An increase in dendritic plateau potentials is associated with experience-dependent cortical map reorganization

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Supplementary Information for

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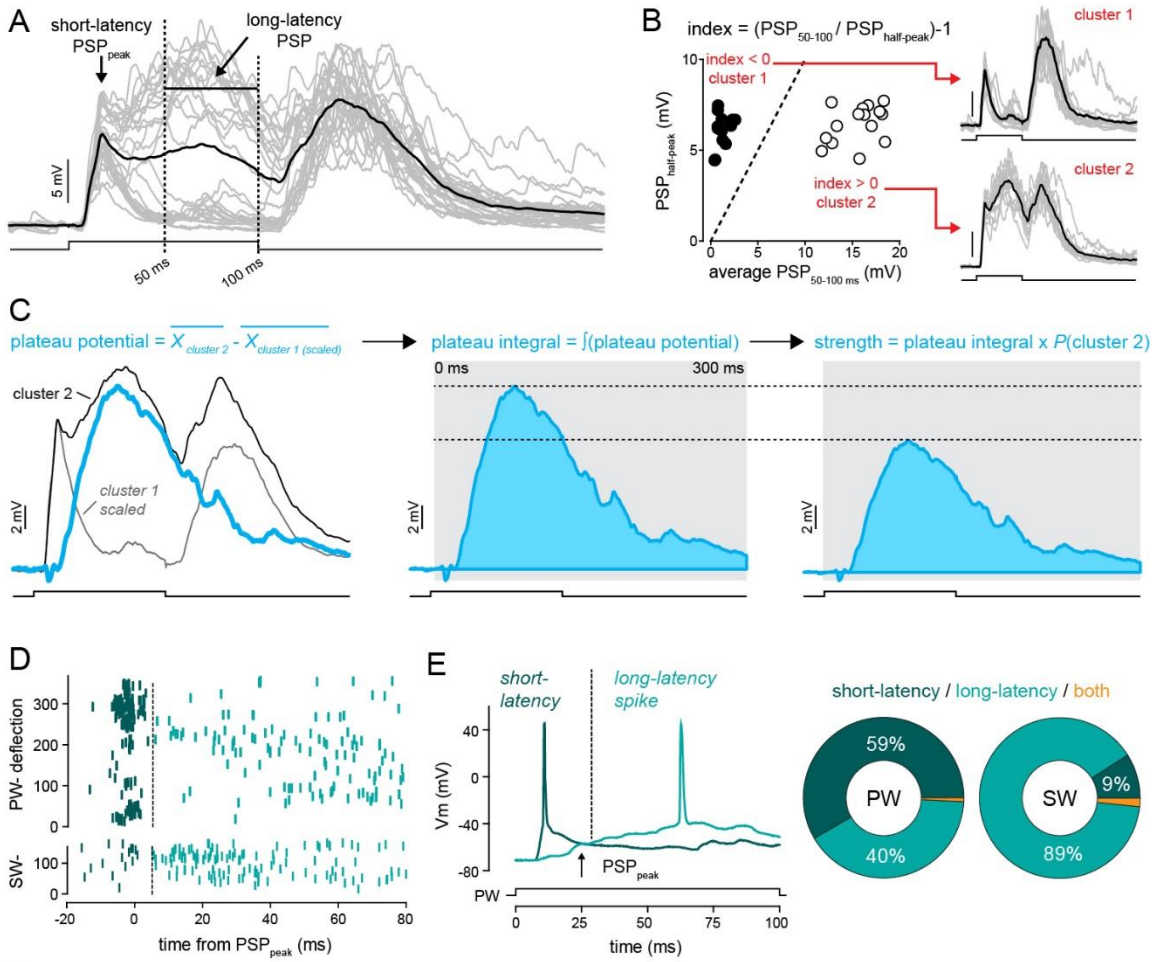

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Parameters	Extraction	Affected by DWE?
Whisker-evoked PSP integral	Integral of whisker-evoked PSP over 100 ms after whisker deflection; average of at least 30 whisker deflections	No
Short-latency PSP peak	Maximal PSP peak amplitude within 40 ms after whisker deflection; average of at least 30 whisker deflections	No
Plateau potential probability	PSP cluster 2 / (PSP cluster 1+PSP cluster 2); at least 30 whisker deflections.	Yes, increased for both PW and SW
Plateau potential integral	Integral of whisker-evoked PSP cluster 2 over 300 ms after whisker deflection; average of at least 30 whisker deflections	No
Plateau potential strength	Averaged plateau potential integral multiplied by the plateau potential probability	Yes, increased for PW; mixed for SW
Long-latency spike probability	Number of evoked spikes (occurring after the short-latency PSP peak (+ 5 ms) and before 100 ms) – number of baseline spike before whisker stimulation (over 100 ms) / number of whisker deflection.	Yes, increased for SW

Fig. S1. Extraction of NMDA plateaus strength and long-latency spikes. A) Single-cell examples of whisker-evoked responses (grey, single trials traces; dark, averaged trace). Square pulse lines, C2 whisker deflection (100 ms). **B)** For each trial, the relationship between the PSP half-peak amplitude and the average membrane potential between 50 and 100 ms after the onset reveals two distinct clusters. Dotted line represents the identity line. Cluster 1 is defined by an index < 0 and consists of PSPs containing only a short-latency PSP that quickly returns to the resting membrane potential. Cluster 2 is defined by an index > 0 and consists of compound PSPs with short and long-latency components. The long-latency component of the PSP has a strong NMDARs dependence. **C)** *Left*, for each cell, the NMDARs-plateau potential (light blue) is inferred by subtracting mean cluster 1 response (scaled to the mean cluster 2 response) from mean cluster 2

response. *Middle*, the integral of plateau is measured from 0 to 300 ms (grey box). *Right*, the strength of plateau potential is obtained by multiplying the integral and the probability of plateau potentials. **D)** Raster plot of PW (*top*) and SW (*bottom*) evoked spikes, as a function of time from whisker-evoked short-latency PSP peak amplitude. Note that only trials containing spikes are presented. FWE and DWE cells are pooled together. **E)** *Left*, Long-latency spikes are defined as whisker-evoked spikes that occur after the short-latency PSP peak (+5 ms, dotted line). *Right*, fraction of trials containing only short-latency spike, or only long-latency spikes, or both.

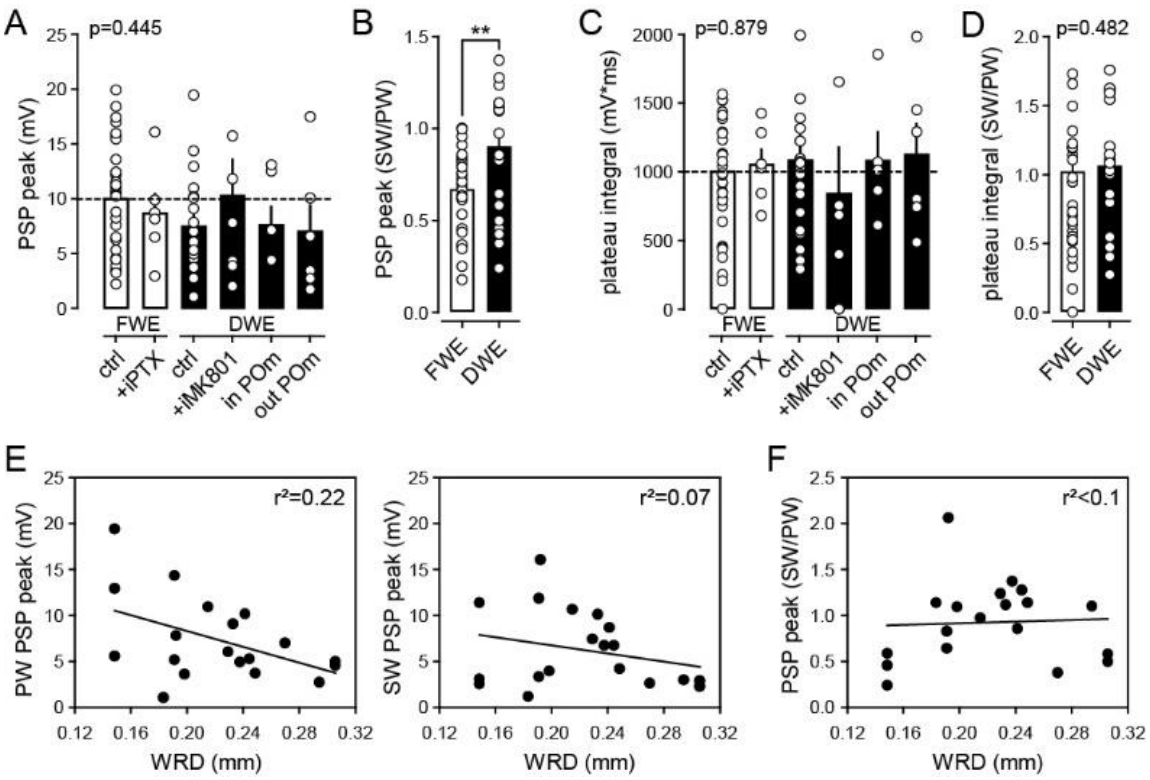

Fig. S2. Comparisons of PW-evoked PSP peak and plateau integral between all conditions. **A)** Mean (± sem) PSP peak amplitude evoked by PW deflection in control mice (FWE) and after DWE, under different pharmacological conditions. **B)** SW/PW ratio of PSP peak amplitudes. **C)** Mean (± sem) PSP plateau potential integral in control mice (FWE) and after DWE, under different pharmacological conditions. **D)** SW/PW ratio of plateau potentials integrals. **E)** Relation between WRD and amplitude of PW-(*left*) and SW-(*right*) evoked PSP peak in DWE mice. **F)** Relation between WRD and SW/PW ratio of PSP peak amplitude. Circles, individual cells; line, linear regression.

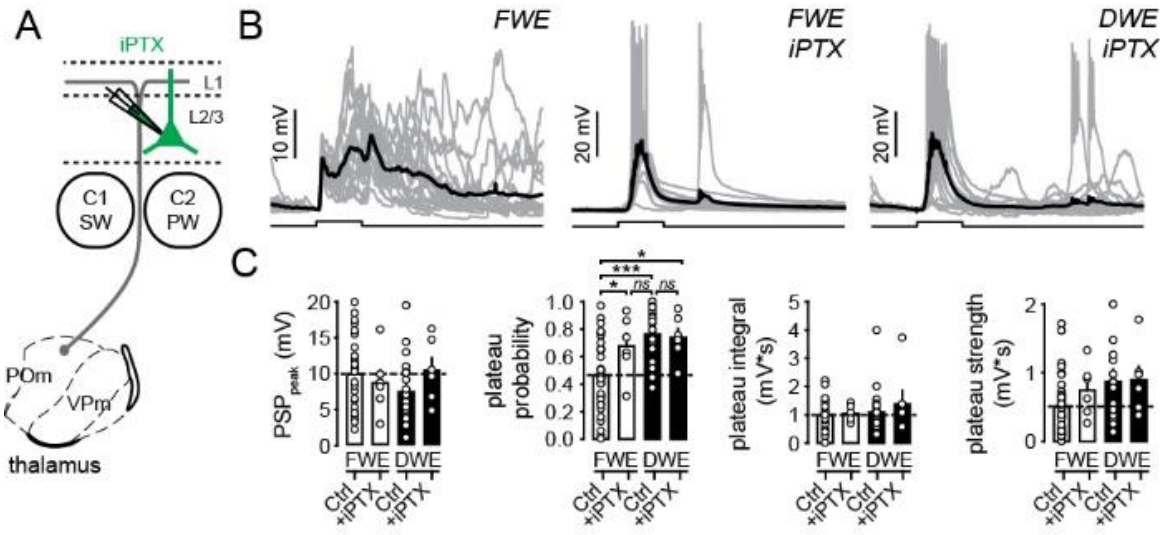

Fig. S3. Effect of GABA-ARs blockade in L2/3 pyramidal neuron *in vivo*. A) Schematic of the thalamo-cortical circuit and pharmacological experiments. The GABA-A receptor antagonist picrotoxin (iPTX, 1 mM) is applied directly to the intracellular recording solution **B)** Single-cell example of whisker-evoked responses in controls (*left*, FWE), and during GABA-AR blockage in controls (*middle*, FWE, iPTX) and deprived mice (*right*, DWE, iPTX). Gray lines, individual trials; Black lines, averaged traces. Square pulse lines, C2 whisker deflection (100 ms) **C)** Mean (± sem) PW-evoked PSP peak amplitude and plateau potential probability, integral and strength. Circles, individual cells.

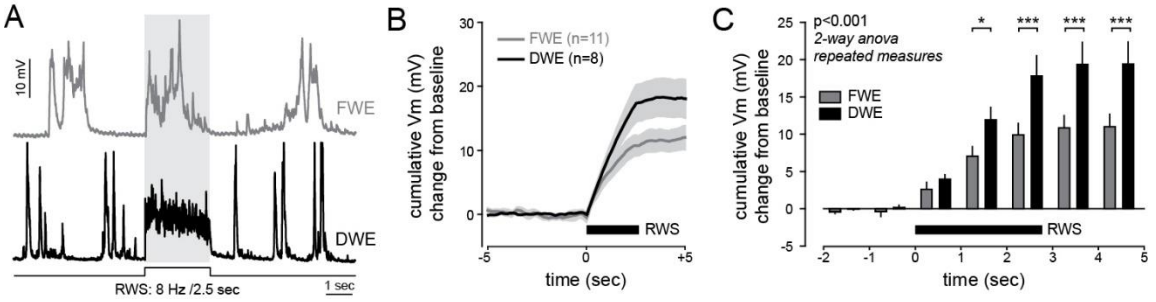

Fig. S4. DWE increases sustained depolarization evoked by 8Hz-train of whisker deflection (RWS, rhythmic whisker stimulation). A) Example of the membrane depolarization (L2/3 cell) upon RWS (20 stimuli at 8 Hz). **B)** Average of the cumulative Vm during RWS for FWE (grey) and DWE (black). **C)** Mean (± sem) of the maximum cumulative Vm at different time intervals.

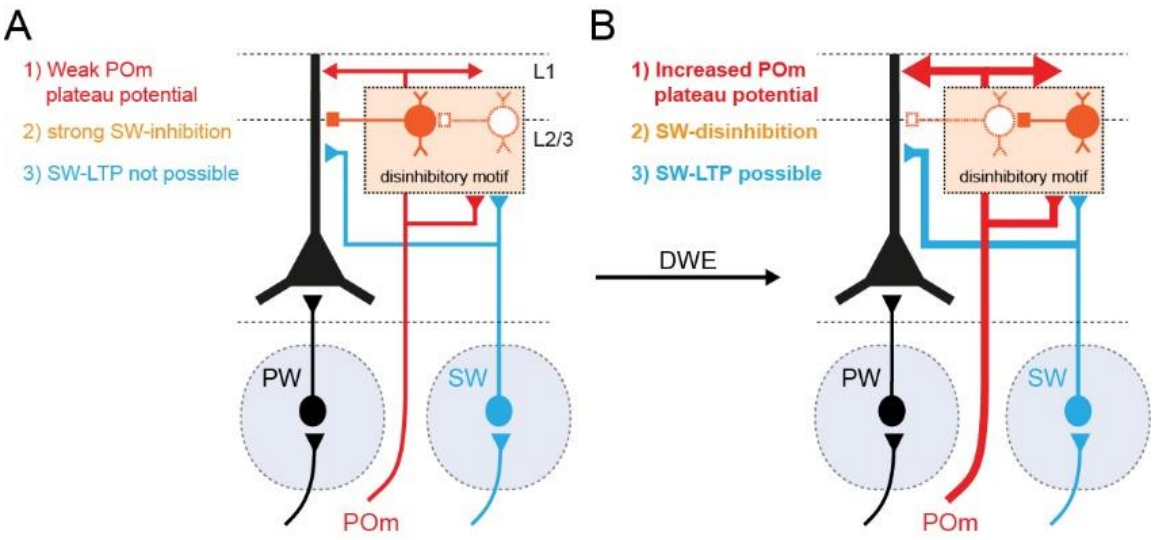

Fig. S5. Functional consequences of partial sensory deprivation at the cellular level. A) FWE mice are characterized by weak POm-plateau potentials (1), strong inter-barrels inhibition (2), and the non-permissive nature of the SW-associated pathway to LTP (3). **B)** In contrast, DWE is associated with an increase in POm-plateau potentials (1), a reduction in SW-evoked inhibitory inputs (2), which facilitate the induction of SW-LTP (3). Although SW-evoked PSPs were still smaller than PW-evoked PSPs, the ratio of the SW-/PW-evoked PSP peak amplitudes increases upon DWE.

fig	variable /units	group	Cell	Mice	mean	Std dev	median	25%	75%	test	p -value
1D	whisker representation distance (WRD, mm)	FWE	*N.A.*	31	0.266	0.0368	0.264	0.241	0.29	*Two-sample Kolmogorov-Smirnov test*	p<0.001
		DWE+2-4	*N.A.*	21	0.212	0.0411	0.212	0.192	0.231	*t-test*	p<0.001
1C	whisker representation distance (WRD, mm)	FWE	*N.A.*	31	0.266	0.0368	0.264	0.241	0.29	*one way anova with multiple compartsons (Holm-Sidak method)*	p<0.001
		DWE+1	*N.A.*	9	0.255	0.0401	0.242	0.231	0.261		*p=0.455 (FWE vs DWE+1)*
		DWE+2	*N.A.*	8	0.215	0.0471	0.205	0.192	0.235		*p=0.001 (FWE vs DWE+2)*
		DWE+3	*N.A.*	9	0.21	0.0451	0.212	0.192	0.241		*p<0.001 (FWE vs DWE+3)*
		DWE+4	*N.A.*	4	0.213	0.0246	0.222	0.196	0.229		*p=0.010 (FWE vs DWE+4)*
		DWE>+5	*N.A.*	9	0.231	0.0233	0.229	0.218	0.248		*p=0.019 (FWE vs DWE>+5)*

fig	variable /units	group	Cell	Mice	mean	Std dev	median	25%	75%	test	p -value
2F	plateau integral (mV*mse)	FWE-PW	33	25	1000.2	501.239	985.05	721.2	1310.9	*Kruskal-Wallis one way anova on ranks*	p=0,949
		DWE-PW	20	17	1082.075	809.282	1005.935	560.205	1267.75		
		FWE-SW	31	25	956.676	613.484	951.03	500.682	1301.85		
		DWE-SW	20	17	969.489	552.807	920.06	595.095	1145.25		
	plateau probability	FWE-PW	33	25	0.466	0.26	0.444	0.274	0.665	*one way anova with multiple compartsons (Holm-Sidak method)*	p<0.001
		DWE-PW	20	17	0.762	0.192	0.814	0.604	0.916		*p<0.001 (PW; FWE vs DWE)*
		FWE-SW	31	25	0.513	0.283	0.487	0.345	0.73		*p<0.001 (SW; FWE vs DWE)*
		DWE-SW	20	17	0.786	0.204	0.809	0.724	0.95		*p<0.001 (PW-FWE vs SW-DWE)*
											p<0.001 (PW-DWE vs SW-FWE)
											p=0.447 (FWE; PW vs SW)
											p=0.753 (DWE; PW vs SW)
	plateau strength (mV*mse)	FWE-PW	33	25	512.244	434.908	428.283	142.966	688.856	*Kruskal-Wallis one way anova on ranks*	p=0,077
		DWE-PW	20	17	870.389	793.636	543.538	418.02	1077.277		
		FWE-SW	31	25	564.484	508.836	456.494	133.751	820.563		
		DWE-SW	20	17	811.178	584.326	641.134	463.765	1010.275		
2G	late spike probability (normalized to the spiking probability in PW-FWE)	FWE-PW	15	15	1	1.152	0.56	0.296	1.28	*t-test*	p=0,376
		DWE-PW	9	9	0.629	0.536	0.391	0.29	0.878	*Mann-Whitney rank sum test*	p=0,602
		FWE-SW	7	7	0.546	0.254	0.522	0.391	0.736	*t-test*	p=0,022
		DWE-SW	5	5	1.167	0.534	1.043	0.898	1.304	*Mann-Whitney rank sum test*	p=0,010

fig	variable /units	group	Cell	Mice	mean	Std dev	median	25%	75%	test	p -value
3C	PW-induced plateau probability	DWE	20	17	0.762	0.192	0.814	0.604	0.916	*t-test*	p<0,001
		DWE+iMK801	7	4	0.203	0.198	0.171	0.015	0.384	*Mann-Whitney rank sum test*	p<0,001
		DWE+muscimol in	6		0.141	0.104	0.169	0.0351	0.227	*t-test*	p<0,001
		DWE+muscimol out	6		0.694	0.107	0.674	0.628	0.706	*Mann-Whitney rank sum test*	p=0,002
3D	plateau probability (normalized to the mean of the FWE control goup)	FWE	33	25	1	0.559	0.954	0.588	1.427	*one way anova with multiple compartsons (Holm-Sidak method)*	p<0.001
		FWE+iPTX	6	4	1.451	0.474	1.462	1.288	1.84		*p<0.001 (FWE vs DWE)*
											p<0.001 (DWE vs DWE+MK801)
		DWE	20	17	1.635	0.413	1.748	1.295	1.966		*p<0.001 (DWE vs DWE+muscimol in POm)*
		DWE+iPTX	6	3	1.581	0.356	1.572	1.417	1.876		*p<0.001 (DWE; muscimol in vs out POm)*
		DWE+iMK801	7	4	0.437	0.425	0.366	0.0322	0.824		*p=0.03 (FWE vs FWE+iPTX)*
		DWE+muscimol in	6	5	0.302	0.222	0.364	0.0753	0.488		*p=0.395 (DWE vs FWE+iPTX)*
		DWE+muscimol out	6	5	1.489	0.231	1.447	1.347	1.515		*p=0.629 (DWE+iPTX vs FWE+iPTX)*
											p=0.499 (DWE vs DWE muscimol out POm)
3F	plateau strength (normalized to the mean of the FWE control goup)	FWE	33	25	1	0.849	0.836	0.279	1.345	*one way anova with multiple compartsons (Holm-Sidak method)*	p=0.002
		FWE+iPTX	6	4	1.454	0.757	1.484	0.829	1.843		*p=0.02 (FWE vs DWE)*
											p=0.013 (DWE vs DWE+MK801)
		DWE	20	17	1.699	1.549	1.061	0.816	2.103		*p=0.005 (DWE vs DWE+muscimol in POm)*
		DWE+iPTX	6	3	1.745	0.967	1.69	0.949	1.956		*p=0.047 (DWE; muscimol in vs out POm)*
		DWE+iMK801	7	4	0.549	0.672	0.228	0.0116	1.208		*p=0.324 (FWE vs FWE+iPTX)*
		DWE+muscimol in	6	5	0.301	0.218	0.422	0.0417	0.448		*p=0.610 (DWE vs FWE+iPTX)*
		DWE+muscimol out	6	5	1.501	0.712	1.437	0.912	1.997		*p=0.626 (DWE+iPTX vs FWE+iPTX)*
											p=0.680 (DWE vs DWE muscimol out POm)

fig	variable /units	group	Cell	Mice	mean	Std dev	median	25%	75%	test	p -value
4A	plateau strength (mV*msec)	PW-FWE	33	25	512.244	434.908	428.283	142.966	688.856	*t-test*	p=0,038
		PW-DWE	20	17	870.389	793.636	543.538	418.02	1077.277	*Mann-Whitney rank sum test*	p=0,046
4B		SW-FWE	31	25	564.484	508.836	456.494	133.751	820.563	*t-test*	p=0,117
		SW-DWE	20	17	811.178	584.326	641.134	463.765	1010.275	*Mann-Whitney rank sum test*	p=0,088
4C	plateau strength (mV*msec) distance <λ	PW-FWE	33	25	512.244	434.908	428.283	142.966	688.856	*t-test*	p=0,001
		PW-DWE	9	9	1305.132	1018.47	1178.164	476.319	1601.103	*Mann-Whitney rank sum test*	p=0,007
		SW-FWE	31	25	564.484	508.836	456.494	133.751	820.563	*t-test*	p=0,022
		SW-DWE	9	9	1078.204	741.833	934.79	552.341	1519.143	*Mann-Whitney rank sum test*	p=0,033
4E	WRD (normalized to pre injection WRD)	DWE/saline-	*N.A.*	5	1.023	0.368	1.002	0.774	1.214	*paired t-test*	p=0,398
		DWE/saline+	*N.A.*	5	0.975	0.308	0.967	0.698	1.216	*Wilcoxon rank sum test*	p=0,625
		DWE/dAP5-	*N.A.*	6	0.99	0.308	1.017	0.933	1.098	*paired t-test*	p=0,034
		DWE/dAP5+	*N.A.*	6	1.39	0.205	1.403	1.177	1.577	*Wilcoxon rank sum test*	p=0,031
		DWE/dAP5-	*N.A.*	7	1	0.313	0.911	0.852	1.179	*paired t-test*	p=0.445
		DWE/dAP5+	*N.A.*	7	0.934	0.231	0.894	0.887	0.928	*Wilcoxon rank sum test*	p=0.563
4F	Δdistance WRD (%)	DWE/saline	*N.A.*	5	-4.847	11.474	-3.519	-13.943	5.137	*one way anova with multiple compartsons (Holm-Sidak method)*	p=0.007
		DWE/dAP5	*N.A.*	6	40.042	33.978	22.917	21.138	54.187		*p=0.004 (dAP5, DWE vs FWE)*
		FWE/dAP5	*N.A.*	7	-4.128	19.051	-4.545	-21.541	9.031		*p=0.007 (DWE, saline vs dAP5)*
											p=0.959 (FWE/dAP5 vs DWE/saline)

fig	variable /units	group	Cell	Mice	mean	Std dev	median	25%	75%	test	p -value
S2A	PSP peak (mV)	FWE	33	25	9.952	4.961	10.574	5.07	12.681	*Kruskal-Wallis one way anova on ranks*	p=0,445
		FWE+iPTX	6	4	8.668	4.34	8.394	6.437	9.841		
		DWE	20	17	7.447	4.464	5.776	4.708	10.09		
		DWE+iMK801	7	4	10.266	8.65	7.76	3.954	14.715		
		DWE+muscimol in	6	5	7.591	4.145	5.721	4.328	12.478		
		DWE+muscimol out	6	5	6.96	5.964	4.971	2.688	10.019		
S2B	PSP peak (ratio SW/PW)	FWE	31	25	0.664	0.215	0.693	0.55	0.817	*t-test*	p=0,014
		DWE	20	17	0.898	0.438	0.913	0.538	1.136	*Mann-Whitney rank sum test*	p=0,049
S2C	PSP integral (mV*msec)	FWE	33	25	1000.2	501.239	985.05	721.2	1310.9	*Kruskal-Wallis one way anova on ranks*	p=0,879
		FWE+iPTX	6	4	1051.15	272.966	1041.05	842.2	1281.4		
		DWE	20	17	1082.075	809.282	1005.935	560.205	1267.75		
		DWE+iMK801	7	4	841.413	889.313	683.61	99.203	1426.392		
		DWE+muscimol in	6	5	1080.322	466.403	1009.7	798.673	1264.85		
		DWE+muscimol out	6	5	1123.722	552.557	1044.07	740.871	1449		
S2D	PSP integral (ratio SW/PW)	FWE	31	25	1.016	0.825	0.857	0.546	1.193	*t-test*	p=0,846
		DWE	20	17	1.056	0.523	1.053	0.537	1.563	*Mann-Whitney rank sum test*	p=0,482

fig	variable /units	group	Cell	Mice	mean	Std dev	median	25%	75%	test	p -value
S3C	PSP peak (mV)	FWE	33	25	9.952	4.961	10.574	5.07	12.681	*one way anova*	p=0.269
		FWE+iPTX	6	4	8.668	4.34	8.394	6.437	9.841		
		DWE	20	17	7.447	4.464	5.776	4.708	10.09		
		DWE+iPTX	6	3	10.389	4.39	10.011	6.749	14.613		
	Plateau probability	FWE	33	25	0.466	0.26	0.444	0.274	0.665	*one way anova with multiple compartsons (Holm-Sidak method)*	p<0.001
		FWE+iPTX	6	4	0.676	0.221	0.681	0.6	0.857		*p=0.045 (FWE vs FWE+iPTX)*
		DWE	20	17	0.762	0.192	0.814	0.604	0.916		*p<0.001 (FWE vs DWE)*
		DWE+iPTX	6	3	0.736	0.166	0.732	0.66	0.874		*p=0.011 (FWE vs DWE+iPTX)*
											p=0.427 (FWE+iPTX vs DWE)
											p=0.814 (DWE vs DWE+iPTX)
											p=0.651 (DWE+iPTX vs FWE+iPTX)
	Plateau integral (mV*sec)	FWE	33	25	1000.2	501.239	985.05	721.2	1310.9	*one way anovaon ranks*	p=0.958
		FWE+iPTX	6	4	1051.15	272.966	1041.05	842.2	1281.4		
		DWE	20	17	1082.075	809.282	1005.935	560.205	1267.75		
		DWE+iPTX	6	3	1379.456	1185.556	1039.55	571.557	1352.4		
	Plateau strength (mV*sec)	FWE	33	25	512.244	434.908	428.283	142.966	688.856	*one way anovaon ranks*	p=0.075
		FWE+iPTX	6	4	744.78	387.539	760.273	424.75	944.189		
		DWE	20	17	870.389	793.636	543.538	418.02	1077.277		
		DWE+iPTX	6	3	893.722	495.364	865.495	486.364	1002.078		

fig	variable /units	group	Cell	Mice	mean	Std dev	median	25%	75%	test	p -value
S4D	cumulative membrane potential (mV*ms) change from baseline before 8Hz-train of whisker deflection	FWE /-2.45 sec	11	7	-0.409	0.787	-0.304	-1.195	0.205	*Two Way Repeated Measures ANOVA (One Factor Repetition) with multiple compartsons (Holm-Sidak method)*	p<0.001 (interaction)
		FWE/-1.45 sec	11	7	-0.392	2.178	-0.0187	-1.057	0.485		*p=0.872 (-2.45 sec, FWE vs DWE)*
		FWE/0.45 sec	11	7	2.608	3.121	2.069	0.922	3.108		*p=0.806 (-1.45 sec, FWE vs DWE)*
		FWE/1.45 sec	11	7	7.026	4.325	6.271	4.105	8.825		*p=0.353 (0.45 sec, FWE vs DWE)*
		FWE/2.45 sec	11	7	9.912	5.138	8.161	5.385	14.533		*p=0.035 (1.45 sec, FWE vs DWE)*
		FWE/3.45 sec	11	7	10.824	5.521	9.651	5.87	16.09		*p=0.001 (2.45 sec, FWE vs DWE)*
		FWE/4.45 sec	11	7	10.994	5.568	8.27	6.47	15.974		*p<0.001 (3.45 sec, FWE vs DWE)*
		DWE /-2.45 sec	8	8	-0.0447	0.379	0.0884	-0.469	0.298		*p<0.001 (4.45 sec, FWE vs DWE)*
		DWE/-1.45 sec	8	8	0.164	0.789	0.0106	-0.465	1.003		
		DWE/0.45 sec	8	8	3.955	1.612	3.57	2.858	4.7		
		DWE/1.45 sec	8	8	11.926	4.731	11.968	7.728	14.929		
		DWE/2.45 sec	8	8	17.809	7.688	19.136	10.215	23.875		
		DWE/3.45 sec	8	8	19.356	8.375	21.246	11.112	25.704		
		DWE/4.45 sec	8	8	19.375	8.451	21.065	11.351	25.393		

Table S1. Data and statistics