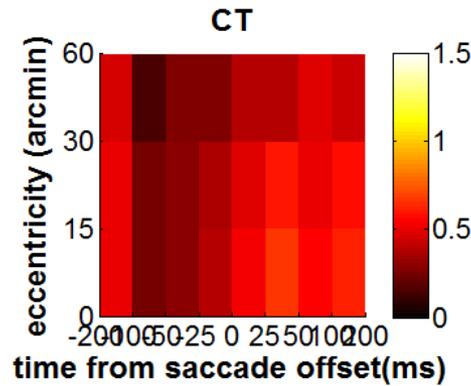
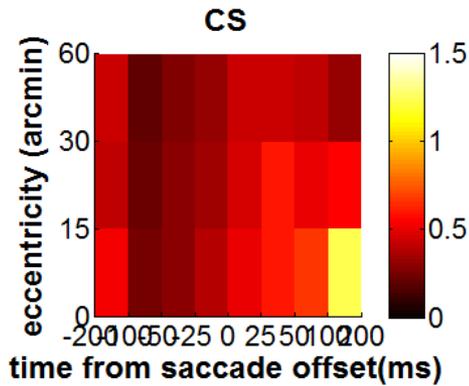


Time course of sensitivity change across the fovea and perifovea

Relative to occurrence of microsaccades and small saccades

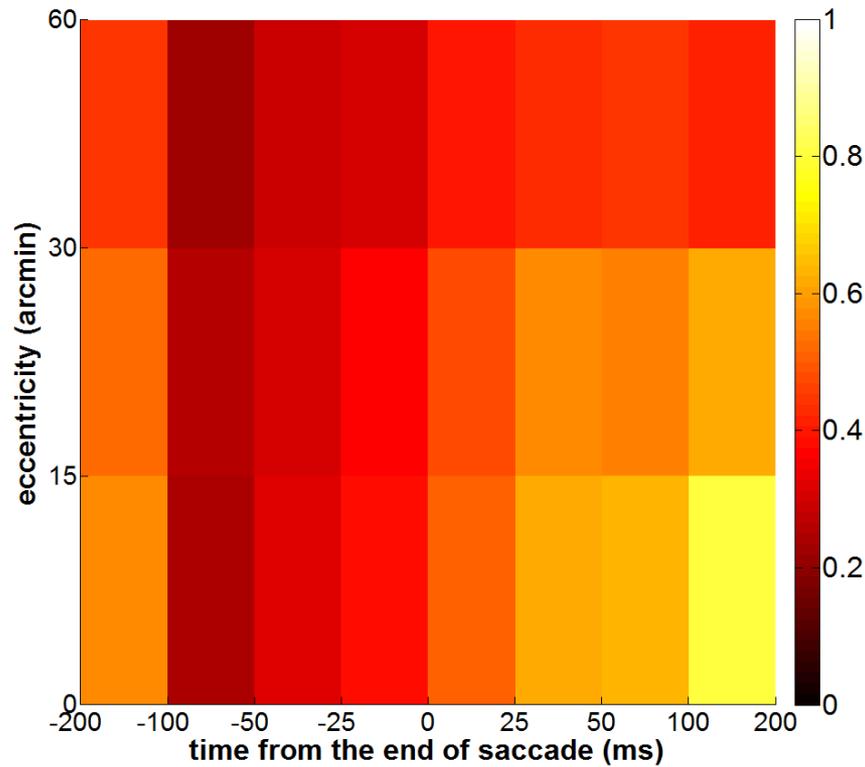


Spatiotemporal contrast sensitivity map.



Spatiotemporal contrast sensitivity map.

Relative to occurrence of microsaccades and small saccades



D-prime analysis (saccade onset)

Contrast step			-200 to -100	-100 to -50	-50 to -25	-25 to 0	0 to 25	25 to 50	50 to 100	100 to 200
120	CS	0-15	13	16	7	11	38	114	47	27
		15-30	20	26	14	22	41	173	57	52
		30-60	38	29	16	21	35	186	66	42
	CT	0-15	5	16	7	13	22	93	31	24
		15-30	20	30	16	18	60	210	64	39
		30-60	31	27	12	16	33	228	76	38
	KS	0-15	17	17	7	10	14	95	53	27
		15-30	24	20	12	16	26	159	94	67
		30-60	53	27	19	16	45	252	136	107
	NM	0-15	5	12	10	13	37	61	43	24
		15-30	18	16	15	19	63	156	106	40
		30-60	21	20	17	17	57	186	142	75
	SA	0-15	3	19	6	4	21	61	27	24
		15-30	39	23	16	11	36	102	37	33
		30-60	36	15	18	5	26	109	40	24
	TS	0-15	12	15	8	7	15	84	27	7
		15-30	36	27	8	8	34	143	45	23
		30-60	46	24	9	11	24	139	45	23

D-prime analysis (saccade onset)

Contrast step			-200 to -100	-100 to -50	-50 to -25	-25 to 0	0 to 25	25 to 50	50 to 100	100 to 200
140	CS	0-15	26	26	19	14	37	152	69	71
		15-30	42	44	33	39	85	307	115	86
		30-60	52	51	27	38	68	322	101	66
	CT	0-15	12	21	6	18	51	166	67	54
		15-30	41	47	29	29	84	324	170	119
		30-60	95	53	22	26	104	463	228	125
	KS	0-15	23	23	12	14	42	171	78	58
		15-30	52	48	27	24	71	368	173	107
		30-60	89	55	28	25	90	562	233	135
	NM	0-15	11	17	7	12	83	147	94	58
		15-30	29	30	27	21	142	278	192	123
		30-60	41	39	25	40	162	375	233	136
	SA	0-15	16	17	13	14	46	119	57	45
		15-30	65	30	13	31	56	230	114	97
		30-60	70	46	27	27	72	337	168	119
	TS	0-15	14	20	10	5	24	131	54	23
		15-30	41	29	15	12	72	256	87	40
		30-60	98	48	20	14	67	316	101	68

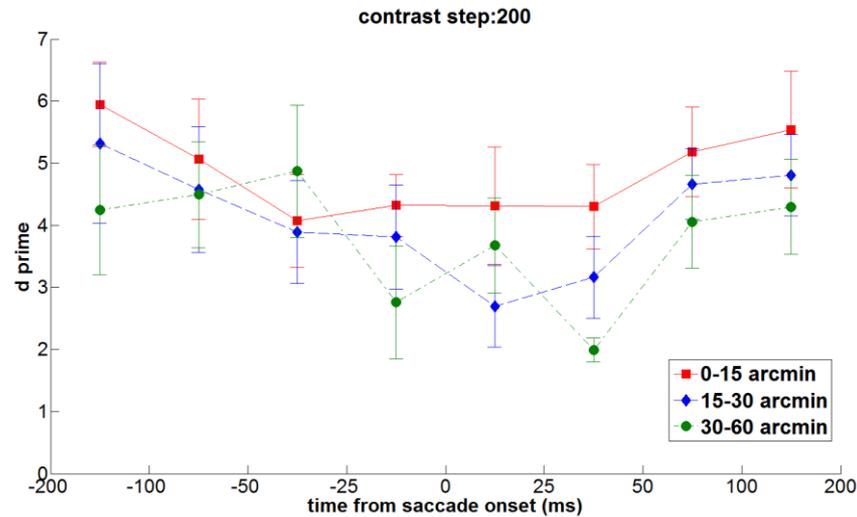
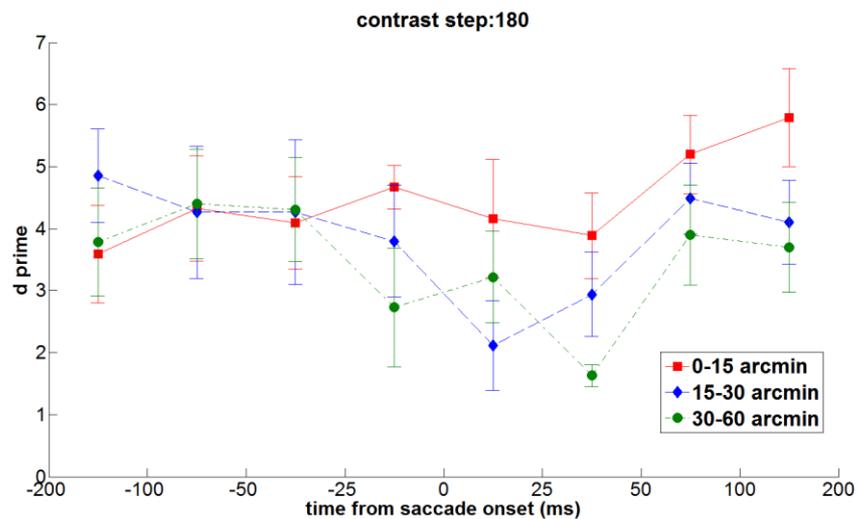
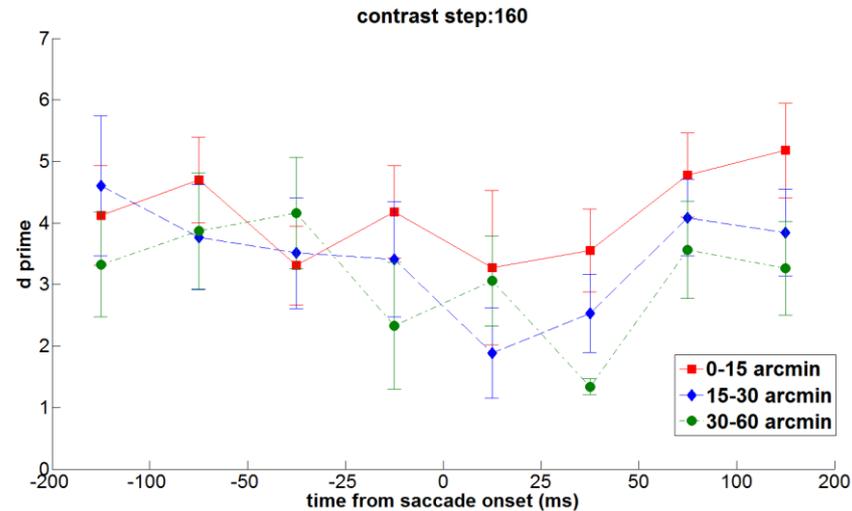
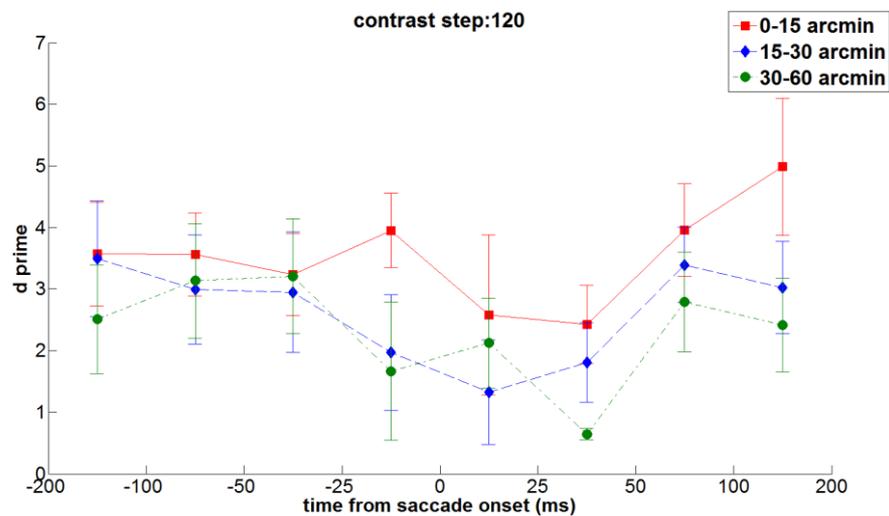
D-prime analysis (saccade onset)

Contrast step			-200 to -100	-100 to -50	-50 to -25	-25 to 0	0 to 25	25 to 50	50 to 100	100 to 200
180	CS	0-15	7	29	17	18	48	167	63	56
		15-30	52	52	50	44	79	284	140	92
		30-60	81	64	29	36	69	359	91	46
	CT	0-15	10	15	10	15	48	183	101	63
		15-30	46	50	29	29	67	346	176	105
		30-60	102	59	21	37	95	462	191	122
	KS	0-15	11	17	15	9	25	168	87	69
		15-30	49	52	24	28	74	347	162	120
		30-60	93	60	42	29	82	547	254	129
	NM	0-15	10	13	13	13	67	148	89	64
		15-30	30	33	26	29	136	309	171	105
		30-60	48	54	37	27	159	373	217	161
	SA	0-15	19	19	12	11	17	99	55	56
		15-30	47	30	16	24	63	214	109	78
		30-60	105	40	27	22	67	352	166	97
	TS	0-15	6	33	16	11	40	131	48	20
		15-30	41	47	22	14	50	290	88	51
		30-60	115	42	20	15	61	341	92	56

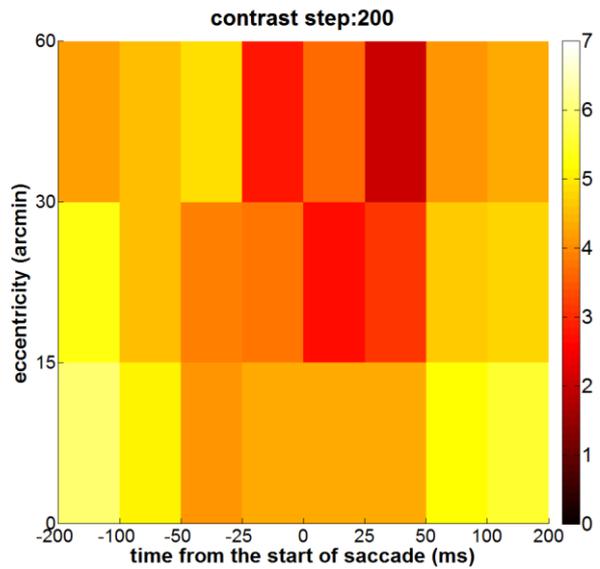
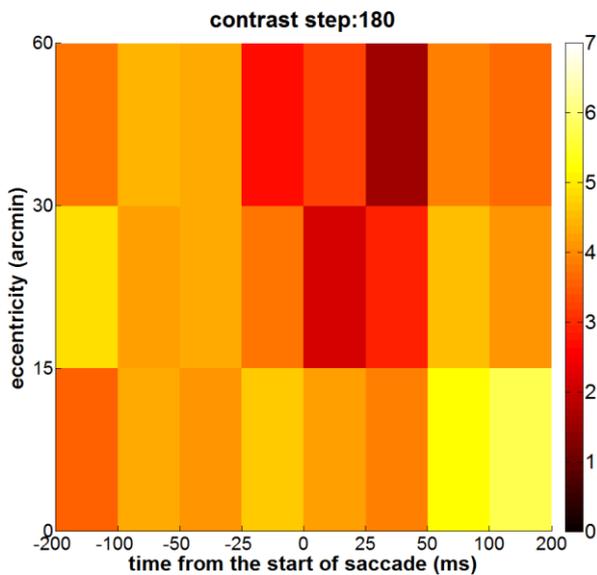
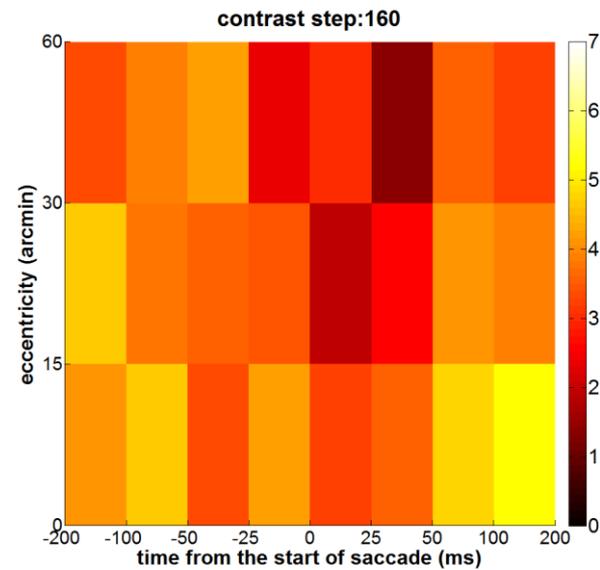
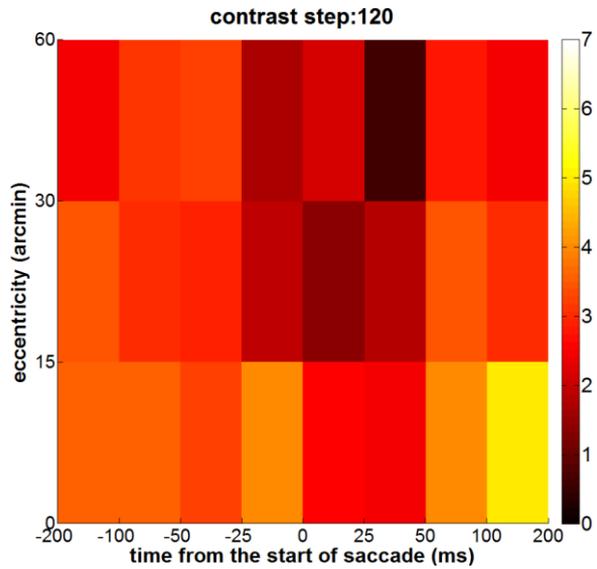
D-prime analysis (saccade onset)

Contrast step			-200 to -100	-100 to -50	-50 to -25	-25 to 0	0 to 25	25 to 50	50 to 100	100 to 200
200	CS	0-15	7	13	8	8	23	115	60	41
		15-30	25	21	15	22	42	170	67	49
		30-60	47	26	22	23	50	169	65	23
	CT	0-15	4	14	3	8	40	116	44	34
		15-30	26	21	18	10	40	233	112	59
		30-60	41	21	18	17	57	283	114	62
	KS	0-15	10	14	7	12	31	88	58	41
		15-30	26	27	21	15	46	194	94	65
		30-60	43	22	21	23	39	324	120	67
	NM	0-15	4	9	4	5	35	73	43	29
		15-30	11	18	12	28	76	176	99	60
		30-60	21	24	23	19	71	218	128	80
	SA	0-15	7	7	10	5	17	70	40	30
		15-30	30	20	11	4	48	143	73	44
		30-60	57	18	9	14	36	164	79	54
	TS	0-15	8	14	9	5	16	83	22	6
		15-30	27	28	14	9	38	162	46	28
		30-60	68	28	13	9	37	207	69	26

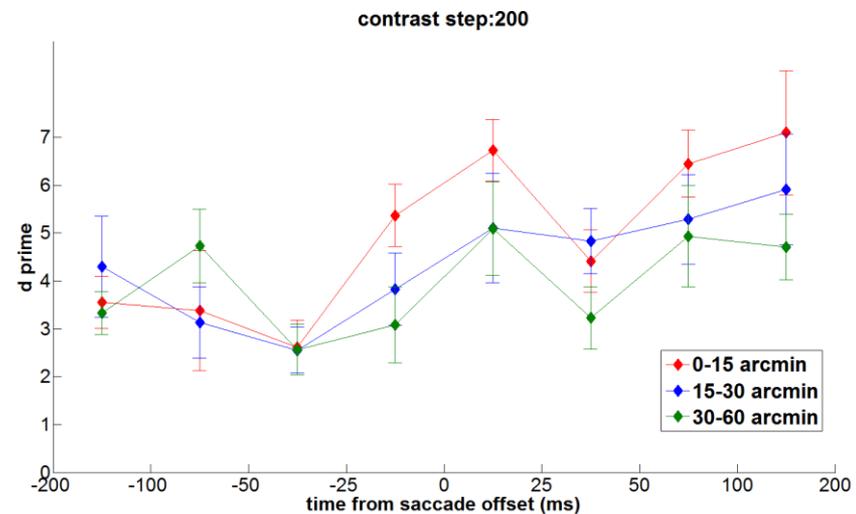
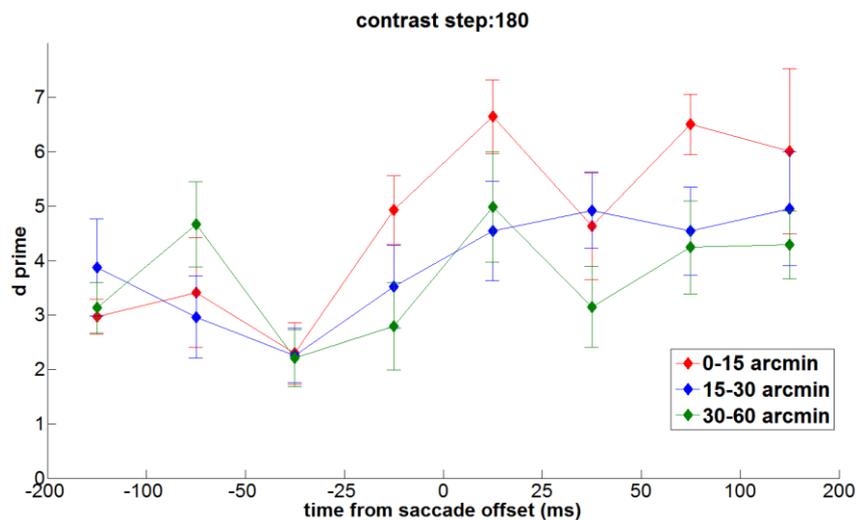
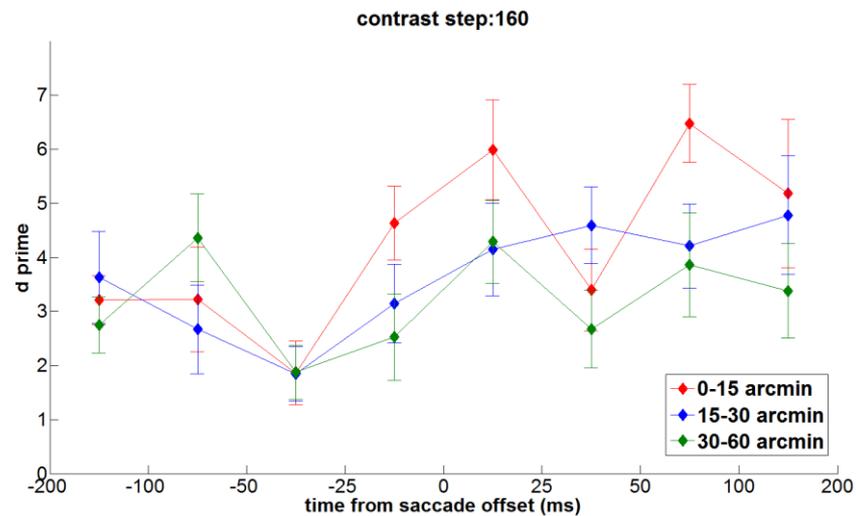
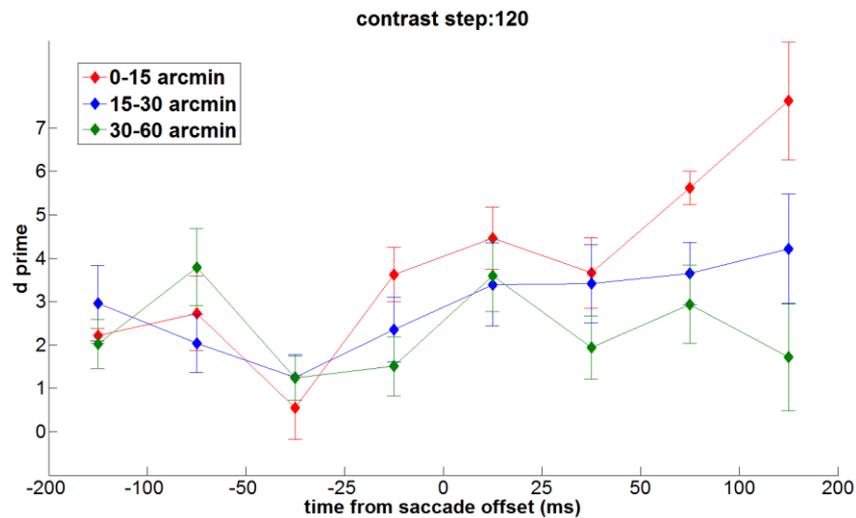
D-prime analysis (saccade onset)



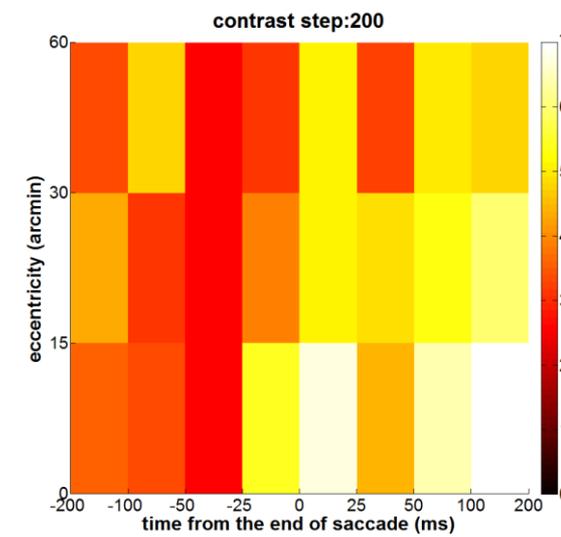
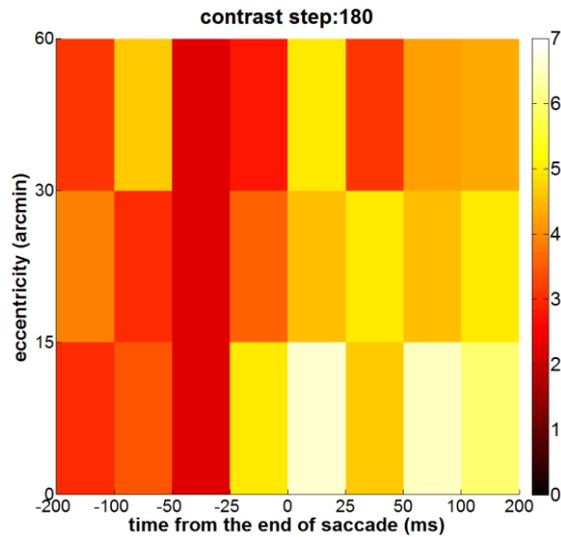
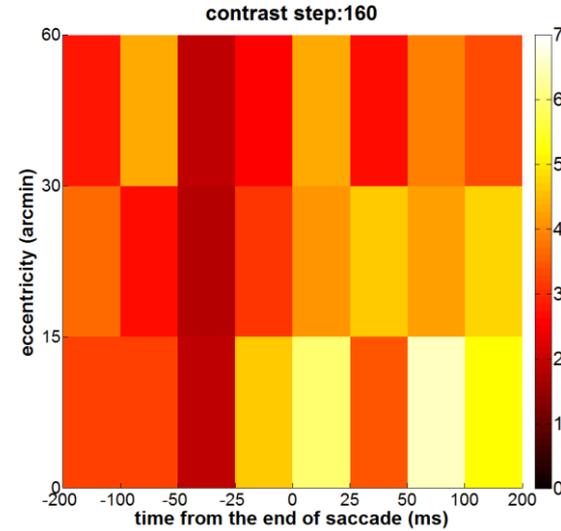
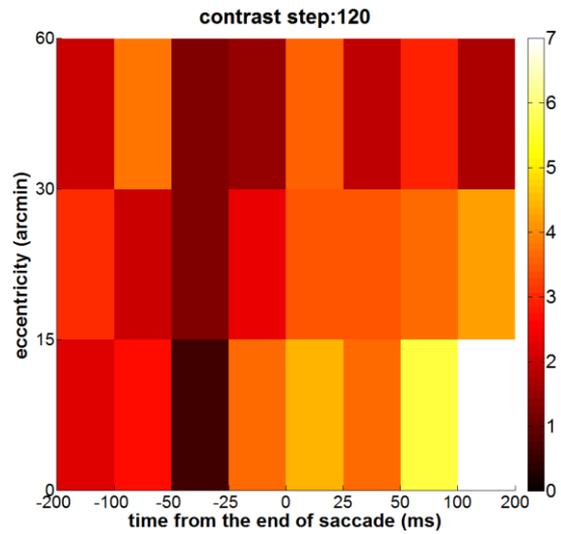
D-prime analysis (saccade onset)



D-prime analysis (saccade offset)



D-prime analysis (saccade offset)



False alarm rate

Sbj	# sessions	#Trials	# no-change trials	Average number of changes in change trials	Average number of button presses in no-change trials	False alarm rate
CS	4	751	93	3.62	1.20	33.18%
CT	2	371	46	3.38	1.65	48.86%
KS	2	395	50	3.30	0.58	17.55%
NM	4	749	93	3.17	1.41	44.38%
SA	1	163	16	3.26	1.75	53.59%
TS	4	756	95	3.26	2.18	66.8%

Summary

- Construct the full spatiotemporal map of contrast sensitivity relative to occurrence of microsaccades.
- Contrast sensitivity is not homogenous within the fovea and perifovea and decreases with increasing eccentricity.
- “Microsaccadic suppression” of visual thresholds with similar time course to saccadic suppression phenomena.