

## Supplementary Information

**Title:** Cell-type-specific plasticity of inhibitory interneurons in the rehabilitation of auditory cortex after peripheral damage

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17 **Supplementary Table 1: Statistical detailed values for figure 1.**

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Figure	Comparison	Statistical test	F, p	N
1e	Sham-Exposed vs Noise-exposed	2-way ANOVA Exposure x time interaction Effect of Exposure	F =21.7, p = $2.8 \times 10^{-12}$ F= 221.3, p = $1.4 \times 10^{-34}$	Noise: 35 mice Sham: 19 mice
1e	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p = $5.8 \times 10^{-14}$ p = $1 \times 10^{-15}$ p = $5 \times 10^{-9}$	35 mice
1e	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	p > 0.99 p > 0.99 p > 0.99	19 mice
1f	Sound-Intensity vs Time	2-way ANOVA Intensity x time interaction Effect of Intensity Effect of Time	F =61.6, p < $1 \times 10^{-15}$ F= 115.5, p < $1 \times 10^{-15}$ F = 98.19, p = $2.0 \times 10^{-14}$	35 mice
1g	Sham-Exposed vs Noise-exposed	2-way ANOVA Exposure x time interaction Effect of Exposure	F =15.25, p = $9.4 \times 10^{-9}$ F= 56.4, p = $7.0 \times 10^{-10}$	Noise: 35 mice Sham: 19 mice
1g	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p = $1.9 \times 10^{-14}$ p = $5.3 \times 10^{-9}$ p = $2.5 \times 10^{-6}$	35 mice
1g	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	p > 0.99 p > 0.99 p = 0.38	19 mice
1h	Sham-Exposed vs Noise-exposed	2-way ANOVA Exposure x time interaction Effect of Exposure	F =8.4, p = $5.9 \times 10^{-5}$ F= 11.6, p = $1.9 \times 10^{-3}$	Noise: 20 mice Sham: 10 mice
1h	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p = $7.2 \times 10^{-5}$ p = $1.1 \times 10^{-4}$ p = $4.8 \times 10^{-4}$	20 mice
1h	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	p = 0.13 p > 0.99 p = 0.92	10 mice
1i	Sham-Exposed vs Noise-exposed	2-way ANOVA Exposure x time interaction Effect of Exposure	F =13.2, p = $3.7 \times 10^{-7}$ F= 21.8, p = $6.7 \times 10^{-5}$	Noise: 20 mice Sham: 10 mice
1i	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p = $7.3 \times 10^{-8}$ p = $2.6 \times 10^{-4}$ p = $1.3 \times 10^{-3}$	20 mice
1i	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	p = 0.53 p > 0.99 p > 0.99	10 mice
1j	Sham-Exposed vs Noise-exposed	2-way ANOVA Exposure x time interaction Effect of Exposure	F =16.4, p = $1.6 \times 10^{-8}$ F= 8.8, p = $6.0 \times 10^{-3}$	Noise: 20 mice Sham: 10 mice
1j	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p = $8.3 \times 10^{-9}$ p = $2.4 \times 10^{-6}$ p = $9.3 \times 10^{-8}$	20 mice
1j	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc		10 mice

		Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	$p = 0.92$ $p > 0.99$ $p > 0.66$	
1k	Sham-Exposed vs Noise-exposed	2-way ANOVA Exposure x time interaction Effect of Exposure	$F = 17.0, p = 2.8 \times 10^{-9}$ $F = 67.9, p = 1.0 \times 10^{-10}$	Noise: 5 mice Sham: 4 mice
1k	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	$p = 8.0 \times 10^{-10}$ $p = 3.0 \times 10^{-8}$ $p = 5.6 \times 10^{-12}$	5 mice
1k	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	$p = 0.07$ $p > 0.99$ $p > 0.99$	4 mice
1m	Sham-Exposed vs Noise-exposed	2-way ANOVA Exposure x Frequency interaction Effect of Exposure	$F = 24.2, p = 1.1 \times 10^{-9}$ $F = 126.2, p = 3.6 \times 10^{-13}$	Noise: 5 mice Sham: 4 mice
1m	Sham-Exposed vs Noise-exposed	Holm-Bonferroni's post hoc 8 kHz 12 kHz 16 kHz 24 kHz 32 kHz	$p > 0.99$ $p = 0.47$ $p = 0.01$ $p = 1.6 \times 10^{-8}$ $p = 6.8 \times 10^{-13}$	Noise: 5 mice Sham: 4 mice

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27 **Supplementary Table 2: Statistical detailed values for figure 2.**

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Figure	Comparison	Statistical test	F, p	N
2d	Sham-Exposed vs Noise-exposed	Mixed model ANOVA Exposure x time interaction Effect of Exposure	$F = 30.4, p = 4.3 \times 10^{-9}$ $F = 63.5, p = 3.8 \times 10^{-6}$	Noise: Pre: 11 mice, d1: 8 mice, d3: 10 mice, and d10: 8 mice Sham: 3 mice
2d	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	$p < 1 \times 10^{-15}$ $p = 2.6 \times 10^{-11}$ $p = 0.002$	Pre: 11 mice, d1: 8 mice, d3: 10 mice, and d10: 8 mice 8-11 mice
2d	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	$p > 0.99$ $p > 0.99$ $p > 0.99$	3 mice
2e	Sound-Intensity vs Time	Mixed-Model ANOVA Intensity x time interaction Effect of Intensity Effect of Time	$F = 5.06, p = 1.2 \times 10^{-13}$ $F = 53.41, p < 1 \times 10^{-15}$ $F = 66.18, p < 1 \times 10^{-15}$	Pre: 11 mice, d1: 8 mice, d3: 10 mice, and d10: 8 mice
2e	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10 Pre-NE vs. NE-day10 (75 and 80 dB)	$p = 2.8 \times 10^{-5}$ $p = 0.007$ $p > 0.99$ $p < 0.04$	Pre: 11 mice, d1: 8 mice, d3: 10 mice, and d10: 8 mice
2f	Sham-Exposed vs Noise-exposed	Mixed model ANOVA Exposure x time interaction Effect of Exposure	$F = 5.1, p = 5.5 \times 10^{-3}$ $F = 20.31, p = 7.1 \times 10^{-4}$	Noise: Pre: 11 mice, d1: 8 mice, d3: 10 mice, and d10: 8 mice 8-11 mice Sham: 3 mice
2f	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	$p = 0.005$ $p = 0.001$ $p = 0.01$	Pre: 11 mice, d1: 8 mice, d3: 10 mice, and d10: 8 mice
2f	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	$p > 0.99$ $p > 0.99$ $p > 0.99$	3 mice
2k	Sham-Exposed vs Noise-exposed	2-way ANOVA Exposure x time interaction Effect of Exposure	$F = 12.4, p = 5.0 \times 10^{-8}$ $F = 11.6, p = 6.9 \times 10^{-4}$	Noise: 358 PNs Sham: 218 PNs
2k	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	$p = 2.0 \times 10^{-10}$ $p = 4.0 \times 10^{-4}$ $p > 0.99$	358 PNs
2k	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	$p > 0.99$ $p > 0.99$ $p > 0.99$	218 PNs
2l	Effect of Noise-exposure	Friedman Test Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	11.95, 0.007 $p = 0.003$ $p = 0.18$ $p > 0.99$	218 PNs
2m	Sound-Intensity vs Time	2-way ANOVA Intensity x time interaction Effect of Intensity Effect of Time	$F = 1.46, p = 0.057$ $F = 20.6, p < 1 \times 10^{-15}$ $F = 12.5, p = 5.3 \times 10^{-7}$	218 PNs

2m	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	$p = 0.016$ $p = 0.80$ $p = 0.001$	218 PNs
2n	Sham-Exposed vs Noise-exposed	2-way ANOVA Exposure x time interaction Effect of Exposure	$F = 4.7, p = 0.002$ $F = 23.3, p = 1.7 \times 10^{-6}$	Noise: 358 PNs Sham: 218 PNs
2n	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	$p = 2.0 \times 10^{-11}$ $p = 1.0 \times 10^{-9}$ $p = 2.3 \times 10^{-12}$	358 PNs
2n	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	$p > 0.99$ $p > 0.13$ $p > 0.64$	218 PNs
2o	Effect of Noise-exposure	Friedman Test Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	10.31, 0.01 $p = 0.003$ $p = 0.03$ $p = 0.01$	218 PNs
2q, left	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	12.18, $1.0 \times 10^{-6}$ $p = 3.6 \times 10^{-5}$ $p = 0.02$ $p = 0.43$	175 PNs
2q, middle	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	5.3, $1.0 \times 10^{-3}$ $p = 0.001$ $p = 0.012$ $p = 0.79$	110 PNs
2q, high	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	6.6, 0.0003 $p = 3.9 \times 10^{-5}$ $p = 0.001$ $p = 0.02$	47 PNs
2r, left	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	9.6, $3.0 \times 10^{-5}$ $p = 6.3 \times 10^{-7}$ $p = 1.3 \times 10^{-5}$ $p = 1.1 \times 10^{-4}$	175 PNs
2r, middle	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	4.5, 0.01 $p = 2.1 \times 10^{-4}$ $p = 0.01$ $p = 0.007$	110 PNs
2r, high	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	4.14, 0.01 $p = 9.8 \times 10^{-4}$ $p = 1.4 \times 10^{-3}$ $p = 0.02$	47 PNs

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**Supplementary Table 3: Default parameter values.**

Parameter	Value	Description
$\tau_m$	10 (ms)	membrane time constant
$\tau_s$	0.5 (ms)	synaptic time constant
$\tau_r$	2 (ms)	refractory period
$E_L$	-65 (mV)	resting potential
$V_{th}$	-50 (mV)	spike threshold
$V_r$	-65 (mV)	reset potential
$w$	0.6 (mV)	synaptic strength of the excitatory connection
$g$	3	the synaptic factor for inhibitory connection
$N_e$	5000	Num. of PNs
$N_p$	520	Num. of PV neurons
$N_s$	520	Num. SOM neurons
$N_v$	0 / 520	Num. VIP neurons (3/4 populations)
$N_{ext}^e$	500	Num. external inputs to PNs
$N_{ext}^p$	400	Num. external inputs to PV neurons
$N_{ext}^s$	0	Num. external inputs to SOM neurons
$N_{ext}^v$	-- / 400	Num. external inputs to VIP neurons (3/4 populations)
$\sigma_{fixed}^2$	10	Fixed background noise level
$r_{bg}^a$	3 (Hz)	Background excitatory firing rate
$r_{stim}^a$	0, 2, 4, or 8 (Hz)	Stimulus firing rate (none, low, med, high)
$\gamma$	0.5	Damage to background firing rate
$\beta^a$	[0.05, 0.5]	Damage to input stimulus firing rate to pop $a$
$I_{recov}^a$	[-5, 5]	Recovery current to pop $a$
$\kappa_{thres}$	-0.7	Stability threshold

**Supplement Table 4: The probability of a connection between presynaptic (columns) and postsynaptic (rows) populations.**

	E	PV	SOM	VIP
E	0.03	0.10	0.10	0
PV	0.05	0.10	0.07	0
SOM	0.05	0	0	0.10
VIP	0.05	0.15	0.05	0

45 **Supplementary Table 5: Statistical detailed values for figure 4.**  
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Figure	Comparison	Statistical test	F, p	N
4d	Sham-Exposed vs Noise-exposed	Mixed model ANOVA Exposure x time interaction Effect of Exposure	F =22.4, p = $2.8 \times 10^{-7}$ F= 89.0, p = $1.0 \times 10^{-9}$	Noise: Pre: 6 mice, d1: 5 mice, d3: 5 mice, and d10: 5 mice Sham: 3 mice
4d	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p = $3.4 \times 10^{-12}$ p < $4.6 \times 10^{-4}$ p = 0.001	Pre: 6 mice, d1: 5 mice, d3: 5 mice, and d10: 5 mice
4d	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	p > 0.99 p > 0.99 p > 0.99	3 mice
4e	Sound-Intensity vs Time	Mixed-Model ANOVA Intensity x time interaction Effect of Intensity Effect of Time	F = 2.9, p = $3.3 \times 10^{-4}$ F= 16.8, p < $1 \times 10^{-15}$ F = 98.5, p < $1 \times 10^{-15}$	Pre: 6 mice, d1: 5 mice, d3: 5 mice, and d10: 5 mice
4e	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p < $1.0 \times 10^{-15}$ p = $4.5 \times 10^{-8}$ p = 0.11	Pre: 6 mice, d1: 5 mice, d3: 5 mice, and d10: 5 mice
4f	Sham-Exposed vs Noise-exposed	Mixed model ANOVA Exposure x time interaction Effect of Exposure	F =7.4, p = $9.6 \times 10^{-4}$ F= 53.7, p = $1.1 \times 10^{-7}$	Noise: Pre: 6 mice, d1: 5 mice, d3: 5 mice, and d10: 5 mice Sham: 3 mice
4f	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p = $4.8 \times 10^{-6}$ p = $6.6 \times 10^{-3}$ p = $2.2 \times 10^{-6}$	Pre: 6 mice, d1: 5 mice, d3: 5 mice, and d10: 5 mice 5-6 mice
4f	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	p > 0.99 p > 0.99 p > 0.99	3 mice
4k	Sham-Exposed vs Noise-exposed	2-way ANOVA Exposure x time interaction Effect of Exposure	F =7.3, p = $8.5 \times 10^{-5}$ F= 11.1, p = 0.001	Noise: 82 PVs Sham: 80 PVs
4k	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p = $4.9 \times 10^{-6}$ p = $5.0 \times 10^{-4}$ p > 0.99	82 PVs
4k	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	p > 0.99 p > 0.99 p > 0.99	80 PVs
4l	Effect of Noise-exposure	Friedman Test Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	11.5, 0.003 p = 0.005 p = 0.003 p = 0.14	82 PVs
4m	Sound-Intensity vs Time	2-way ANOVA Intensity x time interaction Effect of Intensity Effect of Time	F = 2.2, p = 0.00034 F= 15.7, p < $1 \times 10^{-10}$ F = 29.8, p < $1 \times 10^{-10}$	82 PVs
4m	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p = 0.016 p = 0.80 p = 0.001	82 PVs

4n	Sham-Exposed vs Noise-exposed	2-way ANOVA Exposure x time interaction Effect of Exposure	F =10.19, p = $1.6 \times 10^{-6}$ F= 26.9, p = $6.1 \times 10^{-7}$	Noise: 82 PVs Sham: 80 PVs
4n	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p = $1.6 \times 10^{-9}$ p < $1.0 \times 10^{-15}$ p = $5.2 \times 10^{-7}$	82 PVs
4n	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	p > 0.99 p > 0.13 p > 0.64	80 PVs
4o	Effect of Noise-exposure	Friedman Test Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	12.2, 0.002 p = 0.003 p = 0.001 p = 0.04	82 PVs
4q, left	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	12.47, $4.1 \times 10^{-7}$ p = $5.3 \times 10^{-8}$ p = 0.005 p = 0.17	39 PVs
4q, middle	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	4.3, 0.007 p = 0.04 p = 0.0009 p = 0.34	24 PVs
4q, high	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	2.8, 0.002 p = 0.02 p = 0.05 p = 0.72	18 PVs
4r, left	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	8.8, $2.0 \times 10^{-5}$ p = $1.0 \times 10^{-5}$ p = $3.5 \times 10^{-5}$ p = $6.0 \times 10^{-3}$	39 PVs
4r, middle	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	7.4, 0.0002 p = 0.02 p = $1.4 \times 10^{-5}$ p = 0.01	24 PVs
4r, high	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	3.06, 0.03 p = 0.006 p = 0.03 p = 0.006	18 PVs



**Supplementary Table 6: Statistical detailed values for figure 5.**

Figure	Comparison	Statistical test	F, p	N
5d	Sham-Exposed vs Noise-exposed	Mixed model ANOVA Exposure x time interaction Effect of Exposure	$F = 81.34, p = 1.6 \times 10^{-14}$ $F = 682.0, p < 1.0 \times 10^{-15}$	Noise: Pre: 6 mice, d1: 3 mice, d3: 7 mice, and d10: 6 mice Sham: 4 mice
5d	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	$p < 1 \times 10^{-15}$ $p < 1 \times 10^{-15}$ $p < 1 \times 10^{-15}$	Pre: 6 mice, d1: 3 mice, d3: 7 mice, and d10: 6 mice
5d	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	$p > 0.99$ $p > 0.99$ $p > 0.99$	4 mice
5e	Sound-Intensity vs Time	Mixed-Model ANOVA Intensity x time interaction Effect of Intensity Effect of Time	$F = 2.8, p = 2.3 \times 10^{-5}$ $F = 6.7, p = 4.0 \times 10^{-6}$ $F = 82.9, p < 1 \times 10^{-10}$	Pre: 6 mice, d1: 3 mice, d3: 7 mice, and d10: 6 mice 5-6 mice
5e	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	$p < 1.0 \times 10^{-15}$ $p < 1.0 \times 10^{-15}$ $p < 1.0 \times 10^{-15}$	Pre: 6 mice, d1: 3 mice, d3: 7 mice, and d10: 6 mice 5-6 mice
5f	Sham-Exposed vs Noise-exposed	Mixed model ANOVA Exposure x time interaction Effect of Exposure	$F = 2.1, p = 0.12$ $F = 0.38, p = 0.54$	Noise: Pre: 6 mice, d1: 3 mice, d3: 7 mice, and d10: 6 mice Sham: 4 mice
5k	Sham-Exposed vs Noise-exposed	2-way ANOVA Exposure x time interaction Effect of Exposure	$F = 5.3, p = 0.001$ $F = 16.6, p = 8.2 \times 10^{-5}$	Noise: 82 SOMs Sham: 42 SOMs
5k	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	$p = 0.0005$ $p = 0.0002$ $p = 0.03$	82 SOMs
5k	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	$p > 0.99$ $p > 0.99$ $p = 0.37$	42 SOMs
5l	Effect of Noise-exposure	RM on-way ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	11.0, 0.00005 $p = 0.005$ $p = 0.005$ $p = 0.18$	82 SOMs
5m	Sound-Intensity vs Time	2-way ANOVA Intensity x time interaction Effect of Intensity Effect of Time	$F = 1.6, p = 0.02$ $F = 31.04, p < 1 \times 10^{-15}$ $F = 45.9, p < 1 \times 10^{-15}$	82 SOMs
5m	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	$p < 1.0 \times 10^{-15}$ $p < 1.0 \times 10^{-15}$ $p = 5.4 \times 10^{-12}$	82 SOMs
5n	Sham-Exposed vs Noise-exposed	2-way ANOVA Exposure x time interaction Effect of Exposure	$F = 0.28, p = 0.83$ $F = 1.2, p = 0.27$	Noise: 82 SOMs Sham: 42 PVs
5o	Effect of Noise-exposure	RM one-way ANOVA	1.4, 0.24	82 SOMs
5q, left	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	4.2, 0.007 $p = 0.01$ $p = 0.001$ $p = 0.01$	31 SOMs
5q, middle	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3	3.36, 0.001 $p = 0.01$ $p = 0.04$	34 SOMs

		Pre NE vs NE day 10	p = 0.28	
5q, high	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	3.5, 0.005 p = 0.02 p = 0.03 p = 0.23	15 SOMs
5r, left	Effect of Noise-exposure	1-way RM ANOVA	2.3, 0.08	31 SOMs
5r, middle	Effect of Noise-exposure	1-way RM ANOVA	2.4, 0.06	34 SOMs
5r, high	Effect of Noise-exposure	1-way RM ANOVA	1.2, 0.31	15 SOMs

**Supplementary Table 7: Statistical detailed values for figure 6.**

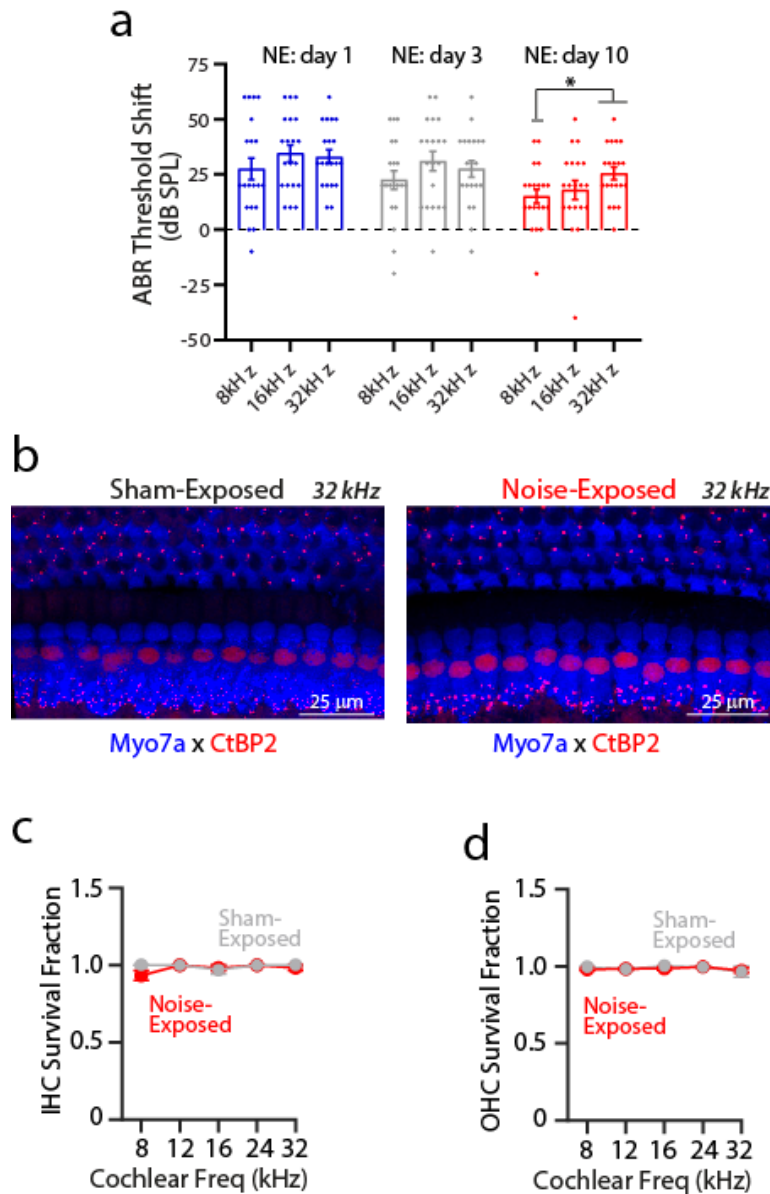
Figure	Comparison	Statistical test	F, p	Neurons(mice)
6d	Sham-Exposed vs Noise-exposed	Mixed model ANOVA Exposure x time interaction Effect of Exposure	F =2.0, p = 0.16 F= 0.89, p = 0.34	SEday1: 20 (3); SEday10: 20 (3) NEday:1 19 (3); NEday10: 20(3)
6e	Sham-Exposed vs Noise-exposed	Mixed model ANOVA Exposure x time interaction Effect of Exposure	F =1.6, p = 0.20 F= 0.07, p = 0.78	SEday1: 20 (3); SEday10: 20 (3) NEday:1 19 (3); NEday10: 20(3)
6g	Sham-Exposed vs Noise-exposed	Mixed model ANOVA Exposure x time interaction Effect of Exposure	F =0.09, p = 0.76 F= 2.6, p = 0.11	SEday1: 20 (3); SEday10: 20 (3) NEday:1 19 (3); NEday10: 20(3)
6h	Sham-Exposed vs Noise-exposed	Mixed model ANOVA Exposure x time interaction Effect of Exposure	F =1.5, p = 0.22 F= 0.02, p = 0.86	SEday1: 20 (3); SEday10: 20 (3) NEday:1 19 (3); NEday10: 20(3)
6m	Sham-Exposed vs Noise-exposed	Mixed model ANOVA Exposure x time interaction Effect of Exposure	F =3.04, p = 0.08 F= 0.42, p = 0.51	SEday1: 20 (3); SEday10: 20 (3) NEday:1 19 (3); NEday10: 20(3)

**Supplementary Table 8: Statistical detailed values for figure 8.**

Figure	Comparison	Statistical test	F, p	N
8d	Sham-Exposed vs Noise-exposed	Mixed model ANOVA Exposure x time interaction Effect of Exposure	F = 8.8, p = 0.0003 F = 34.6, p = $3.3 \times 10^{-6}$	Noise: Pre: 6 mice, d1: 6 mice, d3: 6 mice, and d10: 4 mice Sham: 3 mice
8d	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p = $6.2 \times 10^{-8}$ p = $2.0 \times 10^{-4}$ p > 0.99	Pre: 6 mice, d1: 6 mice, d3: 6 mice, and d10: 4 mice
8d	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	p > 0.99 p > 0.99 p > 0.99	3 mice
8e	Sound-Intensity vs Time	Mixed-Model ANOVA Intensity x time interaction Effect of Intensity Effect of Time	F = 1.02, p = 0.44 F = 22.8, p < $1 \times 10^{-15}$ F = 29.6, p = $8.1 \times 10^{-11}$	Pre: 6 mice, d1: 6 mice, d3: 6 mice, and d10: 4 mice
8e	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p = $5.2 \times 10^{-7}$ p = 0.86 p = 0.0002	Pre: 6 mice, d1: 6 mice, d3: 6 mice, and d10: 4 mice
8f	Sham-Exposed vs Noise-exposed	Mixed model ANOVA Exposure x time interaction Effect of Exposure	F = 3.1, p = 0.04 F = 13.5, p = 0.007	Noise: Pre: 6 mice, d1: 6 mice, d3: 6 mice, and d10: 4 mice Sham: 3 mice
8f	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p = 0.14 p = 0.02 p = 0.11	Pre: 6 mice, d1: 6 mice, d3: 6 mice, and d10: 4 mice
8f	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	p > 0.99 p > 0.99 p > 0.99	3 mice
8k	Sham-Exposed vs Noise-exposed	2-way ANOVA Exposure x time interaction Effect of Exposure	F = 4.7, p = 0.002 F = 6.9, p = 0.001	Noise: 70 VIPs Sham: 60 VIPs
8k	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p = 0.01 p = 0.01 p = $1.0 \times 10^{-5}$	70 VIPs
8k	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	p > 0.99 p > 0.99 p = 0.78	60 VIPs
8l	Effect of Noise-exposure	One-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	8.3, 0.001 p = 0.03 p = 0.01 p > 0.99	70 VIPs
8m	Sound-Intensity vs Time	2-way ANOVA Intensity x time interaction Effect of Intensity Effect of Time	F = 2.6, p = 0.00001 F = 12.1, p < $1 \times 10^{-15}$ F = 39.9, p < $1 \times 10^{-15}$	70 VIPs
8m	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p = $5.1 \times 10^{-8}$ p = 0.004 p = $1.1 \times 10^{-5}$	70 VIPs

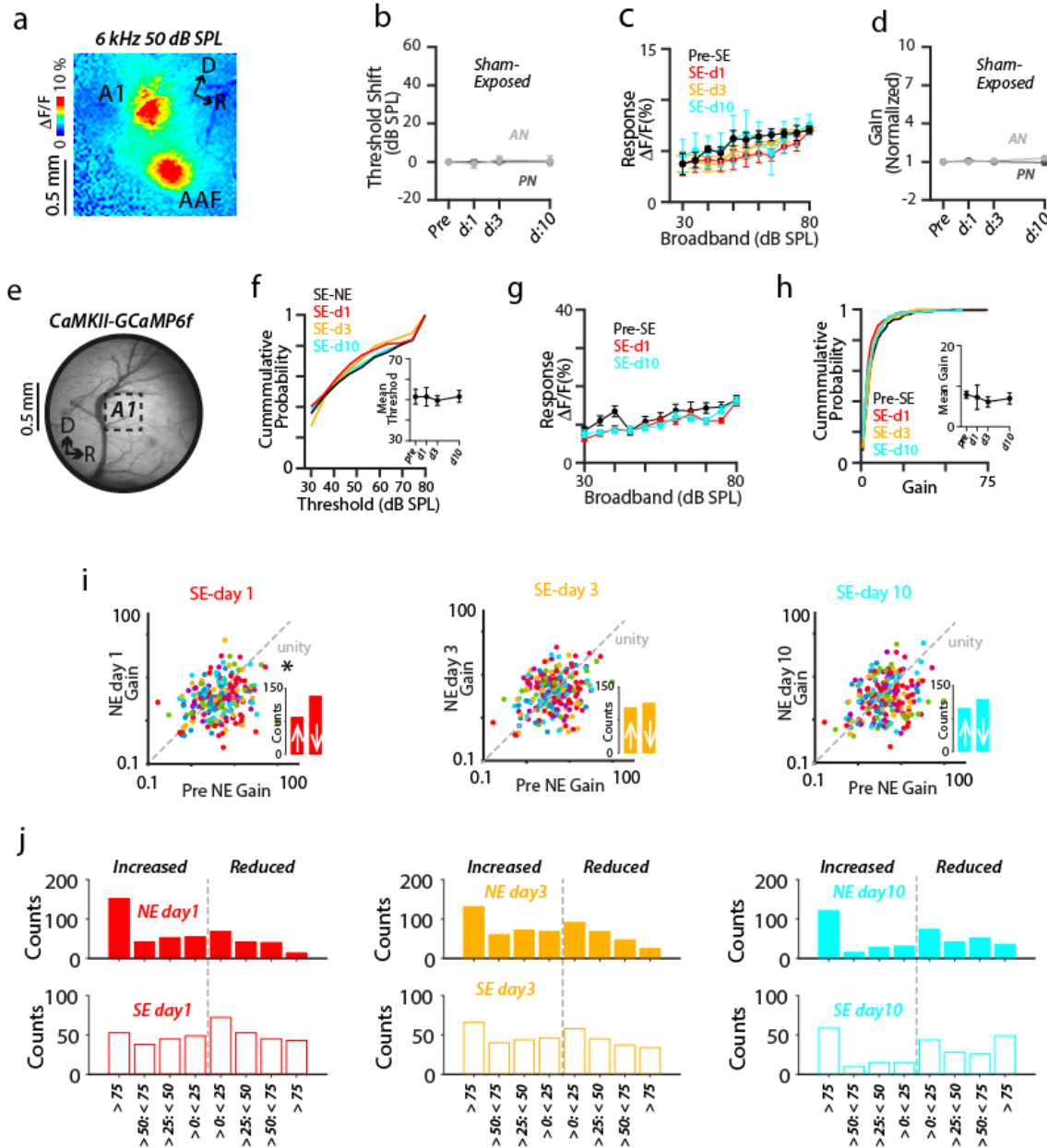
8n	Sham-Exposed vs Noise-exposed	2-way ANOVA Exposure x time interaction Effect of Exposure	F =4.72, p = 0.002 F= 13.7, p = 0.001	Noise: 70 VIPs Sham: 60 VIPs
8n	Pre NE vs NE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	p = 0.01 p =0.01 p = 1.0 x 10 <sup>-5</sup>	70 VIPs
8n	Pre SE vs SE at 1, 3, 10 days	Holm-Bonferroni's post hoc Pre SE vs SE day 1 Pre SE vs SE day 3 Pre SE vs SE day 10	p > 0.99 p > 0.99 p > 0.78	60 VIPs
8o	Effect of Noise-exposure	Friedman test Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	9.4, 0.02 p = 0.56 p = 0.25 p = 0.007	70 VIPs
8q, left	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	4.9, 0.003 p = 0.007 p = 0.01 p = 0.78	33 VIPs
8q, middle	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	2.1, 0.01 p = 0.01 p = 0.72 p = 0.91	18 VIPs
8q, high	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	3.7, 0.002 p = 0.05 p = 0.01 p = 0.04	17 VIPs
8r, left	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	6.4, 0.009 p = 0.01 p = 0.008 p = 0.004	33 VIPs
8r, middle	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	2.8, 0.04 p = 0.62 p = 0.82 p = 0.01	18 VIPs
8r, high	Effect of Noise-exposure	1-way RM ANOVA Pre NE vs NE day 1 Pre NE vs NE day 3 Pre NE vs NE day 10	6.1, 0.002 p = 0.02 p = 0.03 p = 0.001	17 VIPs

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Supplementary Figure 1

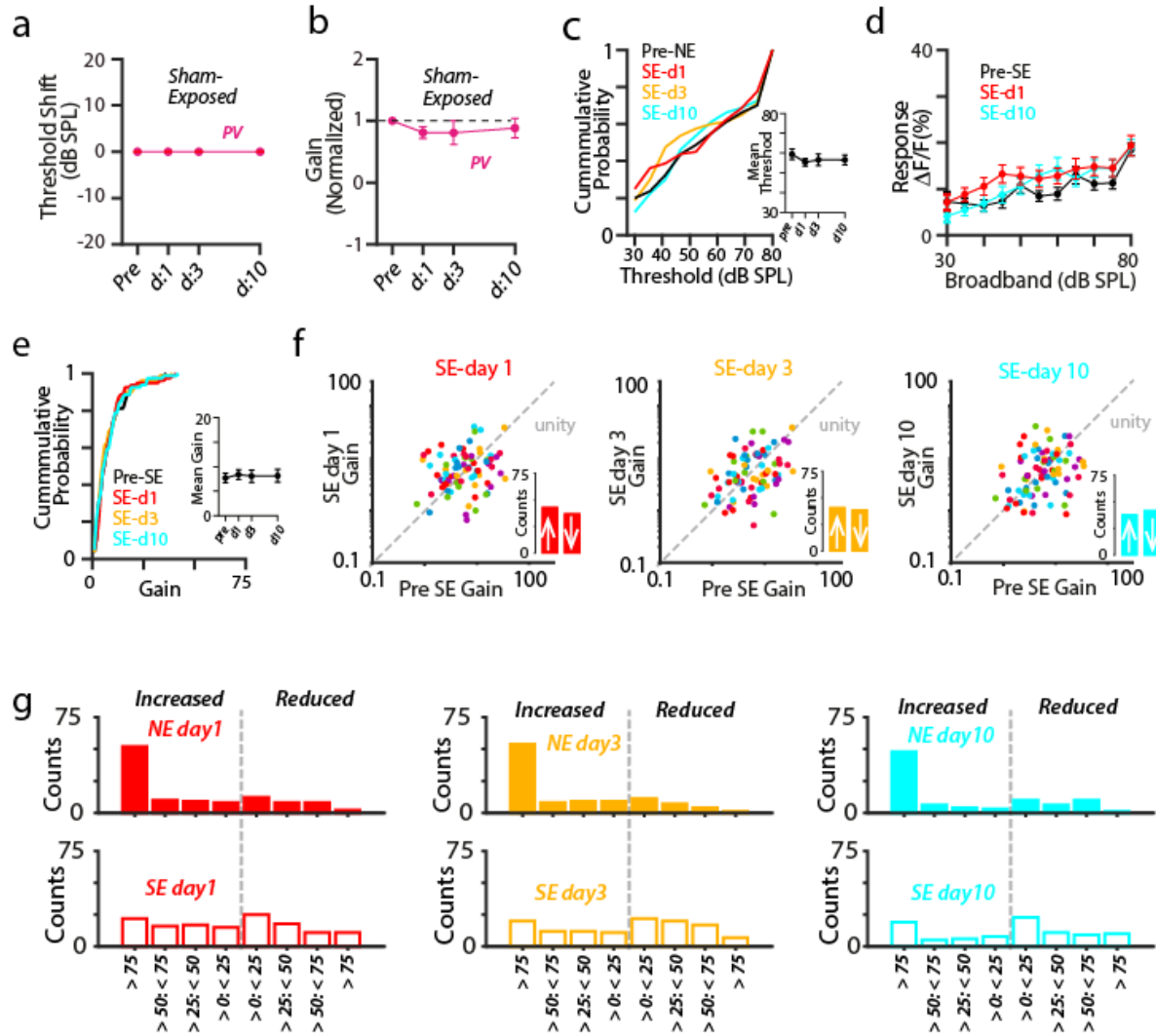
**Supplementary Figure 1. Noise-trauma increased the ABR thresholds for 8-32 kHz tones but did not affect either IHC or OHC survival. (a)** Average ABR threshold shift to 8, 12, 16 kHz tones after NIHL. (n = 20 mice, Frequency vs. time: 2-way ANOVA; effect of frequency,  $F = 12.5$ ,  $p = 6.4 \times 10^{-5}$ ; \*,  $p = 2.5 \times 10^{-5}$ , 32kHz vs 8 kHz, Holm-Bonferroni's post hoc). **(b)** Representative images of OHCs from the 32 kHz region of sham- (left) and noise- (right) exposed mice. **(c)** Quantification of IHC survival from sham- (grey) and noise- (red) exposed mice. (Noise: 5 mice vs. sham: 4 mice, 2-way ANOVA; exposure x frequency,  $F = 1.89$ ,  $p = 0.13$ ; effect of exposure,  $F = 2.7$ ,  $p = 0.10$ ). **(d)** Quantification of OHC survival from sham- (grey) and noise- (red) exposed mice. (Noise: 5 mice vs. sham: 4 mice, 2-way ANOVA; exposure x frequency,  $F = 0.26$ ,  $p = 0.89$ ; effect of exposure,  $F = 0.81$ ,  $p = 0.37$ ).



Supplementary Figure 2

**Supplementary Figure 2. Sham exposure does not alter the sound-evoked activity of A1 L2/3 PNs.** (a) Localization of A1. A 6 kHz 50 dB SPL tone triggered GCaMP6s fluorescence responses in two regions of the auditory cortex representing A1 and the anterior auditory field (AAF; D stands dorsal and R for rostral). (b) Average change in response thresholds of A1 PNs (dark grey) at 1, 3, and 10 days after sham exposure. (n = 3 mice, 1-way repeated measure ANOVA,  $F = 0$ ,  $p > 0.99$ ). Average change in AN threshold (light grey) reproduced from **Figure 1**. (c) Average responses of A1 PNs to broadband sounds from sham-exposed mice. (n = 3 mice, 2-way ANOVA; time x sound level interaction,  $F = 1.3$ ,  $p = 0.35$ ; effect of time,  $F = 0.54$ ,  $p = 0.56$ ). (d) Average response gain of A1 PNs (dark grey) normalized to pre-sham-exposed gain after sham exposure at 1, 3, and 10 days. (n = 3 mice, 1-way repeated measure ANOVA,  $F = 1.3$ ,  $p = 0.34$ ). Normalized AN gain (light grey) reproduced from **Figure 1**. (e). Implantation of cranial glass

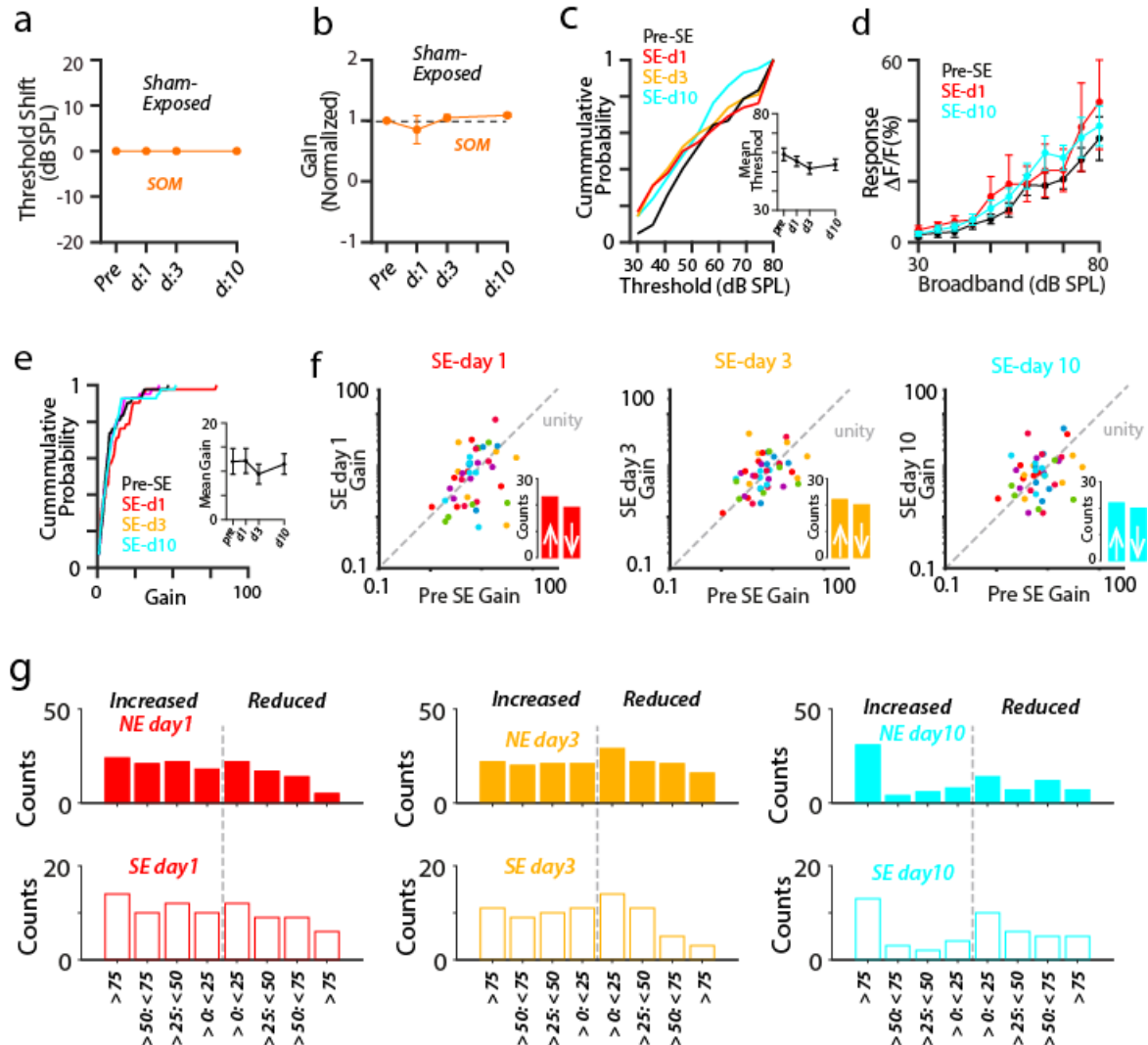
139 window over A1. **(f)** Cumulative probability of response threshold of A1 L2/3 PNs before and after  
140 sham exposure. Inset: Average mean threshold of PNs per mouse (218 PNs from 5 mice, 1-way  
141 repeated measure ANOVA,  $F = 0.17$ ,  $p = 0.87$ ). **(g)** Average sound-evoked responses of A1 L2/3  
142 individual PNs to broadband sounds from sham-exposed mice. (218 PNs from 5 mice, 2-way  
143 ANOVA; sound intensity and time interaction,  $F = 1.6$ ,  $p = 0.072$ ; effect of time,  $F = 2.9$ ,  $p = 0.065$ ).  
144 **(h)** Cumulative probability of gain of A1 L2/3 PNs before and after sham exposure. Inset: Average  
145 mean gain of PNs per mouse (218 PNs from 5 mice, 1-way repeated measure ANOVA,  $F = 0.29$ ,  
146  $p = 0.71$ ). **(i)** Scatter plots of the gain of individual A1 L2/3 PNs before and after sham exposure.  
147 Dotted line represents unity. Insets: Bar graphs representing the number of neurons showing  
148 increased gain ( $\uparrow$  above unity) and reduced gain ( $\downarrow$  below unity) after NIHL. PreSE vs. SEday1:  
149  $p = 0.006$ , PreSE vs. SEday3:  $p = 0.11$ , and PreSE vs. SEday10:  $p = 0.06$ ; permutation test. **(j)**  
150 Histograms showing percentage changes in the gain of L2/3 PNs after noise (top) and sham  
151 (bottom) exposure.  
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Supplementary Figure 3

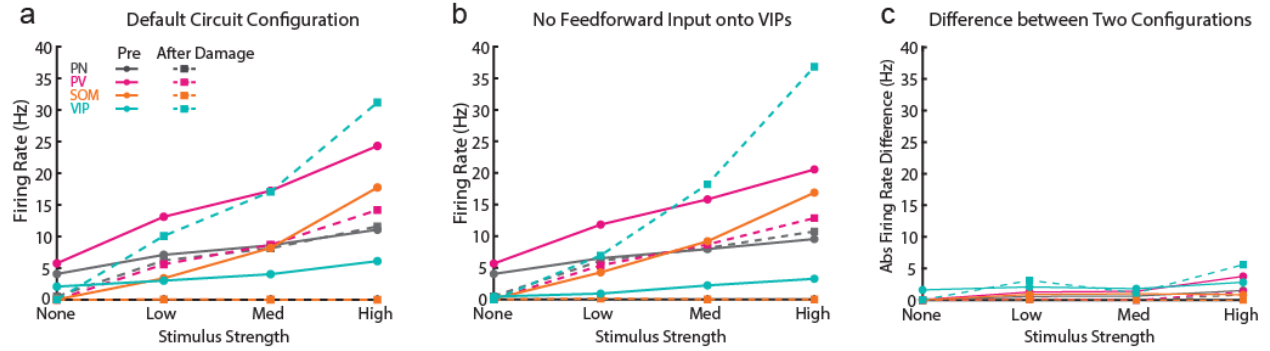
**Supplementary Figure 3. Sham exposure does not alter the sound-evoked activity of A1 L2/3 PVs.** (a) Average change in response thresholds of A1 PVs neurons at 1, 3, and 10 days after sham exposure. ( $n = 3$  mice, 1-way repeated measure ANOVA,  $F = 0$ ,  $p > 0.99$ ). (b) Average response gain of A1 PVs normalized to pre-sham-exposed gain after sham exposure at 1, 3, and 10 days. ( $n = 3$  mice, 1-way repeated measure ANOVA,  $F = 1.09$ ,  $p = 0.40$ ). (c) Cumulative probability of response threshold of A1 L2/3 PV neurons before and after sham-exposure. Inset: Average mean threshold of PVs per mouse (80 neurons from 7 mice, 1-way repeated measure ANOVA,  $F = 0.79$ ,  $p = 0.46$ ). (d) Average responses of A1 L2/3 individual PVs to broadband sounds from sham-exposed mice. (80 neurons from 7 mice, 2-way ANOVA; sound intensity and time interaction,  $F = 1.3$ ,  $p = 0.16$ ; effect of time,  $F = 1.6$ ,  $p = 0.16$ ). (e) Cumulative gain of A1 L2/3 PVs before and after sham exposure. Inset: Average mean gain of PV neurons per mouse (80 neurons from 7 mice, 1-way repeated measure ANOVA,  $F = 0.14$ ,  $p = 0.86$ ). (f) Scatter plots of the gain of individual A1 L2/3 PVs neurons before and after sham exposure. Dotted line represents unity. Insets: Bar graphs represent the number of neurons showing increased gain ( $\uparrow$  above unity) and reduced gain ( $\downarrow$  below unity) after NIHL. PreSE vs. SEday1:  $p = 0.98$ , PreSE vs. SEday3:  $p = 0.67$ , and PreSE vs. SEday10:  $p = 0.96$ ; permutation test. (g) Histograms showing percentage changes in the gain of PVs after noise (top) and sham (bottom) exposure.





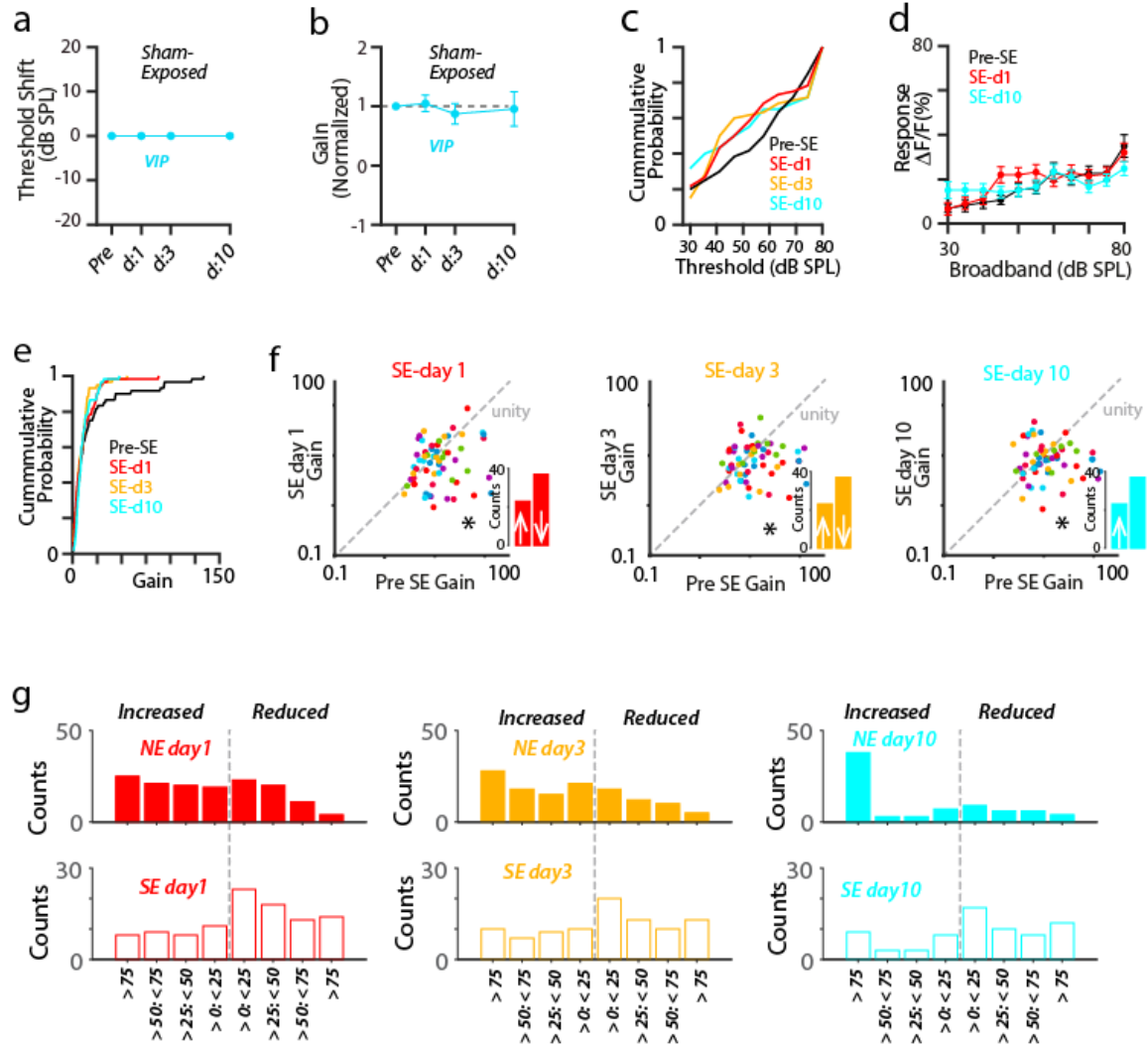
Supplementary Figure 4

**Supplementary Figure 4. Sham exposure did not alter the sound-evoked activity of A1 L2/3 SOMs.** (a) Average change in response thresholds of A1 SOMs at 1, 3, and 10 days after sham exposure. ( $n = 4$  mice, 1-way repeated measure ANOVA,  $F = 0$ ,  $p > 0.99$ ). (b) Average response gain of A1 SOMs normalized to pre-sham-exposed gain after sham exposure at 1, 3, and 10 days. ( $n = 4$  mice, 1-way repeated measure ANOVA,  $F = 0.85$ ,  $p = 0.42$ ). (c) Cumulative probability of response threshold of A1 L2/3 SOMs before and after sham exposure. Inset: Average threshold of SOMs per mouse (42 neurons from 9 mice, 1-way repeated measure ANOVA,  $F = 1.1$ ,  $p = 0.33$ ). (d) Average responses of A1 L2/3 individual SOMs to broadband sounds from sham-exposed mice. (42 neurons from 9 mice, 2-way ANOVA; sound intensity and time interaction,  $F = 0.92$ ,  $p = 0.43$ ; effect of time,  $F = 0.62$ ,  $p = 0.49$ ). (e) Cumulative probability of gain of A1 L2/3 SOMs neurons before and after sham exposure. Inset: Average gain of SOMs per mouse (42 neurons from 9 mice, 1-way repeated measure ANOVA,  $F = 0.35$ ,  $p = 0.70$ ). (f) Scatter plots of the gain of individual A1 L2/3 SOMs before and after sham exposure. Dotted line represents unity. Insets: Bar graphs representing the number of neurons showing increased gain ( $\uparrow$  above unity) and reduced gain ( $\downarrow$  below unity) after NIHL. PreSE vs. SEday1:  $p = 0.55$ , PreSE vs. SEday3:  $p = 0.94$ , and PreSE vs. SEday10:  $p = 0.89$ ; permutation test. (g) Histograms showing percentage changes in the gain of L2/3 SOMs after noise (top) and sham (bottom) exposure.



Supplementary Figure 5

**Supplementary Figure 5. Direct stimulus input onto VIPs can be captured by short-term facilitation from recurrent PN connections.** (a) Example viable parameter set showing all population firing rates for the pre-damage (solid lines with dots) and recovered (dashed lines with squares) states using the default network configuration illustrated in Figure 7a. (b) Same parameter regime as (a), except the direct stimulus input on VIPs was removed and short-term facilitation from PNs was added. Short-term facilitation was modeled by increasing the connection strength of PN→VIP (i.e.,  $w_{VIP,PN}$ ) as a function of the PN firing rate ( $w_{VIP,PN}$  varied from 0.6 to 1.3 as the stimulus strength varied from none to high). Other parameter values can be found in Tables 1 and 2. (c) The absolute firing rate difference between the model used in panels (a) and (b).



Supplementary Figure 6

**Supplementary Figure 6. Sham exposure reduced the gain of A1 L2/3 VIPs.** (a) Average change in response thresholds of A1 VIPs at 1, 3, and 10 days after sham exposure. (n = 3 mice, 1-way repeated measure ANOVA,  $F = 0$ ,  $p > 0.99$ ). (b) Average response gain of A1 VIPs normalized to pre-sham-exposed gain after sham exposure at 1, 3, and 10 days. (n = 3 mice, 1-way repeated measure ANOVA,  $F = 0.03$ ,  $p = 0.98$ ). (c) Cumulative probability of response threshold of A1 L2/3 VIPs before and after sham-exposure. Inset: Average mean threshold of VIP neurons per mouse (60 neurons from 6 mice, 1-way repeated measure ANOVA,  $F = 0.52$ ,  $p = 0.62$ ). (d) Average responses of A1 L2/3 individual VIPs to broadband sounds from sham-exposed mice. (60 neurons from 6 mice, 2-way ANOVA; sound intensity and time interaction,  $F = 4.5$ ,  $p = 0.01$ ; effect of time,  $F = 0.49$ ,  $p = 0.69$ ). (e) Cumulative probability of gain of A1 L2/3 VIPs before and after sham exposure. Inset: Average gain of VIPs per mouse (60 neurons from 6 mice, 1-way repeated measure ANOVA,  $F = 0.44$ ,  $p = 0.61$ ). (f) Scatter plots of the gain of individual A1 L2/3 VIPs before and after sham exposure. Dotted line represents unity. Insets: Bar graphs representing number of neurons showing increased gain ( $\uparrow$  above unity) and reduced gain ( $\downarrow$  below unity) after NIHL. PreSE vs. SEday1:  $p = 0.01$ , PreSE vs. SEday3:  $p = 0.005$ , and PreSE vs. SEday10:  $p = 0.006$ ; permutation test. (g) Histograms showing percentage changes in the gain of L2/3 VIP neurons after noise (top) and sham (bottom) exposure.