Table 1: Statistics for Hodges-Ajne test for non-uniformity of linear wave propagation shown in Figure 3h–j.

FOV #	n (number linear waves)	Hodges-Anje test statistic	*p*-value
1	38	m(38)=3	1.96E-06
2	46	m(46)=2	1.24E-09
3	31	m(31)=6	1.30E-02
4	30	m(30)=6	1.99E-02
5	13	m(13)=3	4.89E-01

Table 2: Statistics for circular non-parametric multi-sample test for equal medians (Berens 2009), shown in Figure 3h–j.

FOV #	n (number linear waves)	CM test statistic	*p*-value
1	38	P(6)=5.410	4.92E-01
2	46	P(6)=9.611	1.42E-01
3	31	P(6)=4.383	6.25E-01
4	30	P(7)=3.752	8.08E-01
5	13	P(5)=5.958	3.10E-01

Table 3: Statistics for Friedman's test for direction selectivity and noise correlation in longitudinally imaged animals, shown in Figure 6b.

	Direction selectivity				Noise Correlation		
Animal	**neurons**	**X2 test statistic**	***p*-value**		**pairs**	**X2 test statistic**	***p*-value**
F1317	33	$X^2(2)=13.64$	1.09E-03		489	$X^2(2)=234.04$	1.50E-51
F1473	147	$X^2(1)=5.72$	1.68E-02		10618	$X^2(1)=8446.12$	0.00E+00
F1509	126	$X^2(2)=14.02$	9.05E-04		7770	$X^2(2)=1.42$	4.91E-01
F1319	13	$X^2(2)=1.08$	5.84E-01		69	$X^2(2)=1384.98$	1.79E-30

Table 4: Statistics for Mann-Whitney test of the significance of the effect of swapping correlation structure from immature to naive, while maintaining naive selectivity and variance, as shown in Figure 7b.

N	naive vs immature correlation
2	z(1848) = -5.63e-01, p = 5.74e-01
3	z(1990) = -1.39e+00, p = 1.65e-01
4	z(1999) = -2.04e+00, p = 4.17e-02
5	z(2000) = -3.11e+00, p = 1.86e-03
6	z(2000) = -4.10e+00, p = 4.22e-05
7	z(2000) = -5.96e+00, p = 2.47e-09
8	z(2000) = -6.53e+00, p = 6.59e-11
9	z(2000) = -7.94e+00, p = 2.00e-15
10	z(2000) = -9.19e+00, p = 3.76e-20
11	z(2000) = -9.73e+00, p = 2.28e-22
12	z(2000) = -1.09e+01, p = 1.15e-27
13	z(2000) = -1.17e+01, p = 7.11e-32
14	z(2000) = -1.34e+01, p = 5.70e-41
15	z(2000) = -1.48e+01, p = 3.07e-49

Statistics for Mann-Whitney test of the significance of the difference between discriminability in naive animals and discriminability from the synthetic data with mean and variance drawn from naive animals and correlation from the immature animals. Degrees of freedom are based on number of groups drawn.

Table 5: Statistics for Mann-Whitney test of the significance of the effect of correlation pre- and post-training, shown in Figure 8j,k.

Group size	pre-training	post-training
2	z(2926) = -1.02e+00, p = 3.08e-01	z(2926) = -3.66e-01, p = 7.15e-01
3	z(3777) = -1.87e+00, p = 6.12e-02	z(3777) = -8.24e-01, p = 4.10e-01
4	z(4041) = -2.41e+00, p = 1.61e-02	z(4041) = -6.15e-01, p = 5.38e-01
5	z(4153) = -2.79e+00, p = 5.28e-03	z(4153) = -6.36e-01, p = 5.24e-01
6	z(4142) = -4.44e+00, p = 8.86e-06	z(4142) = -1.51e+00 , p = 1.31e-01
7	z(4057) = -4.88e+00, p = 1.04e-06	z(4057) = -1.34e+00, p = 1.79e-01
8	z(3951) = -6.17e+00, p = 6.96e-10	z(3951) = -2.10e+00, p = 3.55e-02
9	z(3863) = -6.60e+00, p = 4.17e-11	z(3863) = -2.41e+00, p = 1.58e-02
10	z(3786) = -7.45e+00, p = 9.08e-14	z(3786) = -2.38e+00, p = 1.74e-02
11	z(3578) = -7.90e+00, p = 2.83e-15	z(3578) = -2.76e+00, p = 5.84e-03
12	z(3512) = -8.51e+00, p = 1.72e-17	z(3512) = -3.69e+00, p = 2.26e-04
13	z(3498) = -9.20e+00, p = 3.65e-20	z(3498) = -3.82e+00, p = 1.34e-04
14	z(3488) = -9.69e+00, p = 3.21e-22	z(3488) = -4.11e+00, p = 4.03e-05
15	z(3482) = -1.01e+01, p = 5.27e-24	z(3482) = -4.66e+00, p = 3.15e-06

Statistics for Mann-Whitney test of the significance of the effect of correlation pre- and post-training. “Effect of correlation” is the difference between discriminability computed with the sample covariance and that computed with the trial-shuffled covariance. Degrees of freedom are based on number of groups drawn.

Table 6: Statistics for Mann-Whitney test comparing effect of swapping both correlation and variance pre/post to swapping only correlation pre/post, shown in Figure 8i.

N	training - var swap vs corr swap
2	z(2926) = -9.75e-01, p = 3.30e-01
3	z(3777) = -2.00e+00, p = 4.52e-02
4	z(4041) = -3.45e+00, p = 5.68e-04
5	z(4153) = -4.30e+00, p = 1.70e-05
6	z(4142) = -5.24e+00, p = 1.59e-07
7	z(4057) = -5.51e+00, p = 3.69e-08
8	z(3951) = -6.33e+00, p = 2.41e-10
9	z(3863) = -6.23e+00, p = 4.54e-10
10	z(3786) = -6.54e+00, p = 6.32e-11
11	z(3578) = -5.93e+00, p = 2.98e-09
12	z(3512) = -6.75e+00, p = 1.52e-11
13	z(3498) = -6.95e+00, p = 3.60e-12
14	z(3488) = -7.62e+00, p = 2.50e-14
15	z(3482) = -8.17e+00, p = 3.03e-16
16	z(3428) = -8.82e+00, p = 1.14e-18
17	z(3318) = -9.47e+00, p = 2.85e-21
18	z(3194) = -9.88e+00, p = 5.10e-23
19	z(3190) = -1.04e+01, p = 1.61e-25
20	z(2979) = -1.09e+01, p = 7.26e-28

Statistics for Mann-Whitney test of the significance of the difference between the effects of exchanging pre- and post-training variance and correlation and of exchanging pre- and post-training correlation alone. Degrees of freedom are based on number of groups drawn. Data shown in Fig. 8i.