

Supplemental Material

Research Articles | Systems/Circuits

Early development of direction selectivity in higher visual cortex

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Supplement Figure 1: Stimulus parameters across areas and age groups

- (A) Stimulus spatial frequency as a function of age and recording location. Each symbol indicates one experiment included in the data set. Note that a small random jitter is added to the spatial frequency values for plotting purposes only so that all experiments remain visible in the plot. Dashed lines indicate values that were used in at least one experiment. Symbol color and shape indicate experiments with simultaneous recordings in V1 and PMLS, and experiments in which only PMLS or V1 data was recorded (see legend in (C)).
- (B) Temporal frequency as a function of age and recording location, using the same plot format as in (A).
- (C) Inter-stimulus interval values across experiments (same format as (A)).

Supplement Figure 2: Development of DS and OS, quantified using DSI and OSI.

(Supplement to Fig. 1 & 2)

- (A) Average DSI value per animal, plotted as a function of the animal's age. Same format as Fig. 1D otherwise.
- (B, C) Cumulative DSI distributions for SU data recorded in PMLS and V1, divided into 3 age groups. Same format as Fig. 1E & F.
- (D) Average OSI per-animal as a function of age; same format as Fig. 1D.
- (E, F) Cumulative OSI distributions for SU data recorded in PMLS and V1, divided into 3 age groups. Same format as Fig. 1E & F.
- (G, H) Cumulative distributions of null responses relative to preferred responses for both areas and all age groups.
- (I) Mean null/preferred responses for PMLS and V1 as a function of age. Data were binned into the same age windows used for Fig. 1G. No normalization was used here, in contrast to the data in Fig. 1G. Error bars: SEM.
- See Table 13 for full statistical results.

Supplement Figure 3: Per-animal results for the training cohorts.

(Supplement to Fig. 4)

- (A) Effect of exposure to different stimuli for L_{dir} levels in V1 (left: drifting gratings, middle: gray screen only, right: flashing gratings). In each plot, each column of data points reflects data collected before and after training in one animal, with every data point corresponding to the L_{dir} value of a single visually responsive MU site. The color code indicates corresponding pre- and post-training data for the same animal for a single plot only; it does not indicate correspondence between plots, including V1 and PMLS data for the same training stimulus (i.e. animal 1 for V1 does not have to correspond to animal 1 for PMLS). The black line indicates the before and after L_{dir} levels across animals as estimated from the fixed effect in the LME model. Red lines are per-animal L_{dir} levels as estimated by both the fixed effect and random, per animal effects.
- (B) Effect of different training stimuli on L_{dir} levels in PMLS. Same format as in (A).
- (C) Effect of different training stimuli on L_{ori} levels in V1. Same format as in (A).
- (D) Effect of different training stimuli on L_{ori} levels in PMLS. Same format as in (A).
- See Tables 9 & 10 for full statistics.

Supplement Figure 4: Comparison of responses evoked by flashing and drifting gratings.

(Supplement to Fig. 4)

(A) Correlation in L_{ori} training effect size between V1 and PMLS. Each symbol corresponds to data from a single animal for which both V1 and PMLS data was available, with training effect size determined by the LME model. Error bars: SE estimated for the per-animal random slope. Different training cohorts are indicated by different symbols and colors.

(B) Impact of pre-training L_{dir} levels on training effect size for V1 for all 3 training cohorts. Pre-training levels and training effect sizes were determined from the LME model as before (see legend for the different groups).

(C) Same as (B), but for L_{ori} levels in V1.

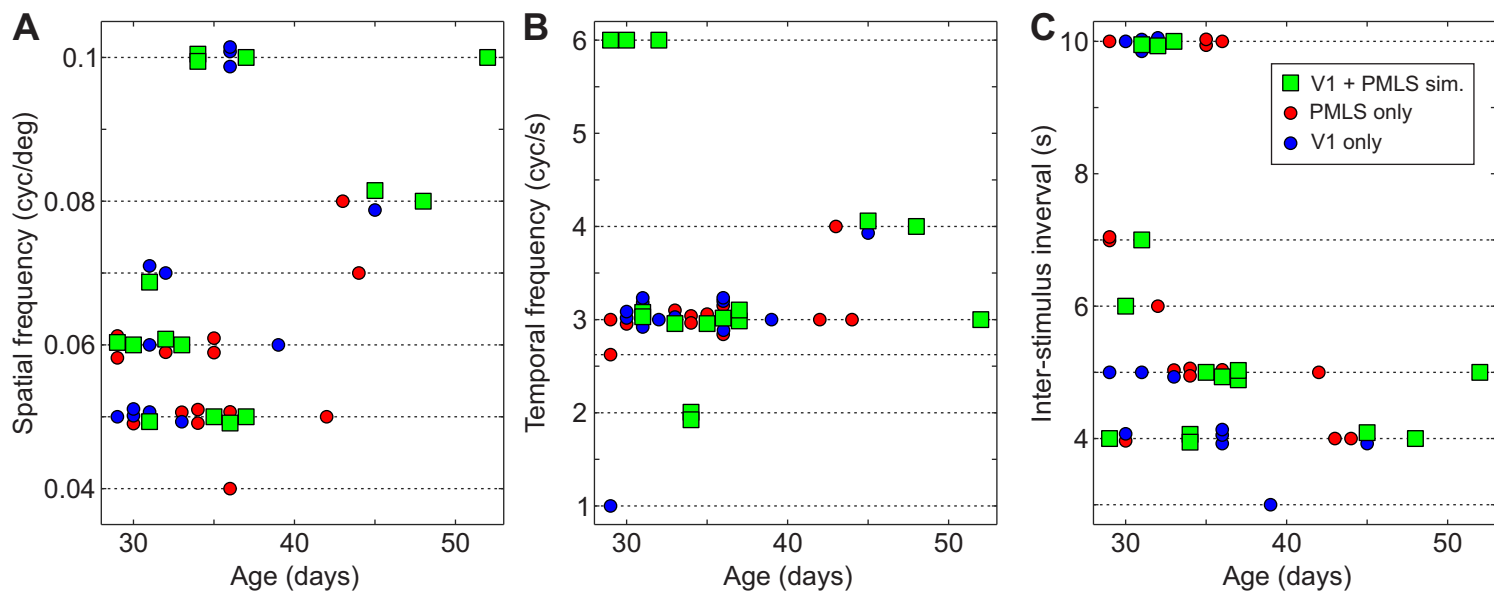
(D) Impact of pre-training L_{dir} levels on training effect size in PMLS for the 3 cohorts. Same format as (B).

(E) Same as (D), but for PMLS L_{ori} levels.

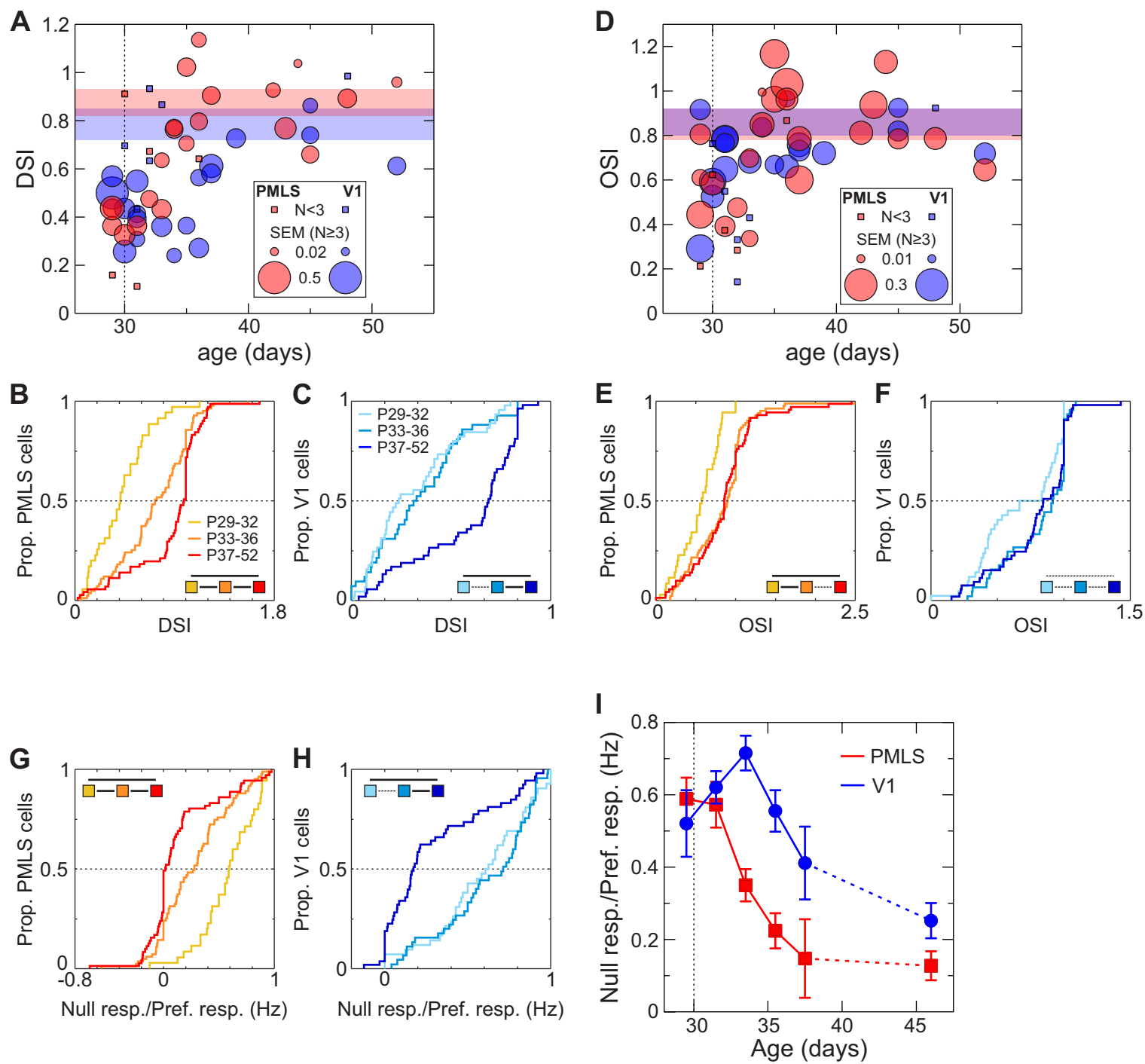
Supplement Figure 5: Comparison of responses evoked by flashing and drifting gratings.

(Supplement to Fig. 4)

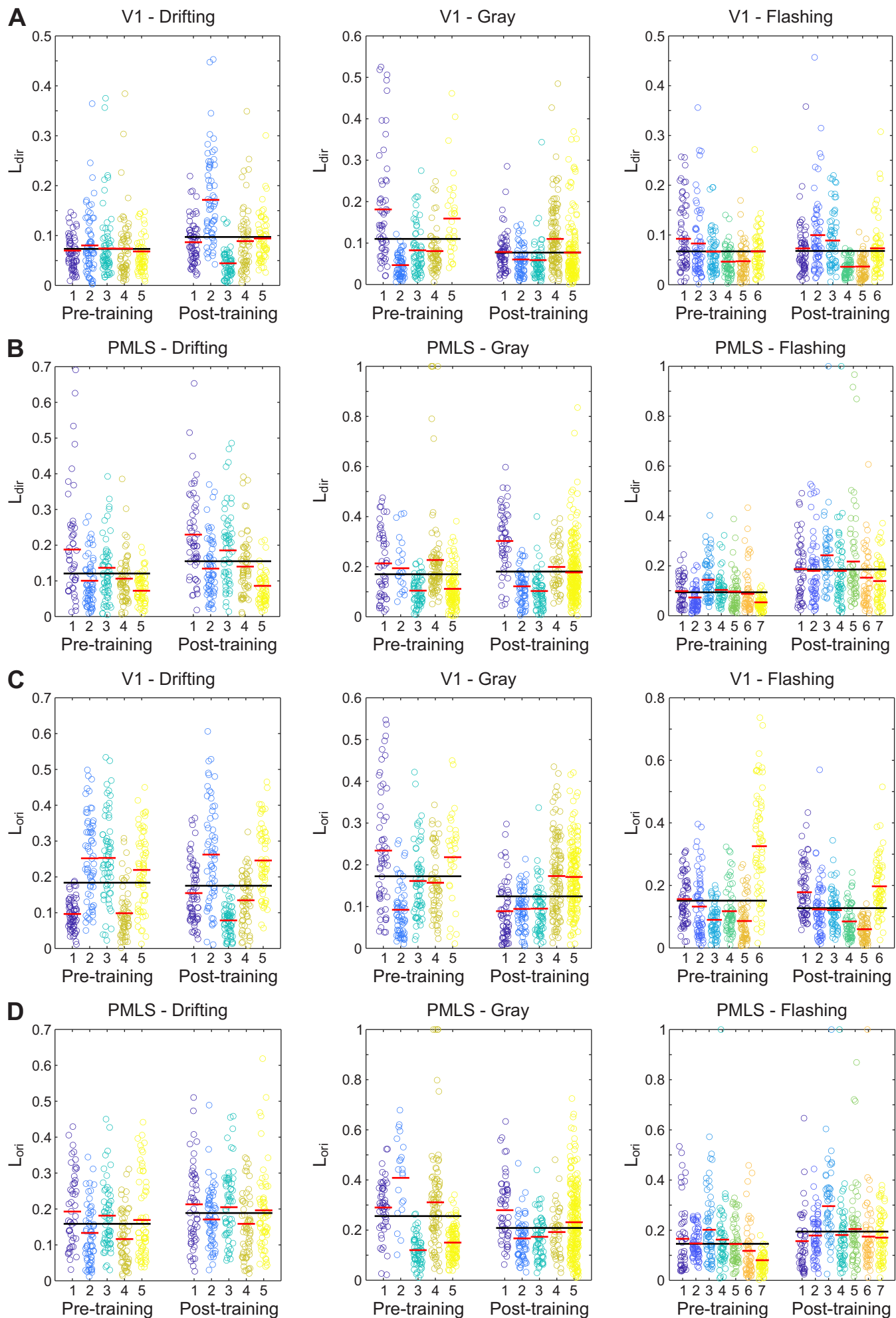
Cumulative distributions of peak rate, response duration and average rate for MU sites recorded in V1 and PMLS in response to drifting and flashing gratings (same color scheme as in Fig. 4I). The legend indicates the outcome of rank-sum tests between flashing and drifting gratings per area (***: $p < .001$). No tests were performed for the peak rate as the group-level ANOVA indicated no differences between the stimulus conditions (see Table 11).



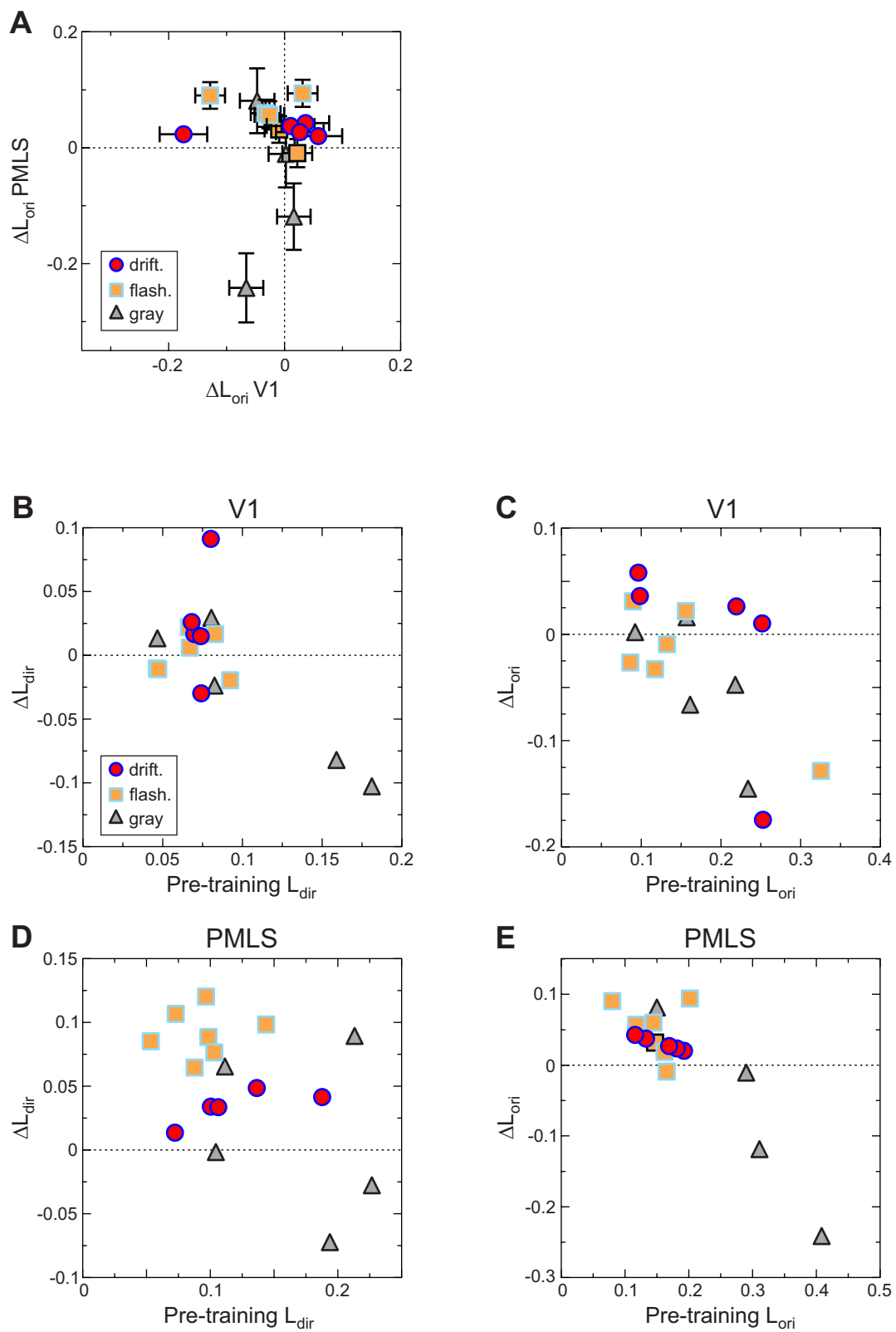
Suppl. Figure 1



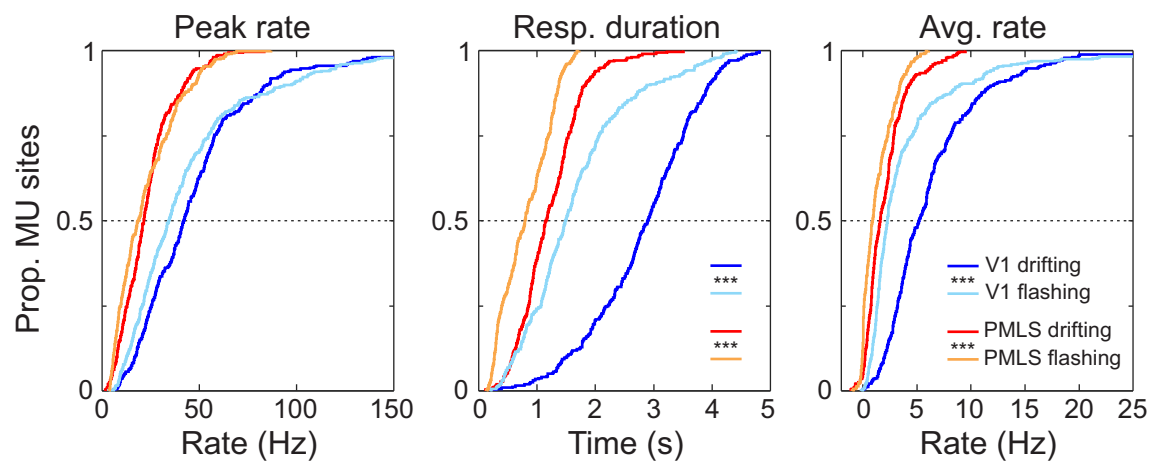
Suppl. Figure 2



Suppl. Figure 3



Suppl. Figure 4



Suppl. Figure 5

Area	Metric	Test	p value	Other
V1 & PMLS	Peak rate	ANOVA: area, stimulus type	Area: <0.001 Stim type: 0.12 IA: 0.3	Area: F(1)=282.4 Stim type: F(1)=2.4 IA: F(1)=1.2
V1 & PMLS	Response duration	ANOVA: area, stimulus type	Area: <0.001 Stim type: <0.001 IA: <0.001	Area: F(1)=973.9 Stim type: F(1)=400.4 IA: F(1)=93.7
V1 & PMLS	Average rate	ANOVA: area, stimulus type	Area: <0.001 Stim type: <0.001 IA: <0.001	Area: F(1)=312.0 Stim type: F(1)=63.7 IA: F(1)=18.5
V1	Response duration	Rank sum	<0.001	
V1	Average rate	Rank sum	<0.001	
PMLS	Response duration	Rank sum	<0.001	
PMLS	Average rate	Rank sum	<0.001	

Table S1: Statistics for Fig. S5 (IA: interaction). All rank-sum tests compare drifting versus flashing gratings.

Metric	Group	Test	PMLS p value	PMLS other	V1 p value	V1 other
L _{dir}	All cohorts	Kruskall-Wallis	<0.001	X(2)=93.0	<0.001	X(2)=30.1
L _{dir}	Drifting vs gray	Rank sum	<0.001		<0.001	
L _{dir}	Drifting vs flashing	Rank sum	<0.001		0.03	
L _{dir}	Flashing vs gray	Rank sum	<0.001		<0.001	
L _{ori}	All cohorts	Kruskall-Wallis	<0.001	X(2)=77.1	<0.001	X(2)=22.5
L _{ori}	Drifting vs gray	Rank sum	<0.001		0.1	
L _{ori}	Drifting vs flashing	Rank sum	0.02		<0.001	
L _{ori}	Flashing vs gray	Rank sum	<0.001		0.003	

Table S2: Comparisons of baseline L_{dir} and L_{ori} levels across cohorts for V1 and PMLS (related to Fig. S4).

Metric	Group	Test	PMLS p value	PMLS other	V1 p value	V1 other
DSI	All age groups	Kruskall-Wallis	<0.001	X=42.1	<0.001	X=27.3
DSI	P29-32 vs P33-36	Rank sum	<0.001		0.6	
DSI	P29-32 vs P37-52	Rank sum	<0.001		<0.001	
DSI	P33-36 vs P37-52	Rank sum	0.2		<0.001	
OSI	All age groups	Kruskall-Wallis	<0.001	X=20.7	0.03	X=6.9
OSI	P29-32 vs P33-36	Rank sum	<0.001		0.01	
OSI	P29-32 vs P37-52	Rank sum	<0.001		0.05	
OSI	P33-36 vs P37-52	Rank sum	0.95		0.6	
Null/Pref	All age groups	Kruskall-Wallis	<0.001	X=42.2	<0.001	X=27.3
Null/Pref	P29-32 vs P33-36	Rank sum	<0.001		0.6	
Null/Pref	P29-32 vs P37-52	Rank sum	<0.001		<0.001	
Null/Pref	P33-36 vs P37-52	Rank sum	<0.001		<0.001	

Table S3: Statistics for Figs. S2B, C, E-H