Ocular Drift: Gain Modulation

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Control of Ocular Drift

- Is drift modulated to adjust gain at different spatial scales?

Drift Diffusion

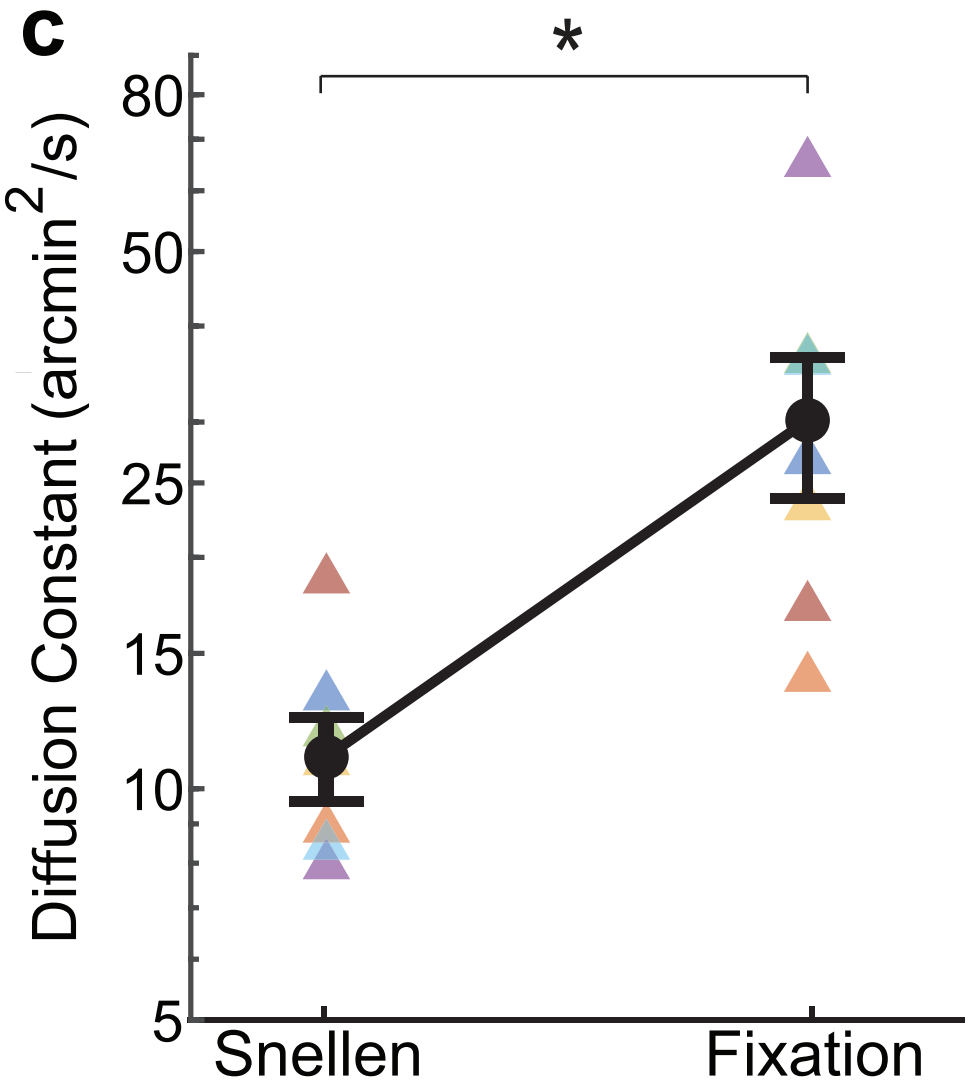
5 arcmin

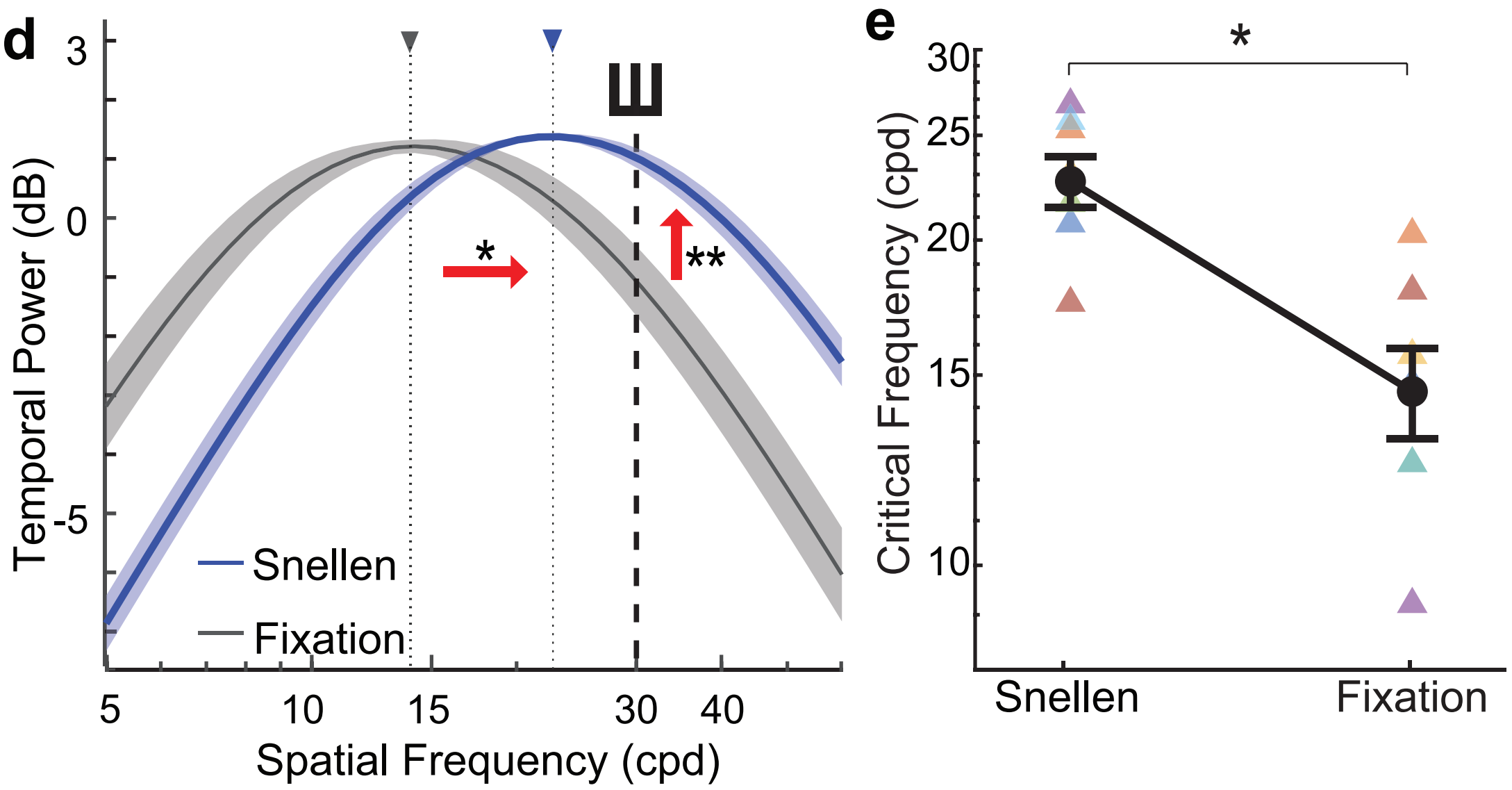
2 arcmin

Probability of gaze displacement over time

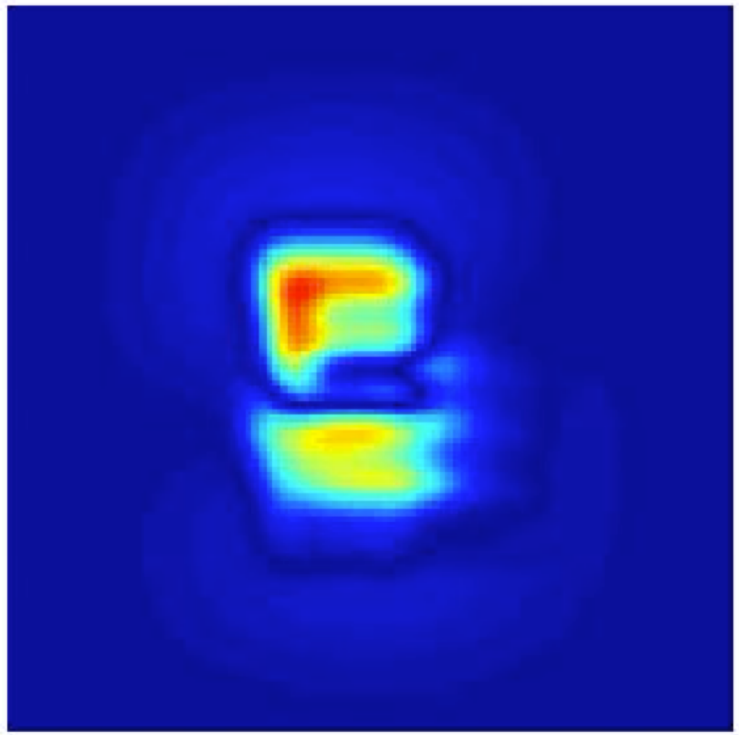
smaller larger

Diffusion Constant

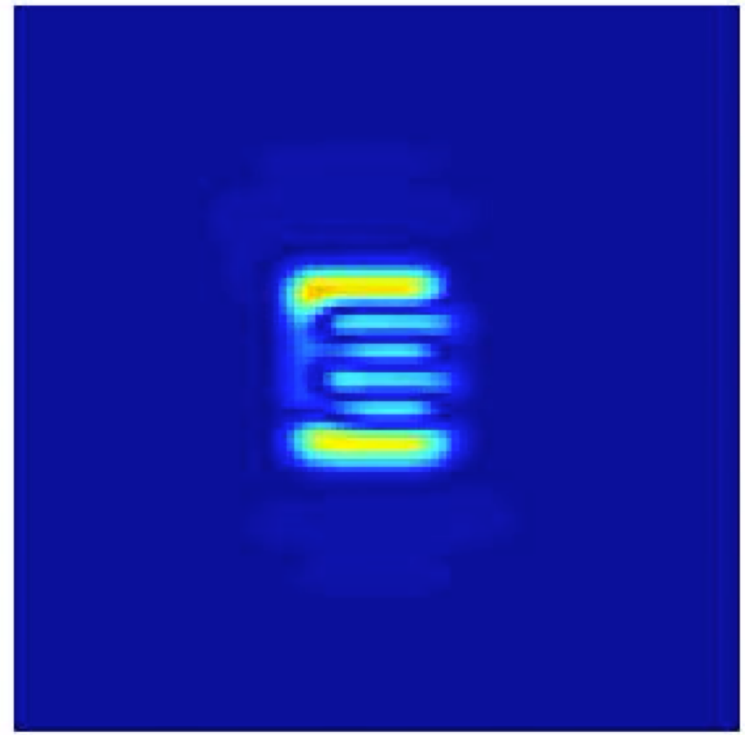



d
3
0
-5
Temporal Power (dB)
Snellen
Fixation
*
**
5
10
15
30
40
Spatial Frequency (cpd)
e
*
30
25
20
15
10
Critical Frequency (cpd)
Snellen
Fixation

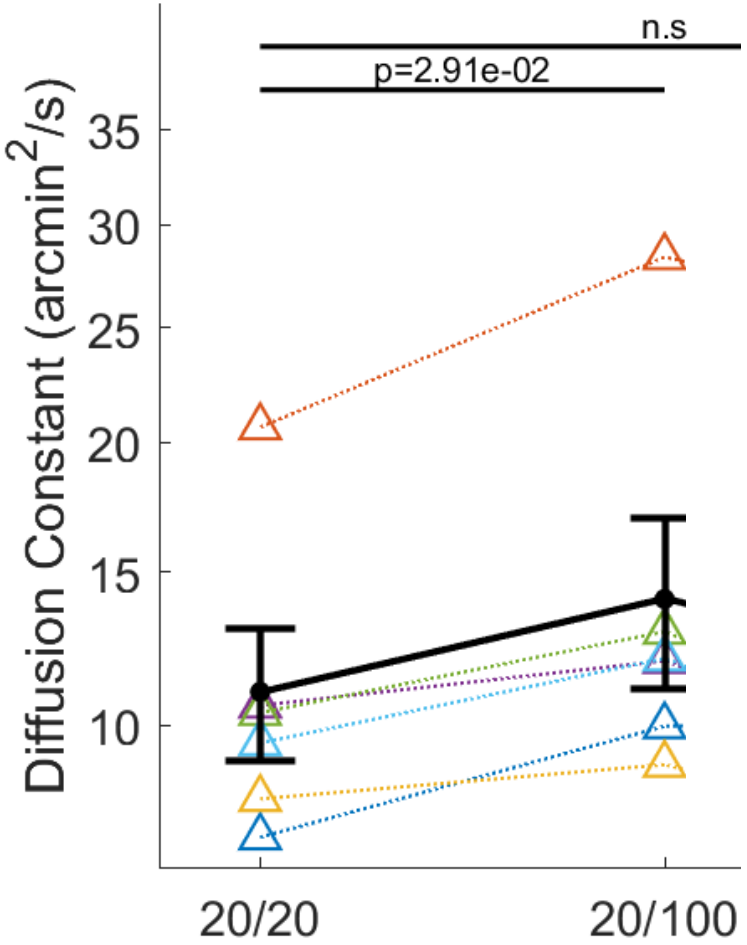
more diffuse drift



less diffuse drift



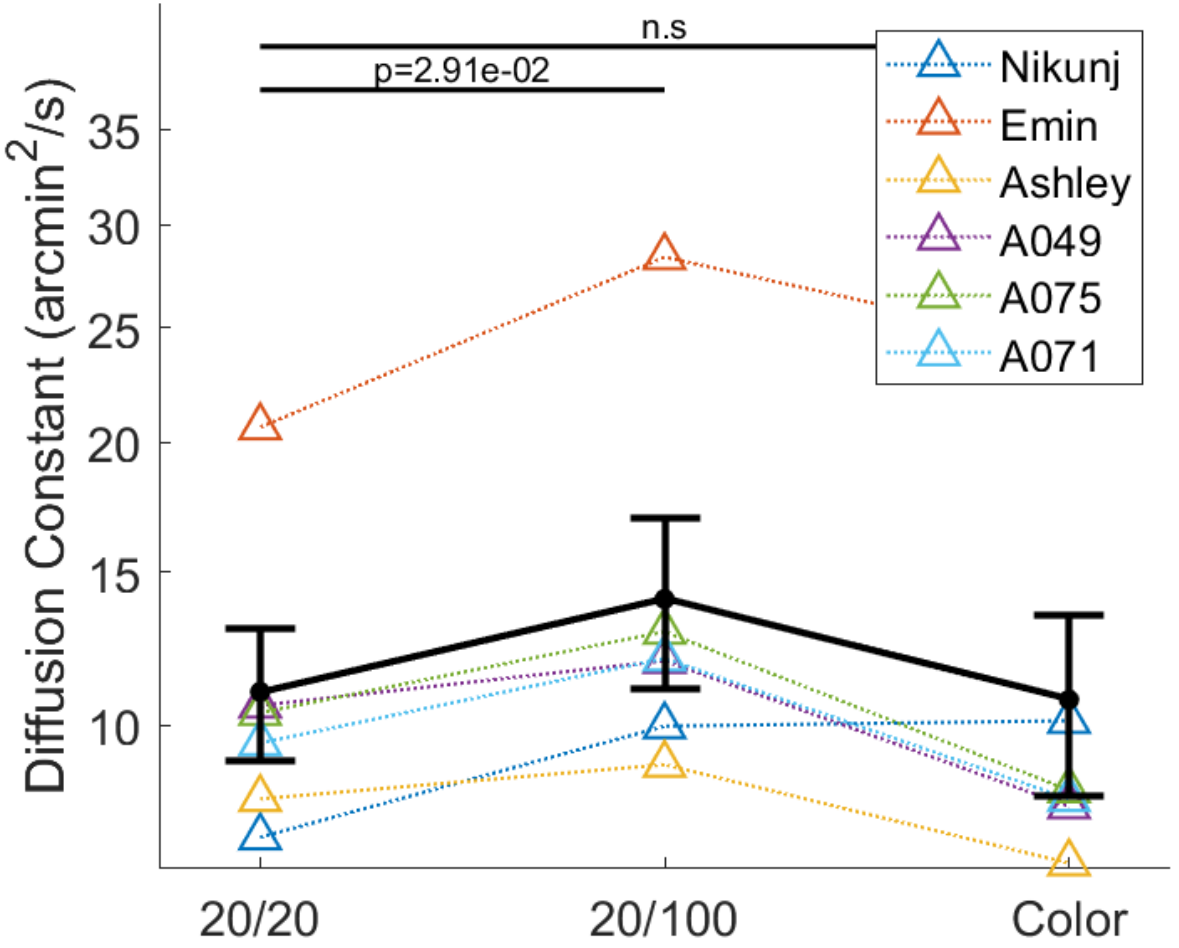
Drift Diffusion by Task



20/100: 5x bigger than 20/20

Color: judge whether 20/20 line is tinted red or green

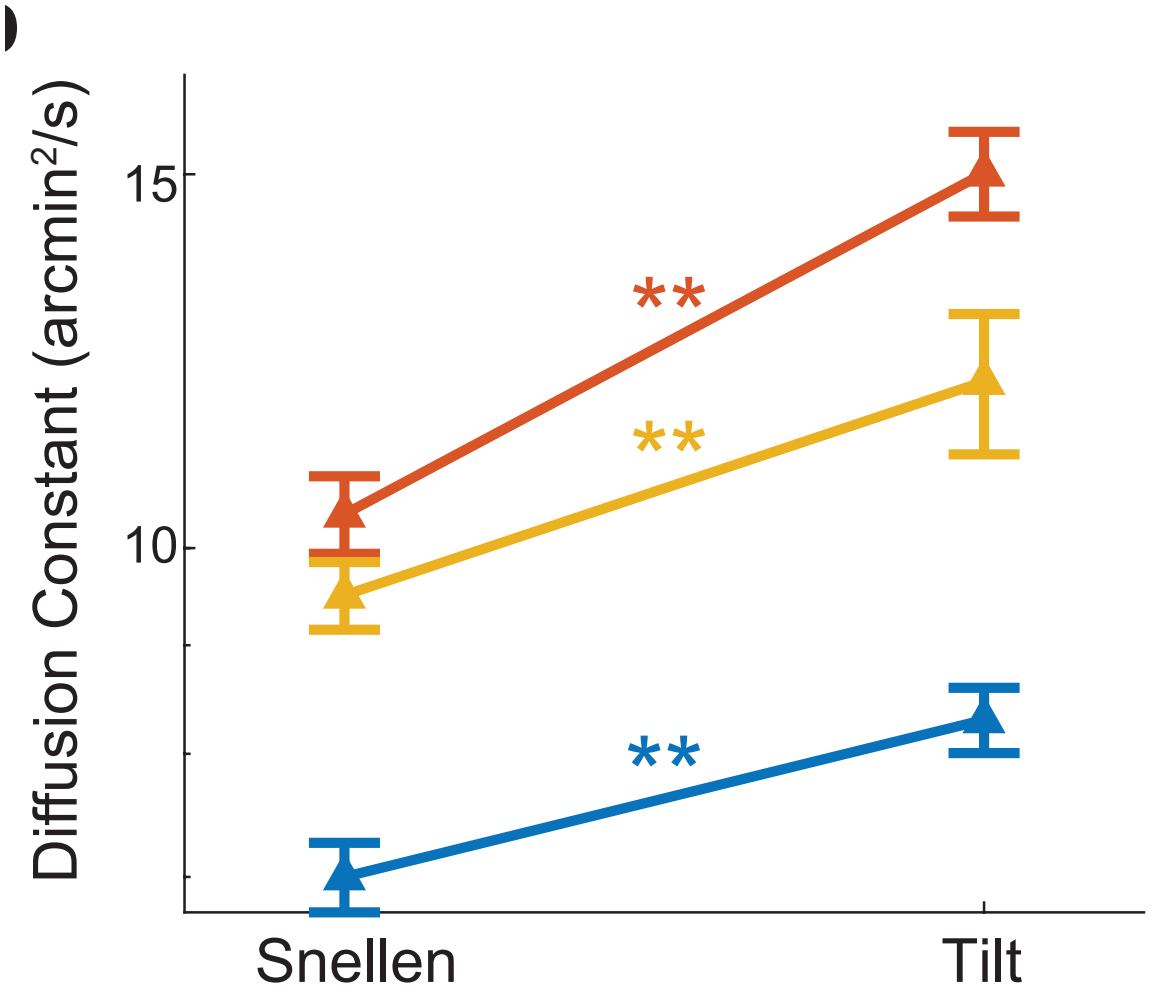
Drift Diffusion by Task



20/100: 5x bigger than 20/20

Color: judge whether 20/20 line is tinted red or green

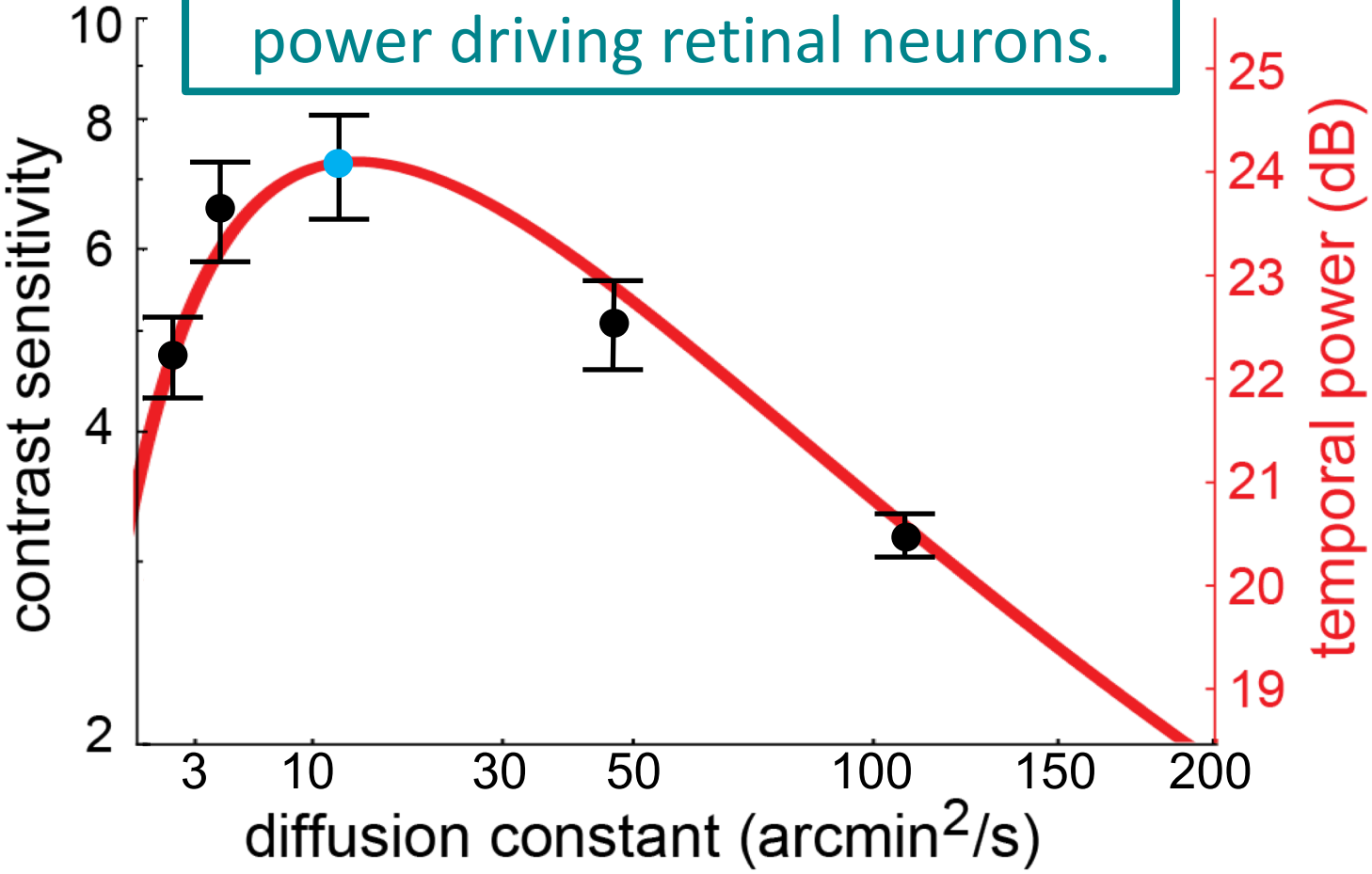
Drift Diffusion by Task



Tilt: 20/20 line tilted +- 4deg from horizontal.

Temporal power from drift

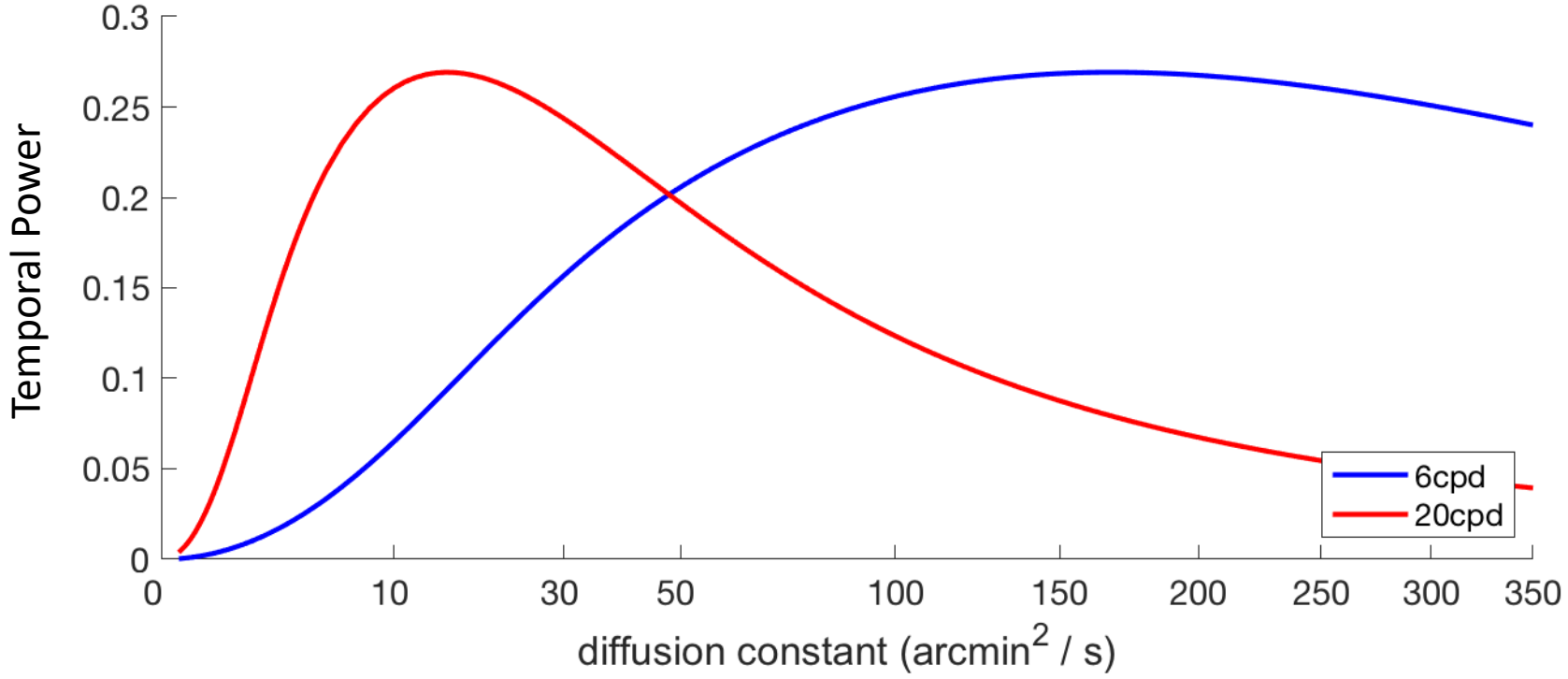
Sensitivity matches temporal power driving retinal neurons.



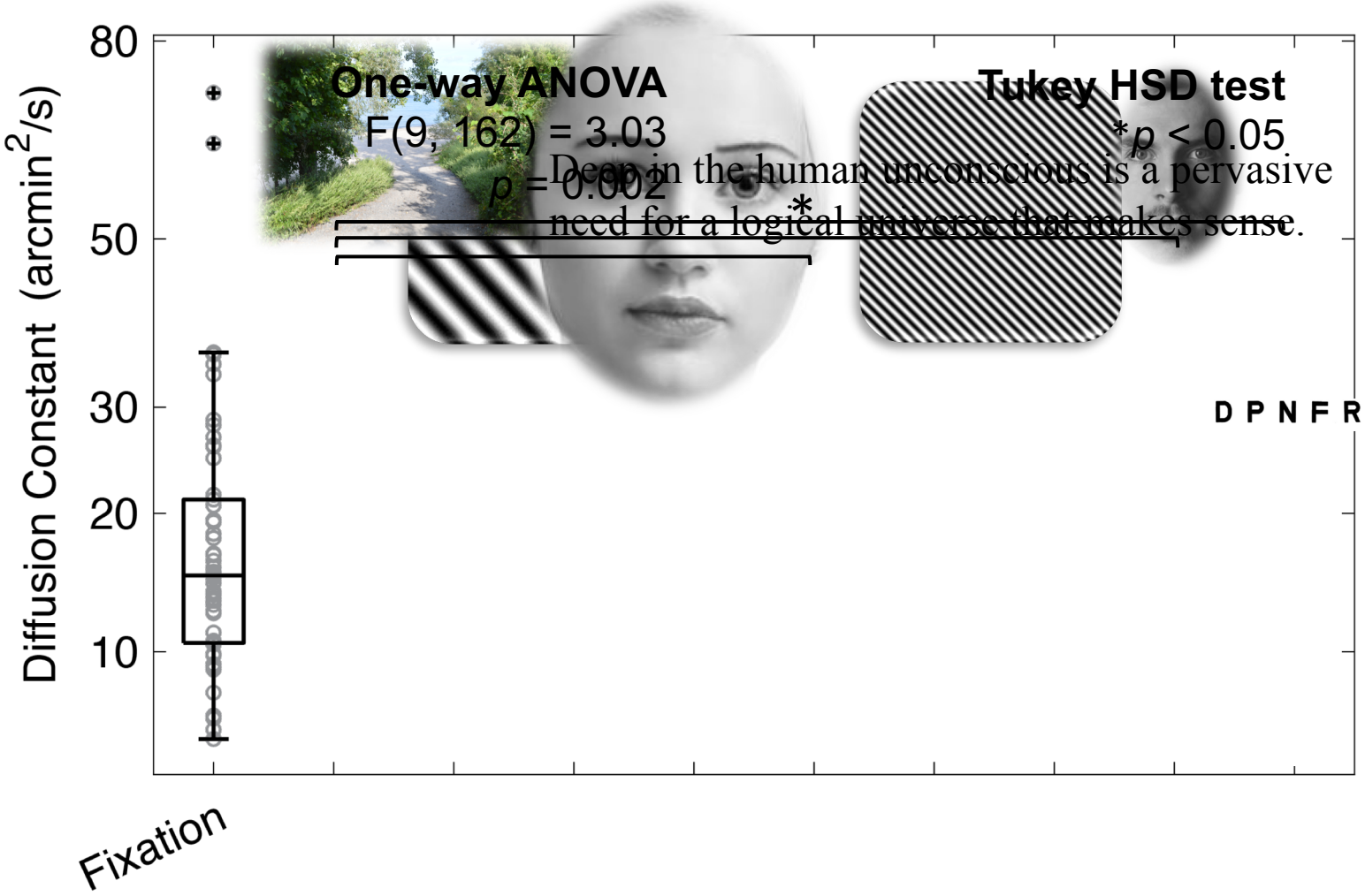
16cpd grating

Retinal image motion was artificially attenuated or amplified

Is drift optimal?



Diffusion Constants by Task

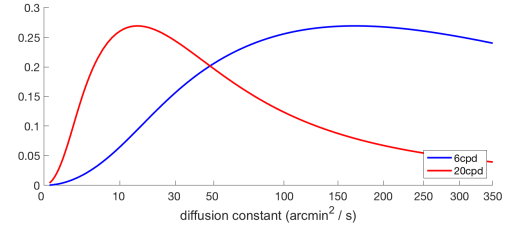


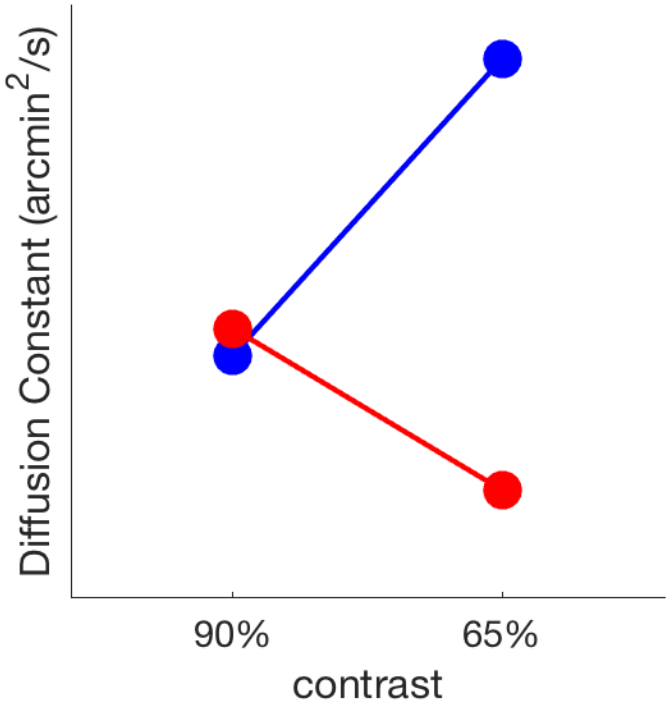
(Cherici et al, 2012; Mostofi et al., 2016; Boi et al, 2017; Bowers & Poletti, 2017; Shelchkova et al., in rev, Intoy et al., in prep.; Intoy & Rucci, in prep.)

Control of Ocular Drift

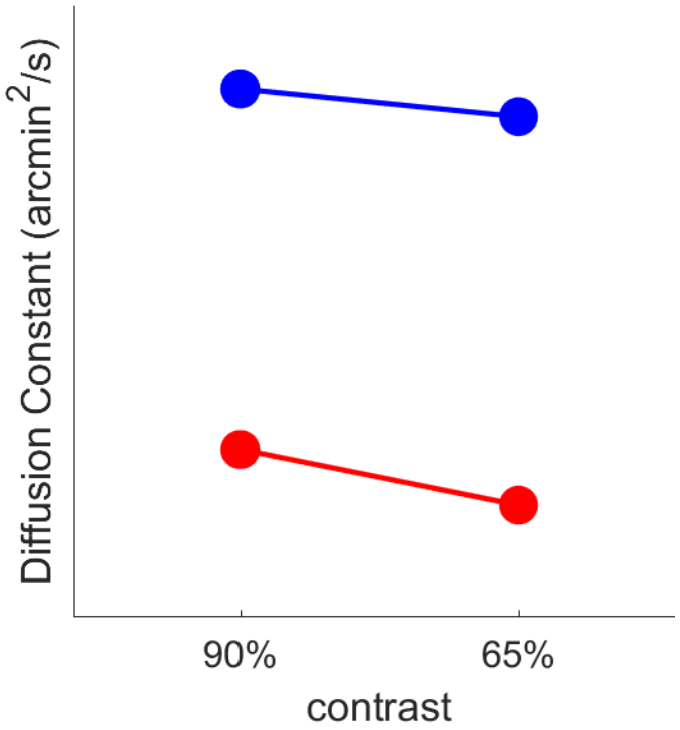
- Is drift modulated to adjust gain at different spatial scales?

Is drift controlled to modulate temporal power on the retina?

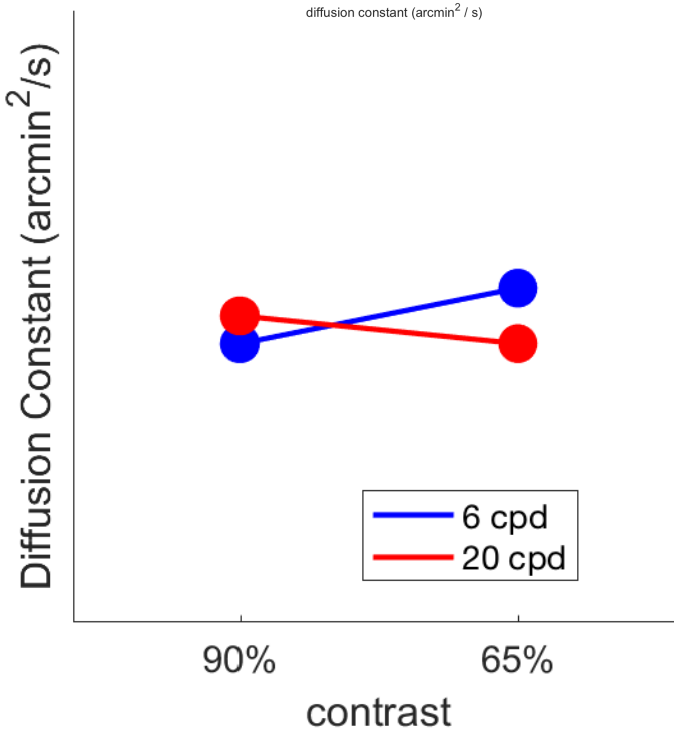




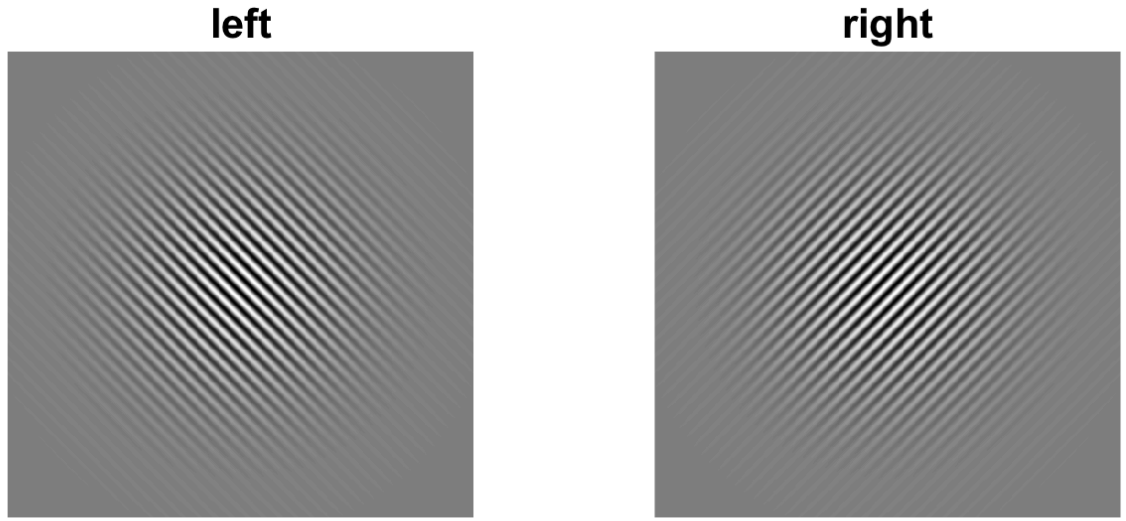
Drift driven by power available on the retina?

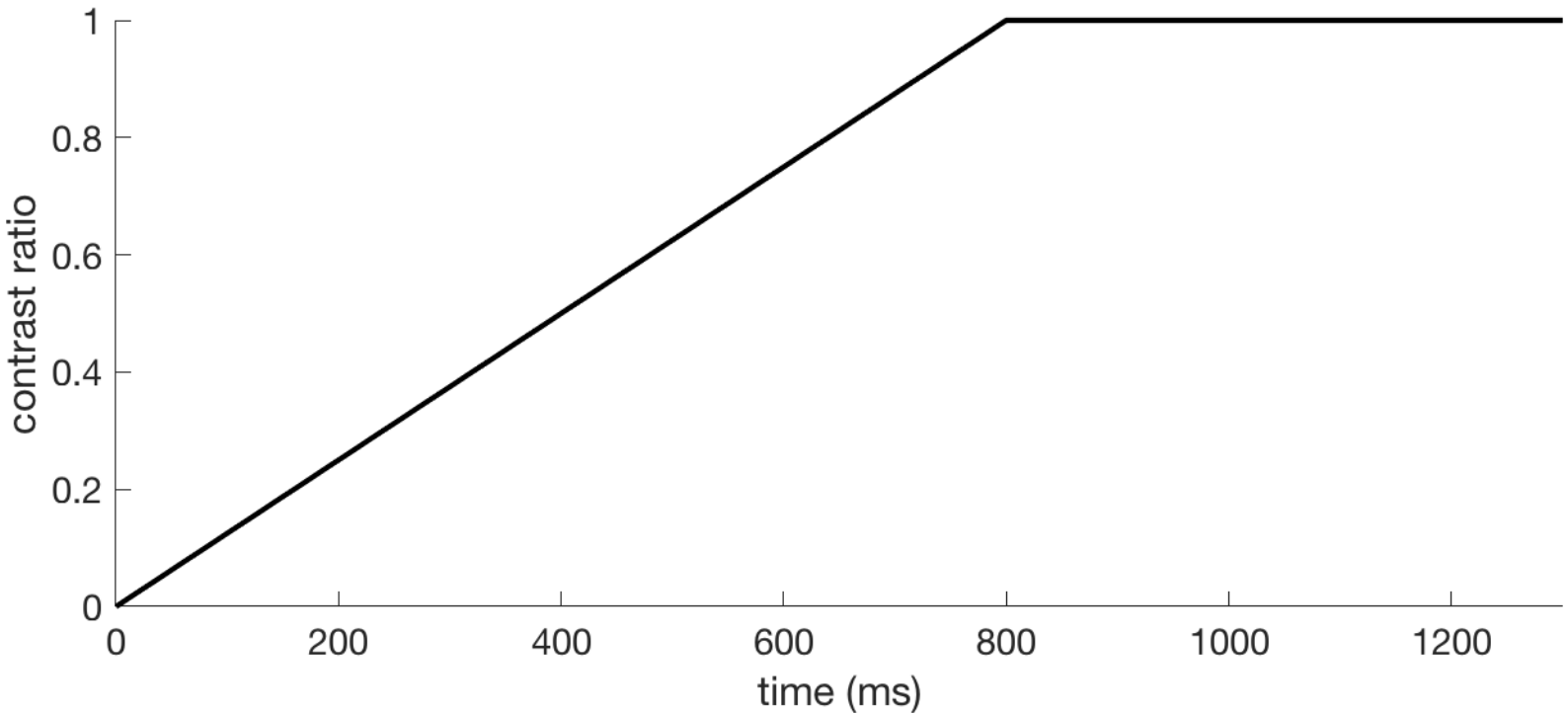


Drift driven by spatial frequency present in stimulus?



Drift is not tuned??? Or does not need tuning in these conditions



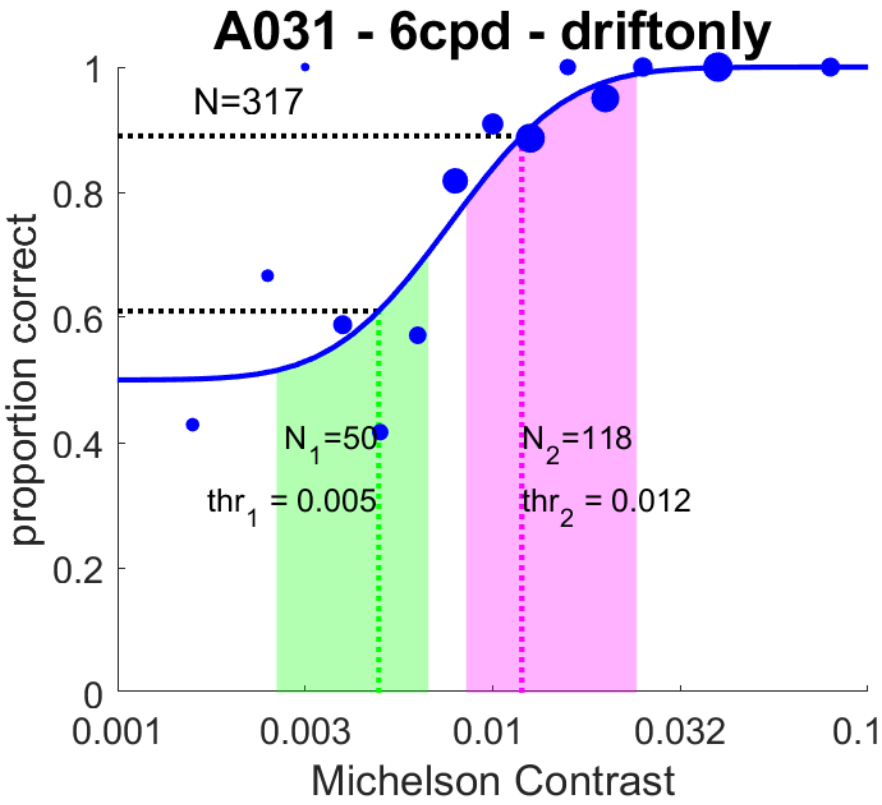


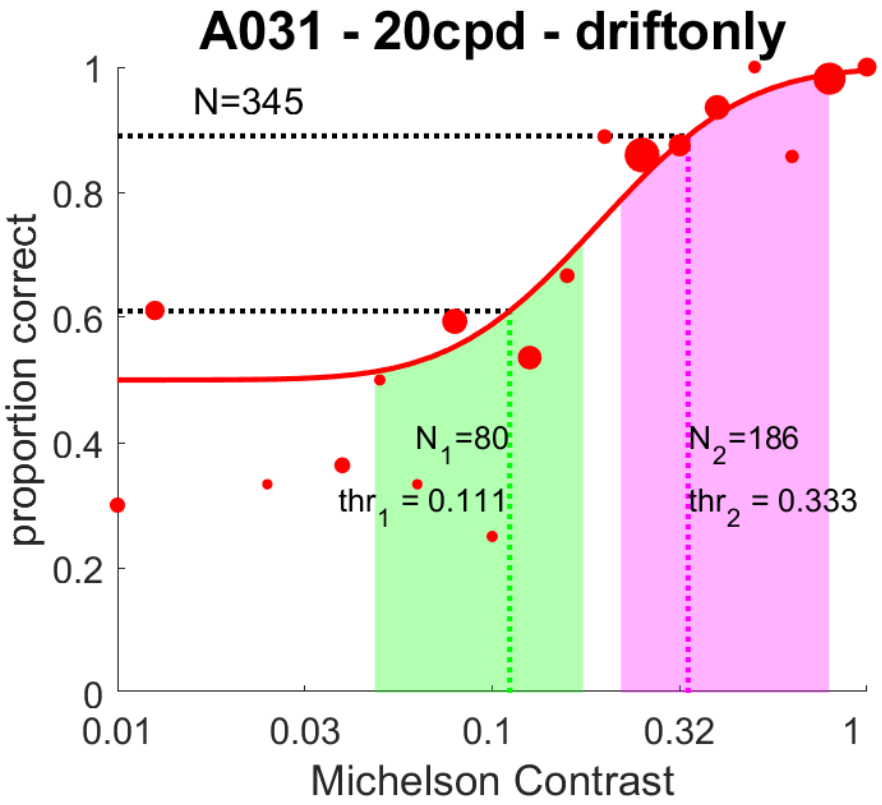
6 or 20cpd gratings

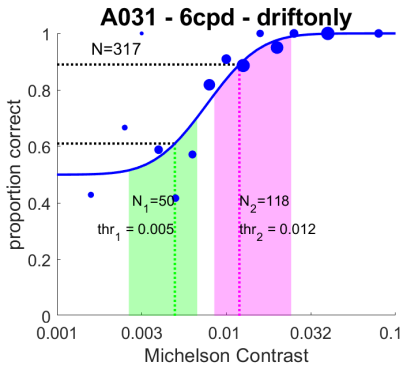
White noise appears at stimulus offset

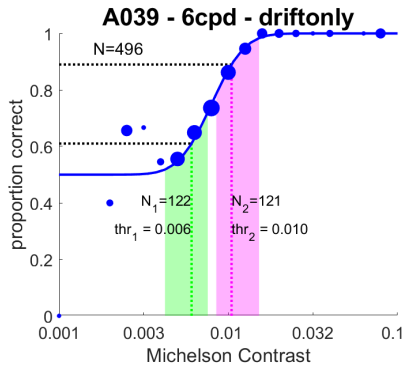
Subject	Total	drift	MS	S	B/NT
A031	1858	747	145	816	150
6cpd	904	332	74	421	77
20cpd	854	347	67	368	72
Fixation	135	0	17	49	69
A039	1334	915	92	276	51
6cpd	739	516	44	147	32
20cpd	595	399	48	129	19
Fixation	139	11	41	50	37
A084	1070	661	121	168	120
6cpd	584	330	103	78	73
20cpd	486	331	18	90	47
Fixation	148	28	82	11	27
A040	587	222	164	152	49
6cpd	287	111	86	55	35
20cpd	300	111	78	97	14
Fixation	71	0	28	20	23
A047_DDPI	490	323	17	20	130
6cpd	240	164	8	8	60
20cpd	250	159	9	12	70
Fixation	30	0	2	1	27

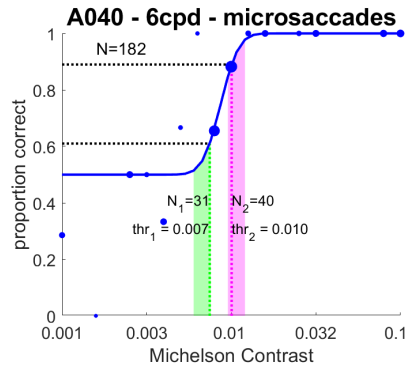
Contrast Sensitivity

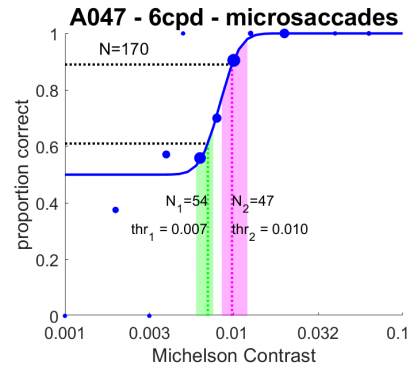


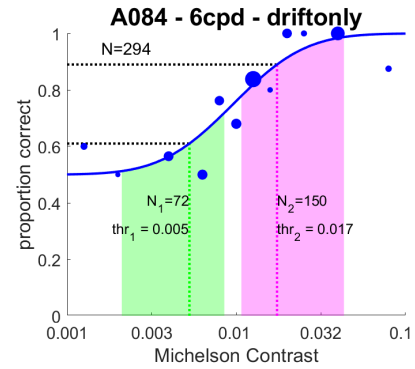


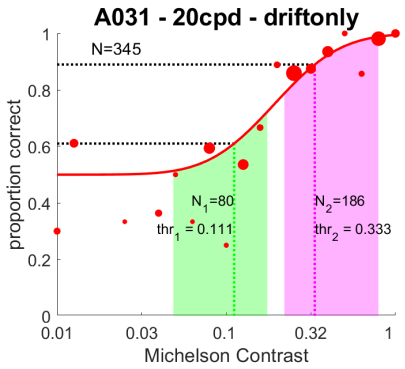

A031 - 6cpd - driftonly
N=317
N1=50
N2=118
thr1 = 0.005
thr2 = 0.012
proportion correct
Michelson Contrast

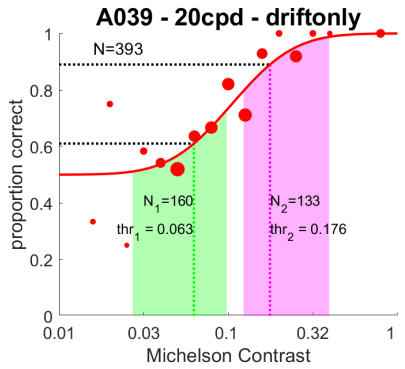

A039 - 6cpd - driftonly
N=496
N1=122
N2=121
thr1 = 0.006
thr2 = 0.010
proportion correct
Michelson Contrast

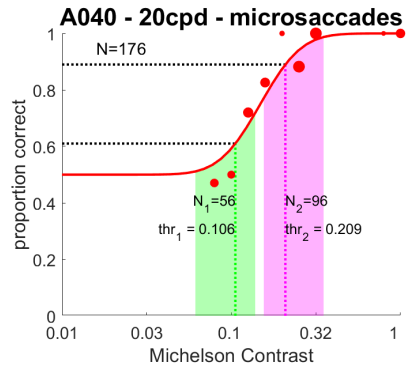

A040 - 6cpd - microsaccades
N=182
N1=31
N2=40
thr1 = 0.007
thr2 = 0.010
proportion correct
Michelson Contrast

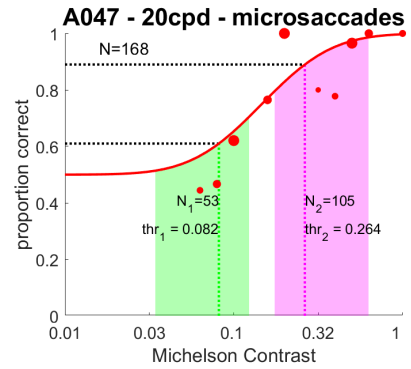

A047 - 6cpd - microsaccades
N=170
N1=54
N2=47
thr1 = 0.007
thr2 = 0.010
proportion correct
Michelson Contrast

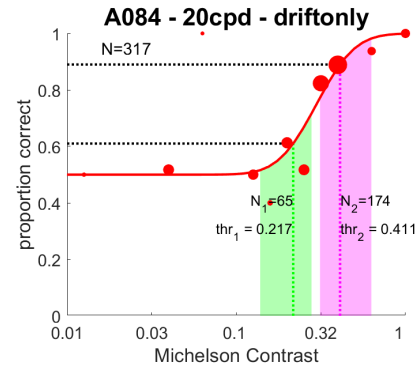

A084 - 6cpd - driftonly
N=294
N1=72
N2=150
thr1 = 0.005
thr2 = 0.017
proportion correct
Michelson Contrast


A031 - 20cpd - driftonly
N=345
N1=80
N2=186
thr1 = 0.111
thr2 = 0.333
proportion correct
Michelson Contrast

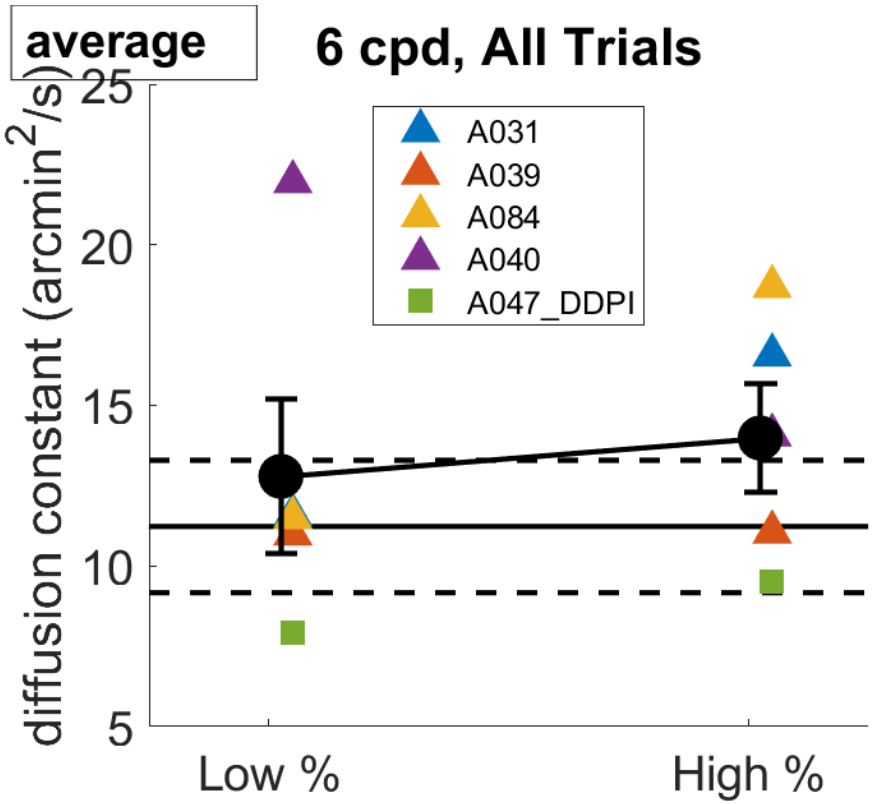

A039 - 20cpd - driftonly
N=393
N1=160
N2=133
thr1 = 0.063
thr2 = 0.176
proportion correct
Michelson Contrast

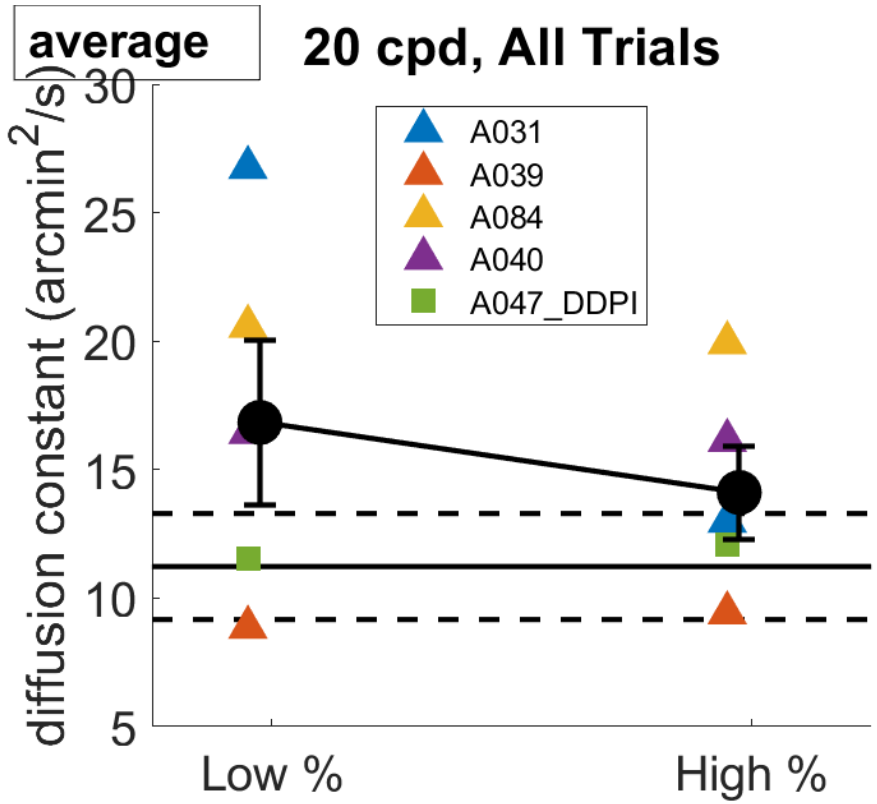

A040 - 20cpd - microsaccades
N=176
N1=56
N2=96
thr1 = 0.106
thr2 = 0.209
proportion correct
Michelson Contrast

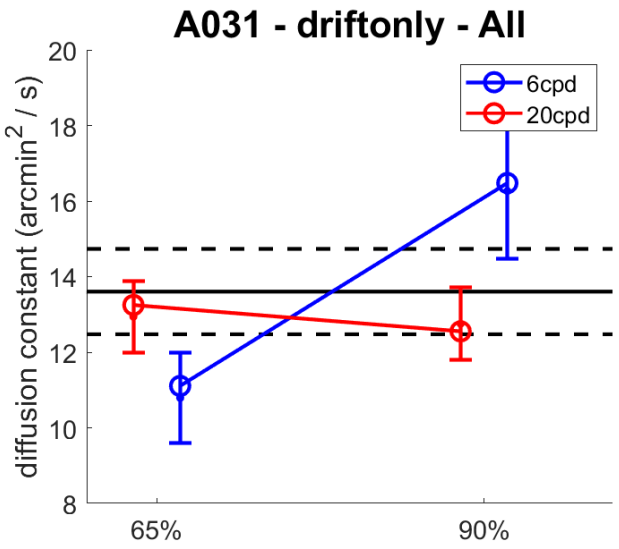

A047 - 20cpd - microsaccades
N=168
N1=53
N2=105
thr1 = 0.082
thr2 = 0.264
proportion correct
Michelson Contrast

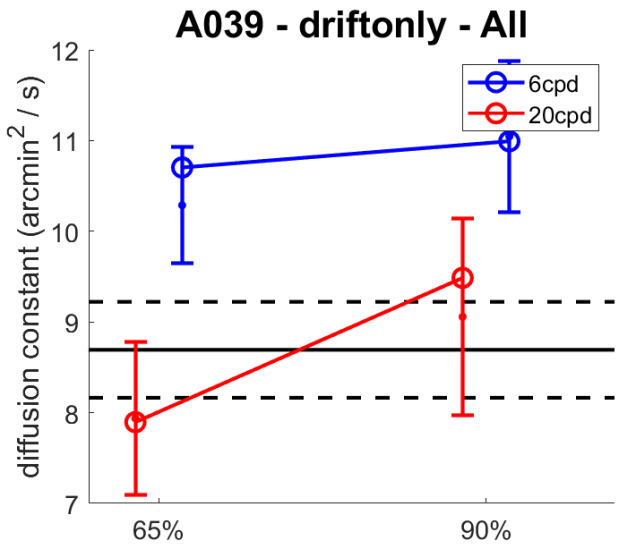

A084 - 20cpd - driftonly
N=317
N1=65
N2=174
thr1 = 0.217
thr2 = 0.411
proportion correct
Michelson Contrast

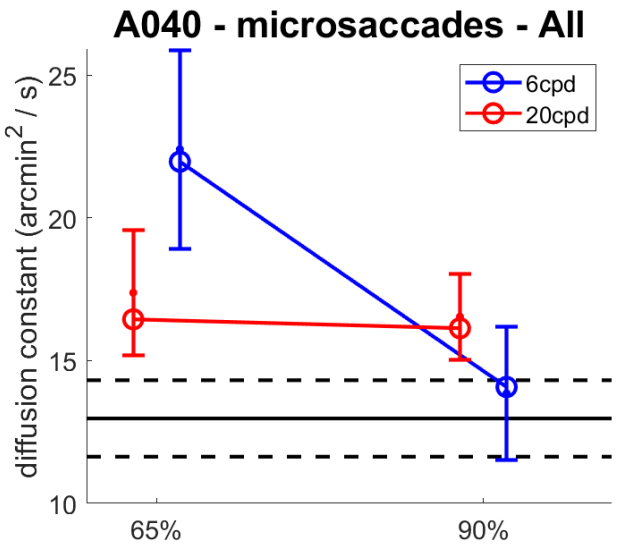
Drift Diffusion

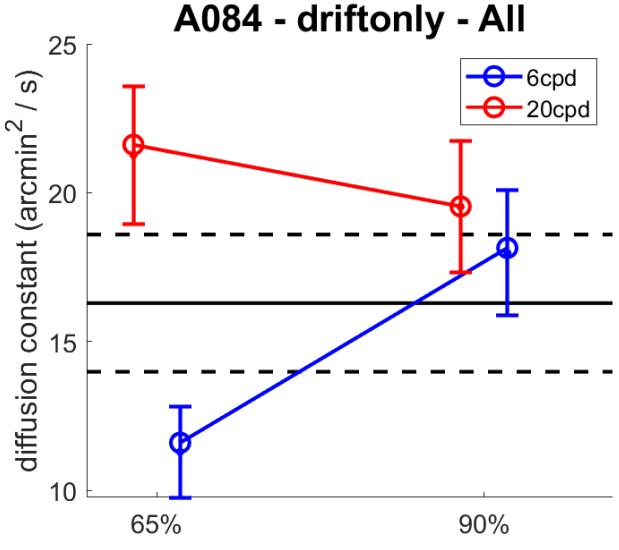


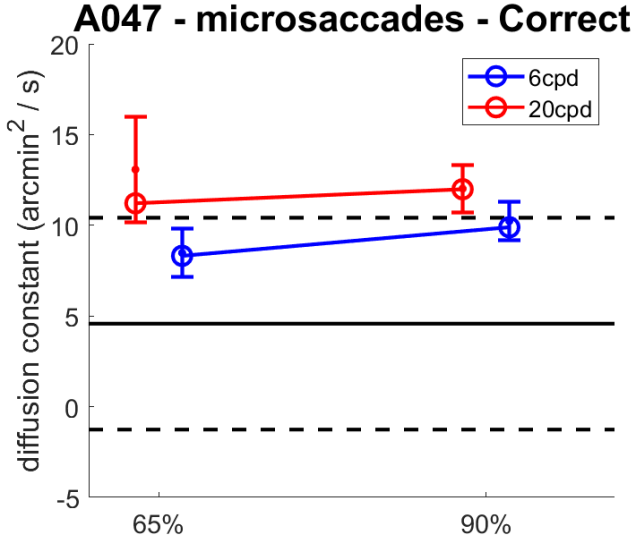



A031 - driftonly - All
diffusion constant (arcmin^2 / s)
20
18
16
14
12
10
8
65%
90%
6cpd
20cpd

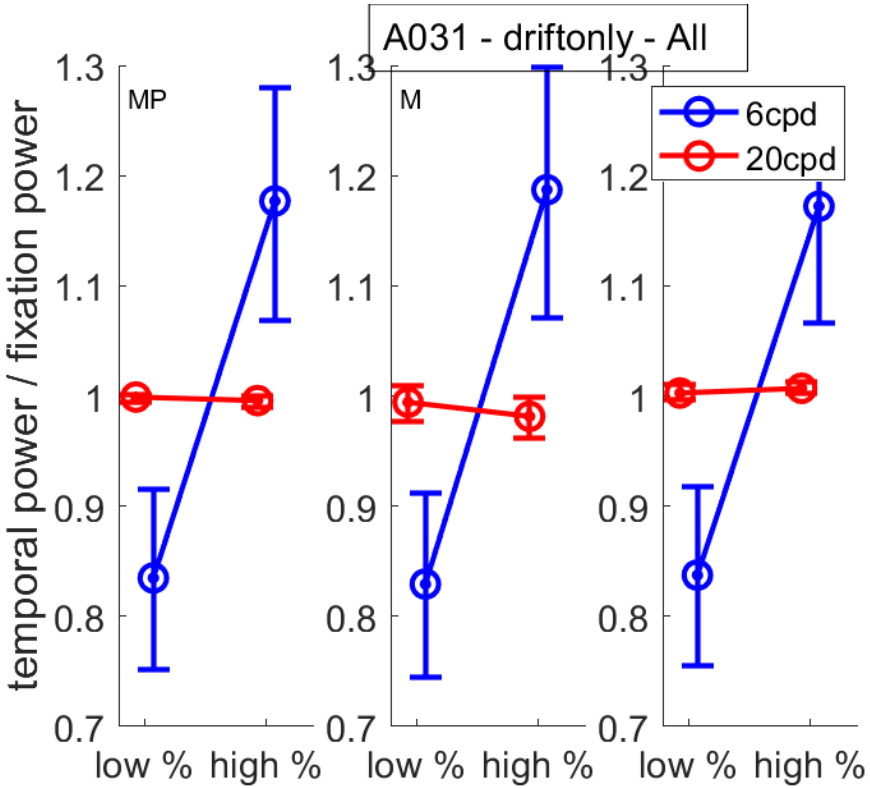

A039 - driftonly - All
diffusion constant (arcmin^2 / s)
12
11
10
9
8
7
65%
90%
6cpd
20cpd

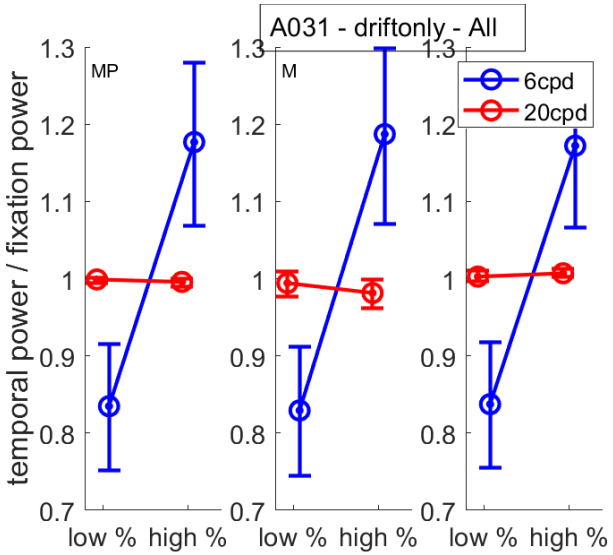

A040 - microsaccades - All
diffusion constant (arcmin^2 / s)
25
20
15
10
65%
90%
6cpd
20cpd

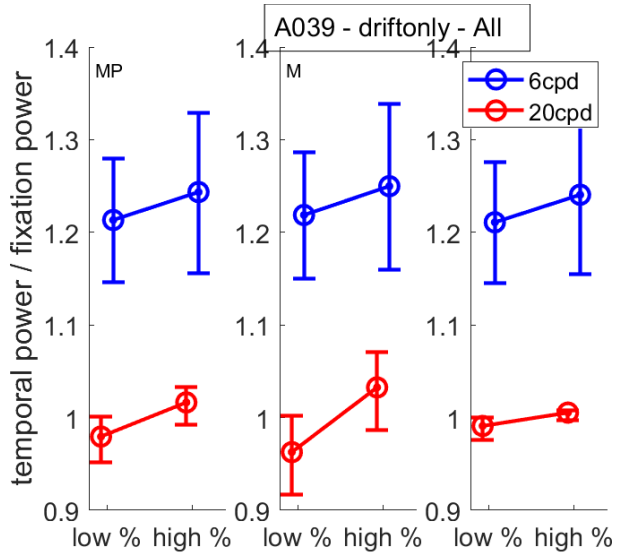

A084 - driftonly - All
diffusion constant (arcmin^2 / s)
25
20
15
10
65%
90%
6cpd
20cpd

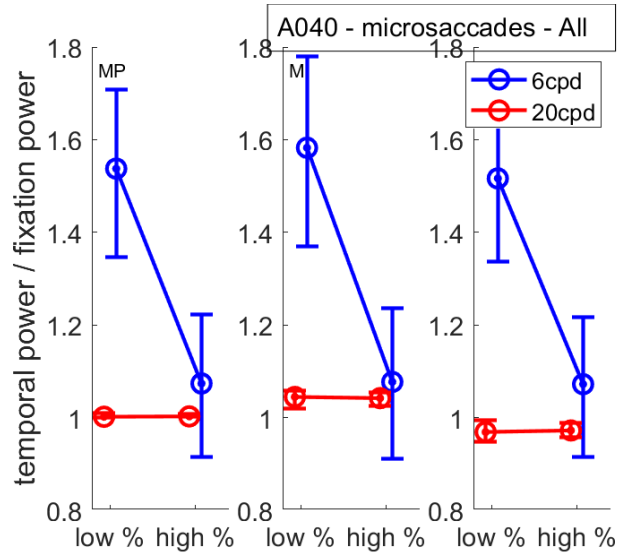

A047 - microsaccades - Correct
diffusion constant (arcmin^2 / s)
20
15
10
5
0
-5
65%
90%
6cpd
20cpd

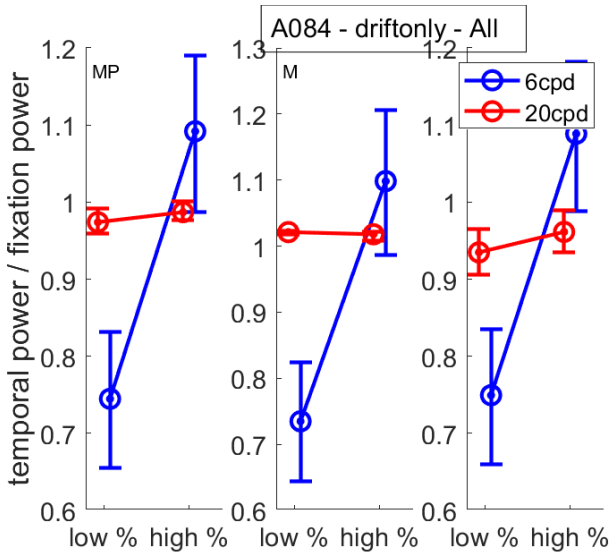
Modulation of Temporal Power

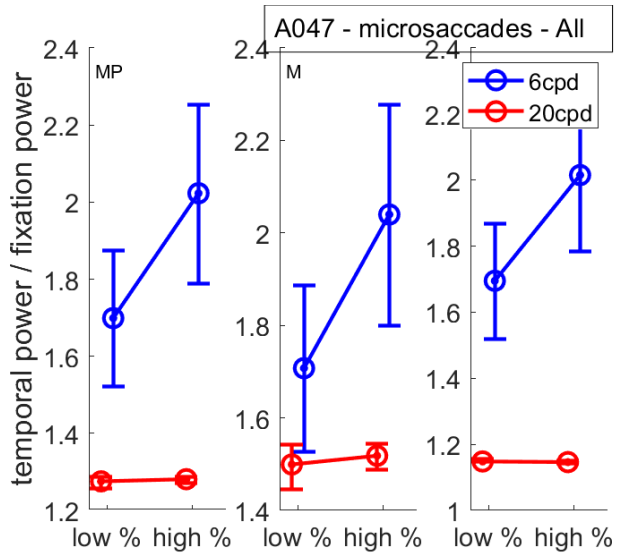



A031 - driftonly - All
MP
M
6cpd
20cpd
temporal power / fixation power
low %
high %


A039 - driftonly - All
MP
M
6cpd
20cpd
temporal power / fixation power
low %
high %


A040 - microsaccades - All
MP
M
6cpd
20cpd
temporal power / fixation power
low %
high %


A084 - driftonly - All
MP
M
6cpd
20cpd
temporal power / fixation power
low %
high %


A047 - microsaccades - All
MP
M
6cpd
20cpd
temporal power / fixation power
low %
high %