Table S1. Behavioral modulation of single units responses.

Measure	Quiet	Whisking	p-value
BA (Hz)	12 ± 7	14 ± 9	$p<0.001^{*}$
RM (spikes/stimulus)	0.29 ± 0.13	0.21 ± 0.1	$p=0.015^{*}$
Peak latency (ms)	13 ± 3	13 ± 3	p= 0.98
1^{st} spike latency (ms)	6.3 ± 0.1	6.4 ± 0.2	p=0.150
1^{st} spike jitter (ms)	1.19 ± 0.08	1.23 ± 0.06	p=0.331

Table S2. Stimulus modulation of single units responses.

Measure	60 µs	120 µs	240 µs	p-value
RM (spikes/stimulus)	0.05 ± 0.10	0.23 ± .19	0.49 ± 0.21	$p<0.001^{***}$
Peak latency (ms)	17 ± 5	13 ± 4	9 ± 2	$p<0.002^{**}$
1^{st} spike latency (ms)	6.7 ± 0.2	6.4 ± 0.2	6.0 ± 0.2	$p<0.001^{***}$
1^{st} spike jitter (ms)	1.39 ± 0.07	1.21 ± 0.09	1.04 ± 0.05	$p<0.001^{***}$

Tables S1 and S2 report the estimated value ± 95% CI for the neurophysiological parameters defined in the data analysis method section: background activity (BA); 2) response magnitude (RM); 3) peak latency; 4) latency of the first spike and 5) jitter of the first spike for the single units. Table S1 reports the change in the neurophysiological parameters as a function of the behavioral state of the animal. Table S2 reports the change in the same parameters as a function of the different stimulus strengths. For both tables the p-value column reports the statistical significance of the corresponding ANOVA FACTOR (Behavior Table S1 and Stimulus Table S2).

Measure	Factor	F-value	p-value
Number of responsive cells (units)	Stimulus	F(2,8)= 9.628	p=0.007**
	Behavior	F(1,4)=134.224	p<0.001***
	Stimulus x Behavior	F(2,8)=1.810	p=0.225
RM (spikes/stimulus)	Stimulus	F(2,196)=77.650	p<0.001***
	Behavior	F(1,98)= 34.348	p<0.001***
	Stimulus x Behavior	F(2,196)=15.256	p<0.001***
Peak latency (ms)	Stimulus	F(2,196)=26.156	p<0.001***
	Behavior	F(1,98)=0.040	p=0.842
	Stimulus x Behavior	F(2,196)=0.745	p=0.476
1st spike latency (ms)	Stimulus	F(2,196)=128.552	p<0.001***
	Behavior	F(1,98)=25.845	p<0.001***
	Stimulus x Behavior	F(2,196)=4.213	p=0.016*
1st spike jitter (ms)	Stimulus	F(2,196)=108.312	p<0.001***
	Behavior	F(1,98)=26.300	p<0.001***
	Stimulus x Behavior	F(2,196)=8.525	p<0.001***
MI All vs. Background (bits)	Encoding	F(1,21)=24.906	p<0.001***
	Behavior	F(1,21)=7.740	p=0.011*
	Encoding x Behavior	F(1,21)=0.217	p=0.646
MI Single vs. Background (bits)	Encoding	F(1,21)=26.500	p<0.001***
	Behavior	F(1,21)=4.529	p=0.045*
	Stimulus	F(2,42)=14.196	p<0.001***
	Encoding x Behavior	F(1,21)=0.015	p=0.905
	Encoding x Stimulus	F(2,42)=7.046	p=0.002**
	Behavior x Stimulus	F(2,42)=5.563	p=0.007**
	Encoding x Stimulus x Behavior	F(2,42)=2.656	p=0.082(*)
MI Discrimination (bits)	Encoding	F(1,21)=77.760	p<0.001***
	Behavior	F(1,21)=6.193	p=0.021*
	Encoding x Behavior	F(1,21)=0.727	p=0.403
Temporal Information (bits)	Encoding	F(1,38)=40.482	p<0.001***
	Behavior	F(1,38)=1.153	p=0.290
	Encoding x Behavior	F(1,38)=1.667	p=0.204

Tables S3 reports all the p values for all ANOVAs performed on the neurophysiological parameters (refer to Table S1-2 legend for abbreviations) and on the Mutual Information (MI) estimates for the cases of: 1) stimulus detection when grouping all responses to the three stimulus intensities together and comparing vs background "MI All vs. Background"; 2) stimulus detection when grouping each single stimulus intensities vs background "MI Single vs. Background (bits)"; 3) stimulus discrimination "MI Discrimination" and 4) information extracted using only first spikes and only responsive trials "Temporal Information". (*) = p<0.1 (tendency), * = p<0.05, ** = p<0.01, *** = p<0.001

Measure	Factor	Level	Mean differences ± 95% C.I.
Number of responsive cells (units)	Stimulus	240 vs. 60 µs	9.30 ± 5.70*
		240 vs. 120 µs	4.80 ± 6.62
		120 vs. 60 µs	4.50 ± 5.25(*)
	Behavior	Quiet vs. Whisking	6.73 ± 1.61***
RM (spikes/stimulus)	Stimulus	240 vs. 60 µs	0.70 ± 0.17***
		240 vs. 120 µs	0.42 ± 0.14***
		120 vs. 60 µs	0.28 ± 0.09***
	Behavior	Quiet vs. Whisking	0.18 ± 0.06***
	Stimulus x Behavior	60 µs: Quiet vs. Whisking	0.02 ± 0.07
		120 µs: Quiet vs. Whisking	0.28 ± 0.09***
		240 µs: Quiet vs. Whisking	0.24 ± 0.09***
Peak Latency (ms)	Stimulus	240 vs. 60 µs	-5.64 ± 1.88***
		240 vs. 120 µs	-3.59 ± 1.80***
		120 vs. 60 µs	-2.06 ± 2.12(*)
	Behavior	Quiet vs. Whisking	0.01 ± 1.1
1st spike latency (ms)	Stimulus	240 vs. 60 µs	-0.67 ± 0.11***
		240 vs. 120 µs	-0.39 ± 0.01***
		120 vs. 60 µs	-0.27 ± 0.09***
	Behavior	Quiet vs. Whisking	0.10 ± 0.04***
	Stimulus x Behavior	60 µs: Quiet vs. Whisking	0.07 ± 0.08(*)
		120 µs: Quiet vs. Whisking	0.06 ± 0.06(*)
		240 µs: Quiet vs. Whisking	0.18 ± 0.05***
1st spike Jitter (ms)	Stimulus	240 vs. 60 µs	-0.33 ± 0.06***
		240 vs. 120 µs	-0.19 ± 0.06***
		120 vs. 60 µs	-0.15 ± 0.06***
	Behavior	Quiet vs. Whisking	0.08 ± 0.03***
	Stimulus x Behavior	60 µs: Quiet vs. Whisking	0.02 ± 0.05
		120 µs: Quiet vs. Whisking	0.07 ± 0.04**
		240 µs: Quiet vs. Whisking	0.15 ± 0.05***
MI All vs Background (bits)	Encoding	Timing vs. Count	0.019 ± 0.014*
	Behavior	Quiet vs. Whisking	0.040 ± 0.017***
MI Single vs Background (bits)	Encoding	Timing vs. Count	0.048 ± 0.019***
	Behavior	Quiet vs. Whisking	0.024 ± 0.023*
	Stimulus	240 vs. 60 µs	0.15 ± 0.08**
		240 vs. 120 µs	0.10 ± 0.05***
		120 vs. 60 µs	0.04 ± 0.05(*)
	Behavior x Stimulus	Quiet: 240 vs. 60 µs	0.17 ± 0.09***
		Quiet: 240 vs. 120 µs	0.10 ± 0.05***
		Quiet: 120 vs. 60 µs	0.07 ± 0.07(*)

		Whisking: 240 vs. 60 µs	0.12 ± 0.10*
		Whisking: 240 vs. 120 µs	0.10 ± 0.08**
		Whisking: 120 vs. 60 µs	0.02 ± 0.06
	Encoding x Stimulus	60 µs: Quiet vs. Whisking	0.023 ± 0.018*
		120 µs: Quiet vs. Whisking	0.032 ± 0.031*
		240 µs: Quiet vs. Whisking	0.089 ± 0.037***
MI Discrimination (bits)	Encoding	Timing vs. Count	0.065 ± 0.15***
	Behavior	Quiet vs. Whisking	0.036 ± 0.030*
Temporal Information (bits)	Encoding	Temporal vs. Count	0.095 ± 0.030***
	Behavior	Quiet vs. Whisking	-0.014 ± 0.030

Tables S4 reports the mean differences between levels for each single factor of all ANOVAs and mean differences between levels for each interaction between factors only if the interaction was statistically significant (see Table S3 for abbreviations). Asterisks denote statistically significant differences: (*) = $p<0.1$ (tendency), * = $p<0.05$, ** = $p<0.01$, *** = $p<0.001$