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Supplementary Figures: 11

Supplementary Tables: 1

Supplementary Videos: 0

Reporting Checklist for Nature Neuroscience

This checklist is used to ensure good reporting standards and to improve the reproducibility of published results. For more information, please read Reporting Life Sciences Research.

Please note that in the event of publication, it is mandatory that authors include all relevant methodological and statistical information in the manuscript.

Statistics reporting, by figure

- Please specify the following information for each panel reporting quantitative data, and where each item is reported (section, e.g. Results, & paragraph number).
- Each figure legend should ideally contain an exact sample size (n) for each experimental group/condition, where n is an exact number and not a range, a clear definition of how n is defined (for example x cells from x slices from x animals from x litters, collected over x days), a description of the statistical test used, the results of the tests, any descriptive statistics and clearly defined error bars if applicable.
- For any experiments using custom statistics, please indicate the test used and stats obtained for each experiment.
- Each figure legend should include a statement of how many times the experiment shown was replicated in the lab; the details of sample collection should be sufficiently clear so that the replicability of the experiment is obvious to the reader.
- For experiments reported in the text but not in the figures, please use the paragraph number instead of the figure number.

Note: Mean and standard deviation are not appropriate on small samples, and plotting independent data points is usually more informative. When technical replicates are reported, error and significance measures reflect the experimental variability and not the variability of the biological process; it is misleading not to state this clearly.

		TEST USED		n			DESCRIPTIVE STATS (AVERAGE, VARIANCE)		P VALUE		DEGREES OF FREEDOM & F/t/z/R/ETC VALUE	
	FIGURE NUMBER	WHICH TEST?	SECTION & PARAGRAPH #	EXACT VALUE	DEFINED?	SECTION & PARAGRAPH #	REPORTED?	SECTION & PARAGRAPH #	EXACT VALUE	SECTION & PARAGRAPH #	VALUE	SECTION & PARAGRAPH #
example	1a	one-way ANOVA	Fig. legend	9, 9, 10, 15	mice from at least 3 litters/group	Methods para 8	error bars are mean +/- SEM	Fig. legend	p = 0.044	Fig. legend	F(3, 36) = 2.97	Fig. legend
example	results, para 6	unpaired t-test	Results para 6	15	slices from 10 mice	Results para 6	error bars are mean +/- SEM	Results para 6	p = 0.0006	Results para 6	t(28) = 2.808	Results para 6

		TEST USED		n			DESCRIPTIVE STATS (AVERAGE, VARIANCE)		P VALUE		DEGREES OF FREEDOM & F/t/z/R/ETC VALUE	
	FIGURE NUMBER	WHICH TEST?	SECTION & PARAGRAPH #	EXACT VALUE	DEFINED?	SECTION & PARAGRAPH #	REPORTED?	SECTION & PARAGRAPH #	EXACT VALUE	SECTION & PARAGRAPH #	VALUE	SECTION & PARAGRAPH #
+ -	1a	two-way repeated measures ANOVA	Result, paragraph #1	9, 11	mice from 3 litters/ group	Result, paragraph #1	error bars are mean +/- SEM	Result, paragraph #1	P = 0.167	Result, paragraph #1	F(1, 18) = 2.078	Result, paragraph #1
+ -	1b	one-way ANOVA	Figure legend	9	mice from 3 litters/ group	Figure legend	error bars are mean +/- SEM	Figure legend	P < 0.0001	Figure legend	F(3, 32)=13.82	Figure legend
+ -	1b	one-way ANOVA	Figure legend	11	mice from 3 litters/ group	Figure legend	error bars are mean +/- SEM	Figure legend	P < 0.0001	Figure legend	F(3, 40) = 48.48	Figure legend
+ -	1b	unpaired t-test	Result, paragraph #1	9, 11	mice from 3 litters/ group	Result, paragraph #1	error bars are mean +/- SEM	Result, paragraph #1	P = 0.0263	Result, paragraph #1	t(18)=2.421	Result, paragraph #1
+ -	1b	two-way ANOVA	Figure legend	9, 11	mice from 3 litters/ group	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.0109	Figure legend	F(3, 54) = 4.091	Figure legend
+ -	1c	two-way repeated measures ANOVA	Result, paragraph #2	10, 15	mice from 5 litters/ group	Result, paragraph #2	error bars are mean +/- SEM	Result, paragraph #2	P < 0.0001	Result, paragraph #2	F(1, 23) = 38.54	Result, paragraph #2
+ -	1d	one-way ANOVA	Result, paragraph #2	10	mice from 5 litters/ group	Result, paragraph #2	error bars are mean +/- SEM	Result, paragraph #2	P = 0.127	Result, paragraph #2	F(3, 36) = 2.029	Result, paragraph #2
+ -	1d	one-way ANOVA	Result, paragraph #2	15	mice from 5 litters/ group	Result, paragraph #2	error bars are mean +/- SEM	Result, paragraph #2	P < 0.0001	Figure legend, page 31, paragraph 1	F(3, 56) = 23.51	Result, paragraph #2
+ -	1d	two-way ANOVA	Figure legend	10, 15	mice from 5 litters/ group	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.0419	Figure legend	F(3, 69) = 2.884	Figure legend
+ -	2a	two-way repeated measures ANOVA	Figure legend	6, 6	slices from 6 mice	Figure legend	error bars are mean +/- SEM	Figure legend	P=0.0185	Figure legend	F(1, 10) = 7.893	Figure legend
+ -	2a	unpaired t-test	Result, paragraph #3	6, 6	slices from 6 mice	Result, paragraph #3	error bars are mean +/- SEM	Result, paragraph #3	P = 0.0311	Result, paragraph #3	t(10) = 2.506	Result, paragraph #3
+ -	2b	two-way repeated measures ANOVA	Figure legend	7, 7	slices from 7 and 6 mice	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.0327	Figure legend	F(1, 12) = 5.828	Figure legend
+ -	2b	unpaired t-test	Result, paragraph #3	7, 7	slices from 7 and 6 mice	Result, paragraph #3	error bars are mean +/- SEM	Result, paragraph #3	P = 0.0194	Result, paragraph #3	t(12)=2.698	Result, paragraph #3

+ -	3b	unpaired t-test	Result, paragraph #4	5, 5	slices from 5 mice/ grou	Result, paragraph #4	error bars are mean +/- SEM	Figure legend, page 32, paragraph 2	P = 0.0398	Figure legend, page 32, paragraph 2	t(8) = 2.452	Figure legend, page 32, paragraph 2
+ -	3b	unpaired t-test	Result, paragraph #7	5, 5	slices from 5 mice/ grou	Result, paragraph #7	error bars are mean +/- SEM	Result, paragraph #7	P = 0.1527	Result, paragraph #7	t (8) = 1.580	Result, paragraph #7
+ -	3c	one-way ANOVA	Figure legend	13	mice (surgery on purchased mice)	Figure legend	error bars are mean +/- SEM	Figure legend	P < 0.0001	Figure legend	F(3, 48) = 9.748	Figure legend
+ -	3c	one-way ANOVA	Figure legend	8	mice (surgery on purchased mice)	Figure legend	error bars are mean +/- SEM	Figure legend	P < 0.0001	Figure legend	F(3, 28) = 15.58	Figure legend
+ -	3c	one-way ANOVA	Figure legend	10	mice (surgery on purchased mice)	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.0331	Figure legend	F(3, 36) = 3.245	Figure legend
+ -	3c	one-way ANOVA	Result, paragraph #6	10	mice (surgery on purchased mice)	Result, paragraph #6	error bars are mean +/- SEM	Result, paragraph #6	P < 0.0001	Result, paragraph #6	F(3, 36) = 10.44	Result, paragraph #6
+ -	3c	unpaired t-test	Result, paragraph #4	13, 10	mice (surgery on purchased mice)	Result, paragraph #4	error bars are mean +/- SEM	Result, paragraph #4	P = 0.0367	Result, paragraph #4	t(21) = 2.231	Result, paragraph #4
+ -	3c	unpaired t-test	Figure legend	10, 10	mice (surgery on purchased mice)	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.0313	Figure legend	t(18)=2.335	Figure legend
+ -	3d	paired t-test	Result, paragraph #5	15, 15	mice (surgery on purchased mice)	Result, paragraph #5	error bars are mean +/- SEM	Result, paragraph #5	P = 0.0197	Result, paragraph #5	t(14)=2.633	Result, paragraph #5
+ -	3d	paired t-test	Result, paragraph #5	15, 15	mice (surgery on purchased mice)	Result, paragraph #5	error bars are mean +/- SEM	Result, paragraph #5	P = 0.535	Result, paragraph #5	t(14)=0.636	Result, paragraph #5
+ -	3e	one sample paired t-test, % time in new location compared to 50%	Result, paragraph #6	5	mice (surgery on purchased mice)	Result, paragraph #6	error bars are mean +/- SEM	Result, paragraph #6	P = 0.0117	Result, paragraph #6	t(4)=4.395	Result, paragraph #6
+ -	3e	one sample paired t-test, % time in new location compared to 50%	Result, paragraph #6	8	mice (surgery on purchased mice)	Result, paragraph #6	error bars are mean +/- SEM	Result, paragraph #6	P = 0.0229	Result, paragraph #6	t(7)=2.904	Result, paragraph #6
+ -	3f	Repeated measures ANOVA	Figure legend	7, 7, 10, 10	slices from 7, 7, 10, 10 mice	Figure legend	error bars are mean +/- SEM	Figure legend	P < 0.0001	Figure legend	F(3, 72) = 140.2	Figure legend
+ -	3g	two-way ANOVA	Result, paragraph #7	7, 7, 10, 10	slices from 7, 7, 10, 10 mice	Result, paragraph #7	error bars are mean +/- SEM	Result, paragraph #7	P = 0.0159	Result, paragraph #7	F(1, 30) = 6.526	Result, paragraph #7
+ -	3g	Bonferroni posttest	Result, paragraph #7	7, 7, 10, 10	slices from 7, 7, 10, 10 mice	Result, paragraph #7	error bars are mean +/- SEM	Result, paragraph #7	P < 0.05	Result, paragraph #7	Difference =14.28, t= 2.478	Result, paragraph #7

+ -	3g	unpaired t-test	Result, paragraph #7	7, 10	slices from 7 and 10 mice	Result, paragraph #7	error bars are mean +/- SEM	Result, paragraph #7	P = 0.0025	Result, paragraph #7	t(15)=3.625	Result, paragraph #7
+ -	3g	unpaired t-test	Figure legend	10, 10	slices from 10 and 10 mice	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.0330	Figure legend	t(18)=2.309	Figure legend
+ -	3g	unpaired t-test	Figure legend	7, 7	slices from 7 and 7 mice	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.1828	Figure legend	t(12)=1.414	Figure legend
+ -	4b	two-way ANOVA	Figure legend	10, 8, 10, 7	cells from 5, 6, 5, 6 mice	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.0028	Figure legend	F(1, 31) = 10.53	Figure legend
+ -	4b	Bonferroni posttest	Figure legend	10, 7	cells from 5, 6 mice	Figure legend	error bars are mean +/- SEM	Figure legend	P < 0.01	Figure legend	Difference=-0.438, t=3.512	Figure legend
+ -	4c	Repeated-measures ANOVA	Result, paragraph #8	12, 11	cells from 5 and 5 mice	Result, paragraph #8	error bars are mean +/- SEM	Result, paragraph #8	P = 0.921	Result, paragraph #8	F(1, 21) = 0.010	Result, paragraph #8
+ -	4d	two-way ANOVA	Figure legend	9, 9, 7, 9	cells from 3, 3, 5, 5, mice	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.0031	Figure legend	F(1, 30) = 10.31	Figure legend
+ -	4d	unpaired t-test	Figure legend	9, 7	cells from 3, 5 mice	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.7355	Figure legend	t(14)=0.3446	Figure legend
+ -	4d	unpaired t-test	Result, paragraph #8	9, 9	cells from 3, 3 mice	Result, paragraph #8	error bars are mean +/- SEM	Result, paragraph #8	P = 0.0100	Result, paragraph #8	t(16)=2.923	Result, paragraph #8
+ -	4d	unpaired t-test	Result, paragraph #8	9, 9	cells from 3, 5 mice	Result, paragraph #8	error bars are mean +/- SEM	Result, paragraph #8	P = 0.0177	Result, paragraph #8	t(16)=2.645	Result, paragraph #8
+ -	4d	two-way ANOVA	Figure legend	9, 9, 7, 9	cells from 3, 3, 5, 5, mice	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.498	Figure legend	F(1, 30) = 0.470	Figure legend
+ -	4e	two-way ANOVA	Figure legend	9, 10, 9, 9	cells from 5, 3, 4, 3 mice	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.0206	Figure legend	F(1, 33) = 5.914	Figure legend
+ -	4e	unpaired t-test	Figure legend	9, 9	cells from 5, 4 mice	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.7901	Figure legend	t(16) = 0.2707	Figure legend
+ -	4e	Result, paragraph #8	Result, paragraph #8	9, 10	cells from 5, 3 mice	Result, paragraph #8	error bars are mean +/- SEM	Result, paragraph #8	P = 0.0013	Result, paragraph #8	t(17) = 3.858	Result, paragraph #8
+ -	4e	unpaired t-test	Result, paragraph #8	10, 9	cells from 3, 3 mice	Result, paragraph #8	error bars are mean +/- SEM	Result, paragraph #8	P = 0.0226	Result, paragraph #8	t(17) = 2.508	Result, paragraph #8
+ -	4e	two-way ANOVA	Figure legend	9, 10, 9, 9	cells from 5, 3, 4, 3 mice	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.839	Figure legend	F(1, 33) = 0.418	Figure legend
+ -	5d	two-way ANOVA	Result, paragraph #9	4, 4, 4, 4	protein extracts from neuronal cultures	Result, paragraph #9	error bars are mean +/- SEM	Result, paragraph #9	P = 0.0342	Result, paragraph #9	F(1, 12) = 5.704	Result, paragraph #9
+ -	5d	Bonferroni posttests	Result, paragraph #9	4, 4	protein extracts from neuronal cultures	Result, paragraph #9	error bars are mean +/- SEM	Result, paragraph #9	P < 0.05	Result, paragraph #9	difference=44.63, t=3.167	Result, paragraph #9
+ -	6a	unpaired t-test	Result, paragraph #10	8, 7	hippocampi from 8, 7 mice	Result, paragraph #10	error bars are mean +/- SEM	Result, paragraph #10	P = 0.0044	Result, paragraph #10	t(13) = 3.438	Result, paragraph #10

+ -	6a	unpaired t-test	Result, paragraph #10	7, 8	hippocampi from 7, 8 mice	Result, paragraph #10	error bars are mean +/- SEM	Result, paragraph #10	P = 0.439	Result, paragraph #10	t(13) = 2.231	Result, paragraph #10
+ -	6b	two-way repeated measures ANOVA	Result, paragraph #10	14, 13, 11, 11	mice from 5 litters/ group	Result, paragraph #10	error bars are mean +/- SEM	Result, paragraph #10	P < 0.0001	Result, paragraph #10	F(3, 45) = 18.76	Result, paragraph #10
+ -	6c	two-way ANOVA	Result, paragraph #10	14, 13, 11, 11	mice from 5 litters/ group	Result, paragraph #10	error bars are mean +/- SEM	Result, paragraph #10	P < 0.0001	Result, paragraph #10	F(1, 45) = 19.79	Result, paragraph #10
+ -	6d	one-way ANOVA	Figure legend	14	mice from 5 litters/ group	Figure legend	error bars are mean +/- SEM	Figure legend	P < 0.0001	Figure legend	F(3, 52) = 33.98	Figure legend
+ -	6d	one-way ANOVA	Figure legend	13	mice from 5 litters/ group	Figure legend	error bars are mean +/- SEM	Figure legend	P < 0.0001	Figure legend	F(3, 48) = 22.54	Figure legend
+ -	6d	one-way ANOVA	Figure legend	11	mice from 5 litters/ group	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.0031	Figure legend	F(3, 40) = 5.441	Figure legend
+ -	6d	one-way ANOVA	Figure legend	11	mice from 5 litters/ group	Figure legend	error bars are mean +/- SEM	Figure legend	P < 0.0001	Figure legend	F(3, 40) = 17.23	Figure legend
+ -	6d	unpaired t-test	Figure legend	14, 11	mice from 5 litters/ group	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.0192	Figure legend	t(23) = 2.518	Figure legend
+ -	6d	unpaired t-test	Result, paragraph #10	11, 11	mice from 5 litters/ group	Result, paragraph #10	error bars are mean +/- SEM	Result, paragraph #10	P = 0.0328	Result, paragraph #10	t(20) = 1.947	Result, paragraph #10
+ -	6e	unpaired t-test	Figure legend	14, 13	mice from 5 litters/ group	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.4592	Figure legend	t(25) = 0.7518	Figure legend
+ -	6e	unpaired t-test	Result, paragraph #10	14, 11	mice from 5 litters/ group	Result, paragraph #10	error bars are mean +/- SEM	Result, paragraph #10	P = 0.0099	Result, paragraph #10	t(23) = 2.813	Result, paragraph #10
+ -	6e	unpaired t-test	Result, paragraph #10	11, 11	mice from 5 litters/ group	Result, paragraph #10	error bars are mean +/- SEM	Result, paragraph #10	P = 0.0335	Result, paragraph #10	t(20) = 2.284	Result, paragraph #10
+ -	6g	unpaired t-test	Figure legend	7, 6	slices from 5, 4 mice	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.2709	Figure legend	t(11) = 1.159	Figure legend
+ -	6g	unpaired t-test	Figure legend	7, 9	slices from 5, 5 mice	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.0001	Figure legend	t(14) = 5.222	Figure legend
+ -	6g	unpaired t-test	Figure legend	9, 7	slices from 5, 6 mice	Figure legend	error bars are mean +/- SEM	Figure legend	P = 0.0031	Figure legend	t(13) = 3.425	Figure legend
+ -	6g	two-way ANOVA	Result, paragraph #11	7, 6, 9, 7	slices from 5, 4, 5, 6 mice	Result, paragraph #11	error bars are mean +/- SEM	Result, paragraph #11	P = 0.0223	Result, paragraph #11	F(1, 25) = 5.936	Result, paragraph #11
+ -	suppl e. 1a	two way repeated measures ANOVA	Supplementary Figure legend	9, 11	mice from 3 litters/ group	Supplementary Figure legend	error bars are mean +/- SEM	Supplementary Figure legend, page 1, paragraph 1	P = 0.954	Supplementary Figure legend, page 1, paragraph 1	F(1, 18) = 0.003	Supplementary Figure legend, page 1, paragraph 1

+ -	suppl e. 1b	unpaired t-test	Supplementary Figure legend, page 1, paragraph 1	16, 22	mice from 6, 7 litters	Supplementary Figure legend, page 1, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 1, paragraph 1	P = 0.194	Supplementary Figure legend, page 1, paragraph 1	t(36)=1.323	Supplementary Figure legend, page 1, paragraph 1
+ -	suppl e. 1c	unpaired t-test	Supplementary Figure legend, page 1, paragraph 1	16, 22	mice from 6, 7 litters	Supplementary Figure legend, page 1, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 1, paragraph 1	P = 0.225	Supplementary Figure legend, page 1, paragraph 1	t(36)=1.234	Supplementary Figure legend, page 1, paragraph 1
+ -	suppl e. 1d	two way repeated measures ANOVA	Supplementary Figure legend, page 1, paragraph 1	10, 15	mice from 5 litters/ group	Supplementary Figure legend, page 1, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 1, paragraph 1	P < 0.0001	Supplementary Figure legend, page 1, paragraph 1	F(1, 23) = 32.99	Supplementary Figure legend, page 1, paragraph 1
+ -	suppl e. 1e	unpaired t-test	Supplementary Figure legend, page 2, paragraph 1	10, 15	mice from 5 litters/ group	Supplementary Figure legend, page 2, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 2, paragraph 1	P = 0.0004	Supplementary Figure legend, page 2, paragraph 1	t(23) = 4.176	Supplementary Figure legend, page 2, paragraph 1
+ -	suppl e. 1f	unpaired t-test	Supplementary Figure legend, page 2, paragraph 1	10, 15	mice from 5 litters/ group	Supplementary Figure legend, page 2, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 2, paragraph 1	P = 0.0004	Supplementary Figure legend, page 2, paragraph 1	t(23) = 4.175	Supplementary Figure legend, page 2, paragraph 1
+ -	Supp le. 2a	unpaired t-test	Supplementary Figure legend, page 3, paragraph 1	9, 11	mice from 3 litters/ group	Supplementary Figure legend, page 3, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 3, paragraph 1	P = 0.4872	Supplementary Figure legend, page 3, paragraph 1	t(18) = 0.7093	Supplementary Figure legend, page 3, paragraph 1
+ -	Supp le. 2b	unpaired t-test	Supplementary Figure legend, page 3, paragraph 1	9, 11	mice from 3 litters/ group	Supplementary Figure legend, page 3, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 3, paragraph 1	P = 0.9063	Supplementary Figure legend, page 3, paragraph 1	t(18) = 0.1194	Supplementary Figure legend, page 3, paragraph 1

+ -	Supple. 2c	one-way ANOVA	Supplementary Figure legend, page 3, paragraph 1	10	mice from 5 litters	Supplementary Figure legend, page 3, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 3, paragraph 1	P = 0.1603	Supplementary Figure legend, page 3, paragraph 1	F(3, 36) = 1.824	Supplementary Figure legend, page 3, paragraph 1
+ -	Supple. 2c	one-way ANOVA	Supplementary Figure legend, page 3, paragraph 1	15	mice from 5 litters	Supplementary Figure legend, page 3, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 3, paragraph 1	P < 0.0001	Supplementary Figure legend, page 3, paragraph 1	F(3, 56) = 36.04	Supplementary Figure legend, page 3, paragraph 1
+ -	Supple. 2d	unpaired t-test	Supplementary Figure legend, page 3, paragraph 1	10, 15	mice from 5 litters/group	Supplementary Figure legend, page 3, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 3, paragraph 1	P = 0.030	Supplementary Figure legend, page 3, paragraph 1	t(23)=2.313	Supplementary Figure legend, page 3, paragraph 1
+ -	Supple. 3	unpaired t-test	Supplementary Figure legend, page 4, paragraph 1	20, 15	mice from at least 5 litters/group	Supplementary Figure legend, page 4, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 4, paragraph 1	P = 0.0223	Supplementary Figure legend, page 4, paragraph 1	t(33) = 2.397	Supplementary Figure legend, page 4, paragraph 1
+ -	Supple. 4a	two way repeated measures ANOVA	Supplementary Figure legend, page 5, paragraph 1	9, 9	slices from 7, 6 mice	Supplementary Figure legend, page 5, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 5, paragraph 1	P = 0.489	Supplementary Figure legend, page 5, paragraph 1	F(1, 16) = 0.502	Supplementary Figure legend, page 5, paragraph 1
+ -	Supple. 4b	two way repeated measures ANOVA	Supplementary Figure legend, page 5, paragraph 1	9, 9	slices from 7, 6 mice	Supplementary Figure legend, page 5, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 5, paragraph 1	P = 0.751	Supplementary Figure legend, page 5, paragraph 1	F(1, 16) = 0.104	Supplementary Figure legend, page 5, paragraph 1
+ -	Supple. 4c	two way repeated measures ANOVA	Supplementary Figure legend, page 5, paragraph 1	9, 9	slices from 7, 6 mice	Supplementary Figure legend, page 5, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 5, paragraph 1	P = 0.674	Supplementary Figure legend, page 5, paragraph 1	F(1, 16) = 0.183	Supplementary Figure legend, page 5, paragraph 1

+ -	Supple. 4e	two way repeated measures ANOVA	Supplementary Figure legend, page 5, paragraph 1	13, 11	slices from 7, 6 mice	Supplementary Figure legend, page 5, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 5, paragraph 1	P = 0.747	Supplementary Figure legend, page 5, paragraph 1	F(1, 21) = 0.107	Supplementary Figure legend, page 5, paragraph 1
+ -	Supple. 5	two way repeated measures ANOVA	Supplementary Figure legend, page 6, paragraph 1	10, 11	slices from 7, 6 mice	Supplementary Figure legend, page 6, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 6, paragraph 1	P = 0.0133	Supplementary Figure legend, page 6, paragraph 1	F(1, 19) = 7.448	Supplementary Figure legend, page 6, paragraph 1
+ -	Supple. 5	unpaired t-test	Supplementary Figure legend, page 6, paragraph 1	10, 11	slices from 7, 6 mice	Supplementary Figure legend, page 6, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 6, paragraph 1	P = 0.0014	Supplementary Figure legend, page 6, paragraph 1	t(19) = 3.725	Supplementary Figure legend, page 6, paragraph 1
+ -	Supple. 6a	unpaired t-test	Supplementary Figure legend, page 7, paragraph 1	5, 5	hippocampi from 5, 5 mice	Supplementary Figure legend, page 7, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 7, paragraph 1	P = 0.0005	Supplementary Figure legend, page 7, paragraph 1	t(8) = 5.587	Supplementary Figure legend, page 7, paragraph 1
+ -	Supple. 7a	two way repeated measures ANOVA	Supplementary Figure legend, page 8, paragraph 1	10, 9, 10, 10	mice (surgery on purchased mice)	Supplementary Figure legend, page 8, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 8, paragraph 1	P = 0.608	Supplementary Figure legend, page 8, paragraph 1	F(3, 34) = 0.618	Supplementary Figure legend, page 8, paragraph 1
+ -	Supple. 7b	two-way ANOVA	Supplementary Figure legend, page 8, paragraph 1	13, 8, 10, 10	mice (surgery on purchased mice)	Supplementary Figure legend, page 8, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 8, paragraph 1	P = 0.818	Supplementary Figure legend, page 8, paragraph 1	F(3, 37) = 0.054	Supplementary Figure legend, page 8, paragraph 1
+ -	Supple. 7c	two way repeated measures ANOVA	Supplementary Figure legend, page 8, paragraph 1	9, 8, 11, 12	hippocampi from 7, 7, 10, 10 mice	Supplementary Figure legend, page 8, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 8, paragraph 1	P = 0.912	Supplementary Figure legend, page 8, paragraph 1	F(3, 36) = 0.175	Supplementary Figure legend, page 8, paragraph 1

+ -	Supple. 7d	two way repeated measures ANOVA	Supplementary Figure legend, page 8, paragraph 1	9, 8, 11, 12	hippocampi from 7, 7, 10, 10 mice	Supplementary Figure legend, page 8, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 8, paragraph 1	P = 0.785	Supplementary Figure legend, page 8, paragraph 1	F(3, 35) = 0.356	Supplementary Figure legend, page 8, paragraph 1
+ -	Supple. 8a	unpaired t-test	Supplementary Figure legend, page 9, paragraph 1	5, 5	hippocampi from 5, 5 mice	Supplementary Figure legend, page 9, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 9, paragraph 1	P < 0.0001	Supplementary Figure legend, page 9, paragraph 1	t(8) = 14.18	Supplementary Figure legend, page 9, paragraph 1
+ -	Supple. 8b	unpaired t-test	Supplementary Figure legend, page 9, paragraph 1	4, 5	hippocampi from 4, 5 mice	Supplementary Figure legend, page 9, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 9, paragraph 1	P = 0.9189	Supplementary Figure legend, page 9, paragraph 1	t(7) = 0.1055	Supplementary Figure legend, page 9, paragraph 1
+ -	Supple. 8c	two way repeated measures ANOVA	Supplementary Figure legend, page 9, paragraph 1	9, 12	mice (surgery on purchased mice)	Supplementary Figure legend, page 9, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 9, paragraph 1	P = 0.233	Supplementary Figure legend, page 9, paragraph 1	F(1, 19) = 1.518	Supplementary Figure legend, page 9, paragraph 1
+ -	Supple. 8d	unpaired t-test	Supplementary Figure legend, page 9, paragraph 1	9, 12	mice (surgery on purchased mice)	Supplementary Figure legend, page 9, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 9, paragraph 1	P = 0.9795	Supplementary Figure legend, page 9, paragraph 1	t(19) = 0.0260	Supplementary Figure legend, page 9, paragraph 1
+ -	Supple. 8e	unpaired t-test	Supplementary Figure legend, page 9, paragraph 1	9, 12	mice (surgery on purchased mice)	Supplementary Figure legend, page 9, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 9, paragraph 1	P = 0.9884	Supplementary Figure legend, page 9, paragraph 1	t(19) = 0.01468	Supplementary Figure legend, page 9, paragraph 1
+ -	Supple. 9b	Unpaired t-test	Supplementary Figure legend, page 10, paragraph 1	8, 8	hippocampi from 8, 8 mice	Supplementary Figure legend, page 10, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 10, paragraph 1	P = 0.0205	Supplementary Figure legend, page 10, paragraph 1	t(14) = 2.612	Supplementary Figure legend, page 10, paragraph 1

+ -	Supple. 9b	Unpaired t-test	Supplementary Figure legend, page 10, paragraph 1	8, 7	hippocampi from 8, 7 mice	Supplementary Figure legend, page 10, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 10, paragraph 1	P = 0.0196	Supplementary Figure legend, page 10, paragraph 1	t(13) = 2.661	Supplementary Figure legend, page 10, paragraph 1
+ -	Supple. 9b	Unpaired t-test	Supplementary Figure legend, page 10, paragraph 1	7, 8	hippocampi from 7, 8 mice	Supplementary Figure legend, page 10, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 10, paragraph 1	P < 0.0001	Supplementary Figure legend, page 10, paragraph 1	t (13) = 5.795	Supplementary Figure legend, page 10, paragraph 1
+ -	Supple. 9c	Unpaired t-test	Supplementary Figure legend, page 10, paragraph 1	5, 5	hippocampi from 5, 5 mice	Supplementary Figure legend, page 10, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 10, paragraph 1	P = 0.3301	Supplementary Figure legend, page 10, paragraph 1	t(8)=1.037	Supplementary Figure legend, page 10, paragraph 1
+ -	Supple. 10	Dunnett's Multiple Comparison Test after ANOVA (D61G/veh)	Supplementary Figure legend, page 11, paragraph 1	7	mice from 4 litters	Supplementary Figure legend, page 11, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 11, paragraph 1	P > 0.05 for T vs. AL and T. vs. O.	Supplementary Figure legend, page 11, paragraph 1	T vs. AL, q=1.259 T vs. O, q=2.145	Supplementary Figure legend, page 11, paragraph 1
+ -	Supple. 10	two-way ANOVA	Supplementary Figure legend, page 11, paragraph 1	8	mice from 5 litters	Supplementary Figure legend, page 11, paragraph 1	error bars are mean +/- SEM	Supplementary Figure legend, page 11, paragraph 1	P < 0.0001	Supplementary Figure legend, page 11, paragraph 1	F(3, 31) = 15.03	Supplementary Figure legend, page 11, paragraph 1

Representative figures

1. Are any representative images shown (including Western blots and immunohistochemistry/staining) in the paper?

   If so, what figure(s)?

   Fig. 3a; Fig. 3b; Fig. 5a, 5b, 5e; Fig. 6a
   Supple Fig. 6; Supple Fig. 8; Supple Fig. 9b, Supple Fig. 9c

2. For each representative image, is there a clear statement of how many times this experiment was successfully repeated and a discussion of any limitations in repeatability?

   If so, where is this reported (section, paragraph #)?

   Actual sample sizes or number of repeats were clearly stated in main text, the legends of each figures and supplementary figures.

Statistics and general methods

1. Is there a justification of the sample size? If so, how was it justified? Where (section, paragraph #)? Even if no sample size calculation was performed, authors should report why the sample size is adequate to measure their effect size.	We did not use any statistical methods to pre-determine the sample sizes, but our sample sizes are similar to those reported in previously published papers. This is described in Method section, section #9.
2. Are statistical tests justified as appropriate for every figure? Where (section, paragraph #)?	Yes, statistical tests are clearly described in the legends for every figures.
a. If there is a section summarizing the statistical methods in the methods, is the statistical test for each experiment clearly defined?	Yes, we have a section summarizing the statistical methods where we clearly defined the statistical test for each experiment.
b. Do the data meet the assumptions of the specific statistical test you chose (e.g. normality for a parametric test)? Where is this described (section, paragraph #)?	Data distribution was assumed to be normal but this was not formally tested. We stated this in method section. This is described in Method section, section #9.
c. Is there any estimate of variance within each group of data? Is the variance similar between groups that are being statistically compared? Where is this described (section, paragraph #)?	In the manuscript, we reported standard error as a measure of variance and that they are similar within each group of data. Stated in the figure legends and last paragraph in method section.
d. Are tests specified as one- or two-sided?	Yes
e. Are there adjustments for multiple comparisons?	Yes
3. Are criteria for excluding data points reported? Was this criterion established prior to data collection? Where is this described (section, paragraph #)?	A mouse showing floating behavior in the water maze was excluded from the further analysis. Criterion had been established prior to data collection. This is described in page 19.
4. Define the method of randomization used to assign subjects (or samples) to the experimental groups and to collect and process data. If no randomization was used, state so. Where does this appear (section, paragraph #)?	Types of virus or drug have always been selected by random fashion and the experimenters were always blinded to genotypes and treatments. This is stated in method section.
5. Is a statement of the extent to which investigator knew the group allocation during the experiment and in assessing outcome included? If no blinding was done, state so. Where (section, paragraph #)?	Experimenters were always blinded to the genotype, drugs, and types of viruses. We stated this in method section.

6. For experiments in live vertebrates, is a statement of compliance with ethical guidelines/regulations included? Where (section, paragraph #)?	All the studies were approved by the Animal Research Committee (ARC) in UCLA and CAU. We stated this in method section, first paragraph.
7. Is the species of the animals used reported? Where (section, paragraph #)?	Yes. Method section, first paragraph.
8. Is the strain of the animals (including background strains of KO/ transgenic animals used) reported? Where (section, paragraph #)?	Yes. Method section, first paragraph.
9. Is the sex of the animals/subjects used reported? Where (section, paragraph #)?	Yes. Method section, first paragraph.
10. Is the age of the animals/subjects reported? Where (section, paragraph #)?	Yes. Method section, first paragraph.
11. For animals housed in a vivarium, is the light/dark cycle reported? Where (section, paragraph #)?	Yes. Method section, first paragraph.
12. For animals housed in a vivarium, is the housing group (i.e. number of animals per cage) reported? Where (section, paragraph #)?	Yes. Method section, first paragraph.
13. For behavioral experiments, is the time of day reported (e.g. light or dark cycle)? Where (section, paragraph #)?	Yes. Method section, first paragraph.
14. Is the previous history of the animals/subjects (e.g. prior drug administration, surgery, behavioral testing) reported? Where (section, paragraph #)?	Yes. Method section, paragraph #3.
a. If multiple behavioral tests were conducted in the same group of animals, is this reported? Where (section, paragraph #)?	Yes, we used the same group of animals for both hidden and visible platform version of water maze. We stated this in Method section, paragraph #4.
15. If any animals/subjects were excluded from analysis, is this reported? Where (section, paragraph #)?	Yes, we excluded one mouse in the water maze experiment from the analysis because of the floating. We report this in method section, paragraph #4.
a. How were the criteria for exclusion defined? Where is this described (section, paragraph #)?	f the mouse dose not show any voluntary movement for more than 10 seconds in more than 2 trials, we call this floating and exclude this mouse from the analysis. We stated this in method section, paragraph #4.

b. Specify reasons for any discrepancy between the number of animals at the beginning and end of the study.

Where is this described (section, paragraph #)?

N/A

Reagents

1. Have antibodies been validated for use in the system under study (assay and species)?

We only used commercially available antibodies that have been commonly used in the field.

a. Is antibody catalog number given?

Where does this appear (section, paragraph #)?

Yes, we give the catalog numbers for the antibodies in the method section, paragraph #6.

b. Where were the validation data reported (citation, supplementary information, Antibodypedia)?

Where does this appear (section, paragraph #)?

All antibodies used in this study are commercially available. Data available online through the respective antibody companies' websites.

2. If cell lines were used to reflect the properties of a particular tissue or disease state, is their source identified?

Where (section, paragraph #)?

N/A

a. Were they recently authenticated?

Where is this information reported (section, paragraph #)?

Data deposition

Data deposition in a public repository is mandatory for:

a. Protein, DNA and RNA sequences
b. Macromolecular structures
c. Crystallographic data for small molecules
d. Microarray data

Deposition is strongly recommended for many other datasets for which structured public repositories exist; more details on our data policy are available here. We encourage the provision of other source data in supplementary information or in unstructured repositories such as Figshare and Dryad.

1. Are accession codes for deposit dates provided?

Where (section, paragraph #)?

N/A

Computer code/software

Any custom algorithm/software that is central to the methods must be supplied by the authors in a usable and readable form for readers at the time of publication. However, referees may ask for this information at any time during the review process.

1. Identify all custom software or scripts that were required to conduct the study and where in the procedures each was used.

N/A

2. Is computer source code/software provided with the paper or deposited in a public repository? Indicate in what form this is provided or how it can be obtained.

N/A

Human subjects

1. Which IRB approved the protocol?

   Where is this stated (section, paragraph #)?

N/A

2. Is demographic information on all subjects provided?

   Where (section, paragraph #)?

N/A

3. Is the number of human subjects, their age and sex clearly defined?

   Where (section, paragraph #)?

N/A

4. Are the inclusion and exclusion criteria (if any) clearly specified?

   Where (section, paragraph #)?

N/A

5. How well were the groups matched?

   Where is this information described (section, paragraph #)?

N/A

6. Is a statement included confirming that informed consent was obtained from all subjects?

   Where (section, paragraph #)?

N/A

7. For publication of patient photos, is a statement included confirming that consent to publish was obtained?

   Where (section, paragraph #)?

N/A

fMRI studies

For papers reporting functional imaging (fMRI) results please ensure that these minimal reporting guidelines are met and that all this information is clearly provided in the methods:

1. Were any subjects scanned but then rejected for the analysis after the data was collected?

N/A

   a. If yes, is the number rejected and reasons for rejection described?

      Where (section, paragraph #)?

N/A

2. Is the number of blocks, trials or experimental units per session and/or subjects specified?

   Where (section, paragraph #)?

N/A

3. Is the length of each trial and interval between trials specified?	N/A
4. Is a blocked, event-related, or mixed design being used? If applicable, please specify the block length or how the event-related or mixed design was optimized.	N/A
5. Is the task design clearly described? Where (section, paragraph #)?	N/A
6. How was behavioral performance measured?	N/A
7. Is an ANOVA or factorial design being used?	N/A
8. For data acquisition, is a whole brain scan used? If not, state area of acquisition.	N/A
a. How was this region determined?	
9. Is the field strength (in Tesla) of the MRI system stated?	N/A
a. Is the pulse sequence type (gradient/spin echo, EPI/spiral) stated?	
b. Are the field-of-view, matrix size, slice thickness, and TE/TR/ flip angle clearly stated?	
10. Are the software and specific parameters (model/functions, smoothing kernel size if applicable, etc.) used for data processing and pre-processing clearly stated?	N/A
11. Is the coordinate space for the anatomical/functional imaging data clearly defined as subject/native space or standardized stereotaxic space, e.g., original Talairach, MNI305, ICBM152, etc? Where (section, paragraph #)?	N/A
12. If there was data normalization/standardization to a specific space template, are the type of transformation (linear vs. nonlinear) used and image types being transformed clearly described? Where (section, paragraph #)?	N/A
13. How were anatomical locations determined, e.g., via an automated labeling algorithm (AAL), standardized coordinate database (Talairach daemon), probabilistic atlases, etc.?	N/A
14. Were any additional regressors (behavioral covariates, motion etc) used?	N/A
15. Is the contrast construction clearly defined?	N/A

16. Is a mixed/random effects or fixed inference used?	N/A
a. If fixed effects inference used, is this justified?	
17. Were repeated measures used (multiple measurements per subject)?	N/A
a. If so, are the method to account for within subject correlation and the assumptions made about variance clearly stated?	
18. If the threshold used for inference and visualization in figures varies, is this clearly stated?	N/A
19. Are statistical inferences corrected for multiple comparisons?	N/A
a. If not, is this labeled as uncorrected?	
20. Are the results based on an ROI (region of interest) analysis?	N/A
a. If so, is the rationale clearly described?	
b. How were the ROI's defined (functional vs anatomical localization)?	
21. Is there correction for multiple comparisons within each voxel?	N/A
22. For cluster-wise significance, is the cluster-defining threshold and the corrected significance level defined?	N/A

Additional comments

Additional Comments	None.