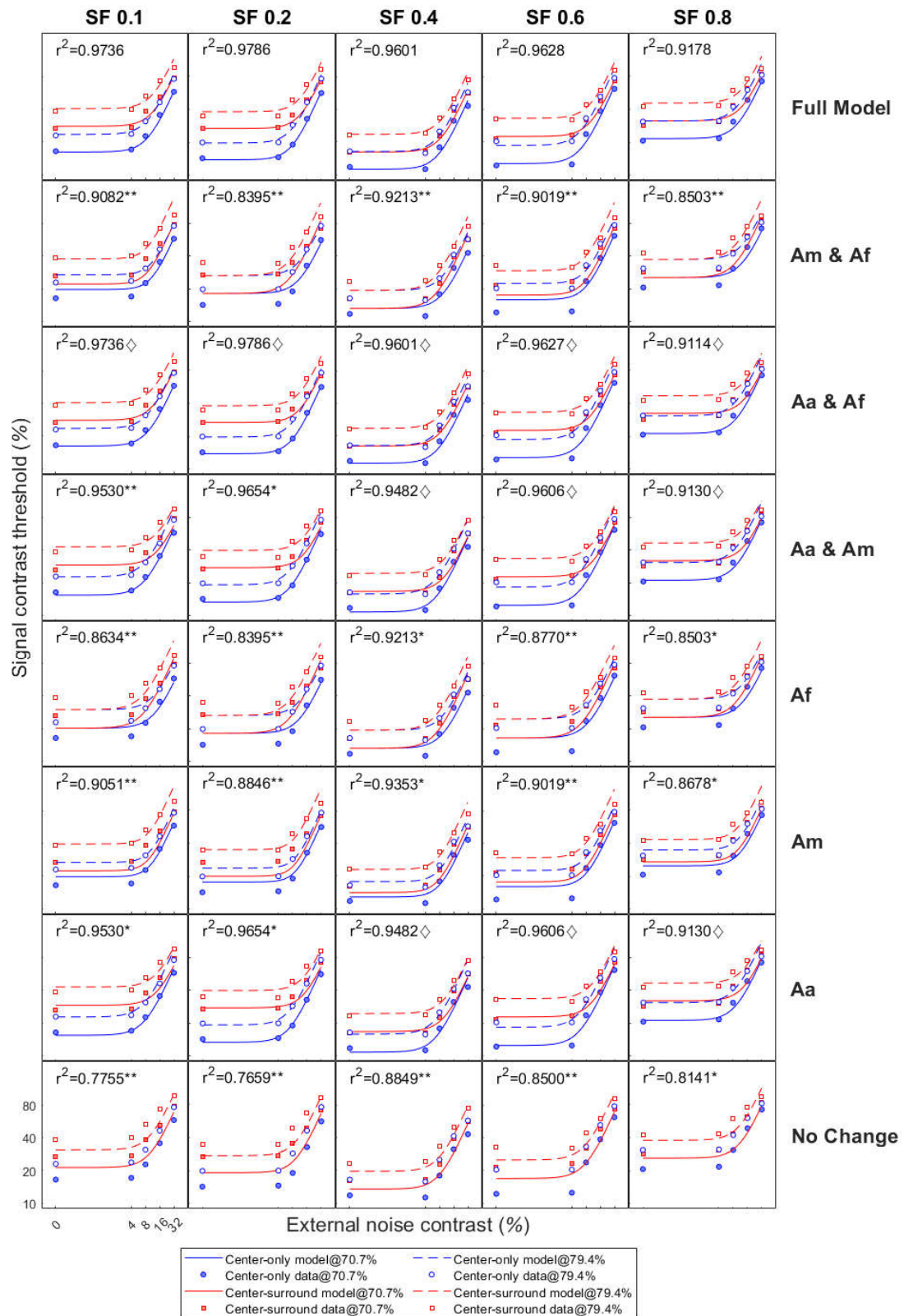


**S- Figure 1**



**S-Figure 1.** This figure matrix shows the results of PTM modeling arranged by SF (columns) and models (rows). In each panel, dots and squares represent mean contrast thresholds at each noise level, and smooth curves represent model fit to the data. Goodness-of-fit statistics for a given model are

provided, \* and \*\* indicate significant difference between full model and each reduced model.  $\diamond$  represents statistically equivalence between full model and each reduced model.

**S-Table 1:** P vaules of model comparisons between neuronal TvC functions at different spatial frequencies (SFs) in center-only (cRF) and center-surround (cRF+sRF) condition.  $r^2$  indicates goodness of fit.  $N_a$ ,  $N_{ext}$ ,  $N_m$ ,  $\beta$  and  $\gamma$  denotes respectively the standard deviation of internal additive noise, the standard deviation of external noise, the proportional constant of multiplicative noise, the gain of the perceptual template, and the exponent of the non-linear transducer.  $A_a$ , parameter associated with signal enhancement or equivalent to internal additive noise reduction;  $A_m$ , parameter associated with the proportional constant of multiplicative noise;  $A_f$ , parameter associated with external noise exclusion.

**Full Model**

SF	SF 0.1		SF 0.2		SF 0.1-0.2		SF 0.4		SF 0.6		SF 0.8		SF 0.4-0.8	
	cRF	cRF+sRF	cRF	cRF+sRF	cRF	cRF+sRF	cRF	cRF+sRF	cRF	cRF+sRF	cRF	cRF+sRF	cRF	cRF+sRF
$r^2$	0.9736		0.9786		0.9736		0.9601		0.9628		0.9178		0.9591	
$N_a$	0.0659±0.0678		0.0518±0.0400		0.0694±0.0772		0.0524±0.0468		0.0550±0.0430		0.0874±0.0482		0.0595±0.0441	
$N_m$	0.1393±0.1813		0.0801±0.1463		0.1399±0.1846		0.1055±0.1665		0.0696±0.1381		0.0257±0.0882		0.0635±0.1353	
$\beta$	0.6812±0.2266		0.6288±0.1163		0.6995±0.2974		0.7644±0.1721		0.5679±0.1123		0.5355±0.1522		0.6354±0.1134	
$\gamma$	1.6964±1.1733		1.4478±0.7947		1.7016±1.1791		1.5031±0.8423		1.2577±0.5990		1.1410±0.3356		1.2962±0.6301	
$A_a$	2.2828±1.7445		2.4038±1.1691		2.3461±1.8211		1.6630±0.8384		2.1336±1.4204		1.5370±0.3517		1.8184±0.8869	
$A_m$	2.1617±1.9584		2.0547±1.8478		2.1352±1.9787		1.6708±1.4963		1.9432±1.7891		1.7203±1.4675		1.8592±1.6894	
$A_f$	1.4306±0.4116		1.2907±0.2303		1.4578±0.5117		1.2254±0.2165		1.1409±0.1450		1.2109±0.2326		1.2062±0.1749	



$r^2$	0.9736		0.9786		0.9736		0.9601		0.9627		0.9114		0.9644	
p	1		1		1		1		0.934		0.3329		1	
Na	0.0704±0.0695		0.0529±0.0385		0.0749±0.0755		0.0601±0.0526		0.0525±0.0405		0.0871±0.0419		0.0623±0.0445	
Nm	0.1324±0.1870		0.0974±0.1615		0.1308±0.1839		0.1001±0.1693		0.0875±0.1581		0.0342±0.0947		0.0691±0.1426	
$\beta$	0.7037±0.2371		0.6409±0.1035		0.7207±0.3020		0.7914±0.2109		0.5736±0.1139		0.5310±0.1028		0.6464±0.1219	
$\gamma$	1.4538±0.7982		1.3282±0.4782		1.4623±0.8641		1.4034±0.7500		1.2310±0.4723		1.1268±0.2646		1.2256±0.4890	
Aa	1	2.5748± 1.9971	1	2.6074± 1.4531	1	2.5212± 1.9760	1	1.6888± 0.8660	1	2.2839± 1.6314	1	1.5416± 0.3817	1	1.9119± 1.1795
Am	1		1		1		1		1		1		1	
Af	1	1.4792± 0.4434	1	1.3270± 0.2176	1	1.4944± 0.5087	1	1.2571± 0.2273	1	1.1454± 0.1362	1	1.2056± 0.1866	1	1.2251± 0.1689

**Aa & Am**

SF	SF 0.1		SF 0.2		SF 0.1-0.2		SF 0.4		SF 0.6		SF 0.8		SF 0.4-0.8	
Parameters	cRF	cRF+sRF	cRF	cRF+sRF	cRF	cRF+sRF	cRF	cRF+sRF	cRF	cRF+sRF	cRF	cRF+sRF	cRF	cRF+sRF
$r^2$	0.953		0.9654		0.953		0.9482		0.9606		0.913		0.9592	
p	0.0071		0.014		0.0071		0.0712		0.401		0.4022		1	
Na	0.0624±0.0675		0.0496±0.0390		0.0609±0.0676		0.0496±0.0439		0.0492±0.0381		0.0789±0.0387		0.0520±0.0391	

Nm	0.1301±0.1736		0.0909±0.1486		0.1288±0.1733		0.0844±0.1373		0.0749±0.1399		0.0296±0.0888		0.0615±0.1266	
$\beta$	0.6285±0.2490		0.5898±0.1005		0.6119±0.2523		0.7035±0.1586		0.5403±0.1102		0.4952±0.0799		0.5884±0.1035	
$\gamma$	1.6139±1.0406		1.4598±0.8321		1.6577±1.0698		1.4932±0.8645		1.2922±0.6124		1.1457±0.3220		1.3243±0.6567	
Aa	1	2.5769± 2.0106	1	2.6052± 1.4425	1	2.6363± 2.0247	1	1.6347± 0.8025	1	2.2851± 1.5047	1	1.5935± 0.3871	1	2.0502± 1.2281
Am	1	2.5802± 2.9271	1	2.7441± 3.0424	1	2.5341± 2.8169	1	3.6856± 3.7130	1	2.0745± 2.4176	1	2.5239± 2.5406	1	2.3627± 2.7912
Af	1		1		1		1		1		1		1	

**Af**

SF	SF 0.1		SF 0.2		SF 0.1-0.2		SF 0.4		SF 0.6		SF 0.8		SF 0.4-0.8	
Parameters	cRF	cRF+sRF	cRF	cRF+sRF	cRF	cRF+sRF	cRF	cRF+sRF	cRF	cRF+sRF	cRF	cRF+sRF	cRF	cRF+sRF
$r^2$	0.8634		0.8395		0.8634		0.9213		0.877		0.8503		0.8931	
p	0		0		0		0.0122		0.0004		0.0203		0.0019	
Na	0.1101±0.1008		0.1028±0.0615		0.1193±0.1011		0.0819±0.0628		0.0820±0.0492		0.1160±0.0520		0.0896±0.0548	
Nm	0.0905±0.1706		0.0414±0.1171		0.0838±0.1636		0.0700±0.1517		0.0534±0.1341		0.0258±0.0985		0.0445±0.1216	
$\beta$	0.7844±0.3927		0.7344±0.1663		0.7997±0.3708		0.8427±0.2201		0.6206±0.1165		0.5752±0.1127		0.6991±0.1319	
$\gamma$	1.5370±1.0992		1.1780±0.4493		1.3886±0.9471		1.3281±0.7026		1.1569±0.4789		1.1332±0.4300		1.1794±0.5001	







$r^2$	0.7755	0.7659	0.7755	0.8849	0.85	0.8141	0.8555
p	0	0	0	0.0026	0.0003	0.0119	0.0007
Na	0.0745±0.0672	0.0664±0.0457	0.0769±0.0668	0.0668±0.0539	0.0669±0.0445	0.0942±0.0417	0.0719±0.0459
Nm	0.1084±0.1839	0.0696±0.1539	0.1187±0.1921	0.0780±0.1588	0.0628±0.1455	0.0235±0.0941	0.0570±0.1394
$\beta$	0.5769±0.1898	0.5528±0.0900	0.5841±0.1774	0.7036±0.1751	0.5314±0.1106	0.4815±0.0826	0.5823±0.0966
$\gamma$	1.5382±0.9457	1.3160±0.5392	1.5183±0.9813	1.3690±0.7465	1.2320±0.5740	1.1369±0.3298	1.2094±0.5108
Aa	1	1	1	1	1	1	1
Am	1	1	1	1	1	1	1
Af	1	1	1	1	1	1	1