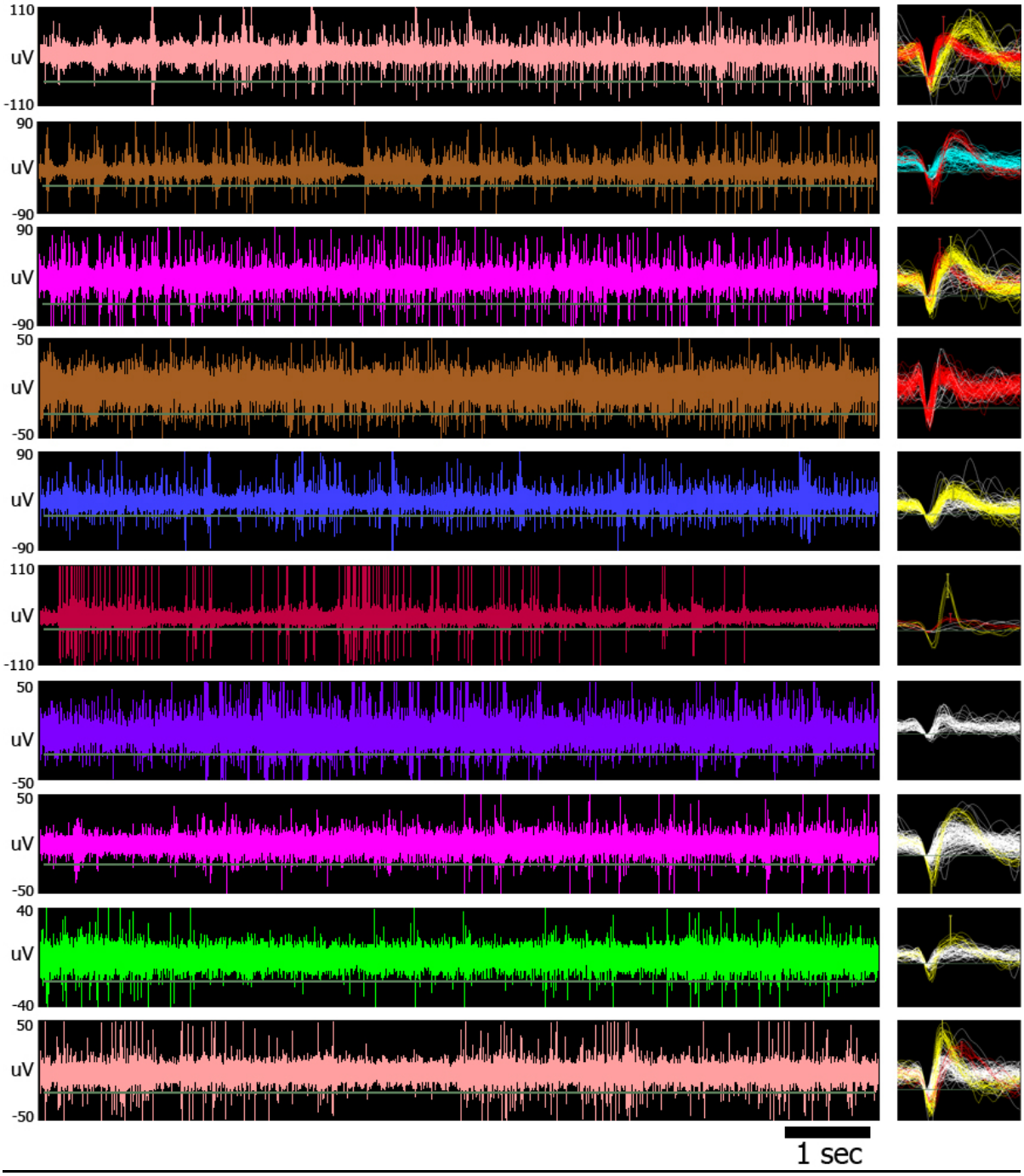
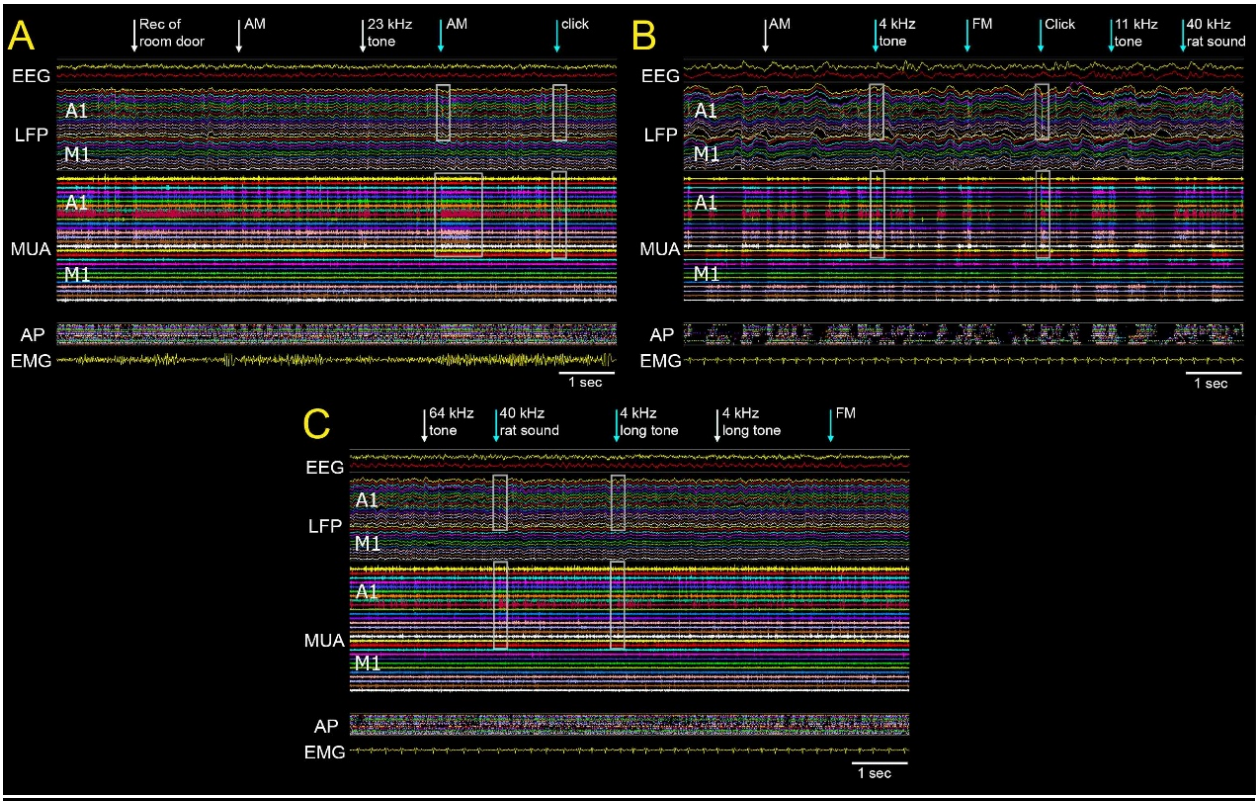
Supplementary Figure 1: Unit identification



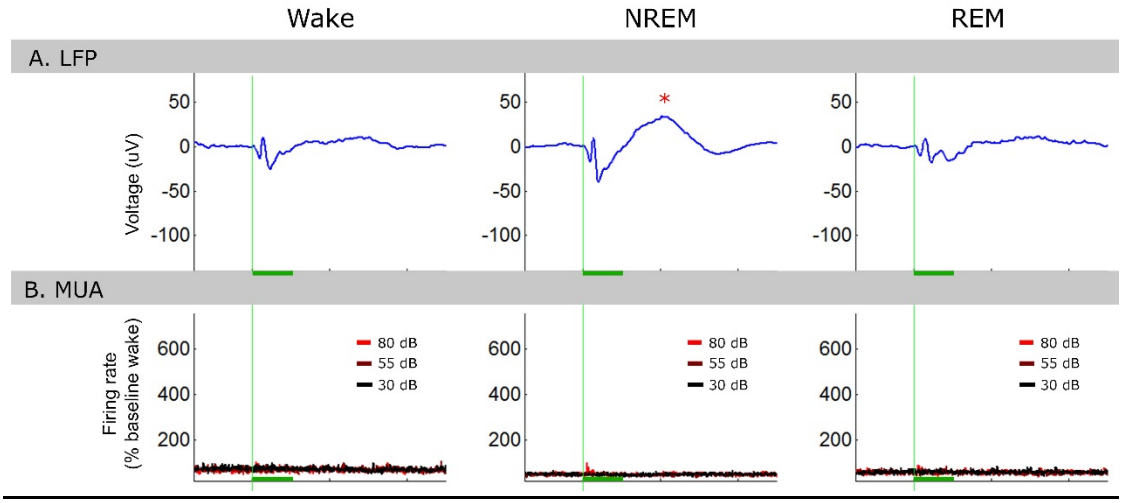
Supplementary Figure 1. Ten representative examples of high-pass filtered LFPs (>300Hz) recorded in different animals along with thresholds for identification of putative action potentials. Right column shows waveforms of putative action potential events identified during the 10sec on the left, that are then subsequent to offline spike sorting (not shown).

Supp Figure 2: representative data snapshots during auditory stimulation across vigilance states



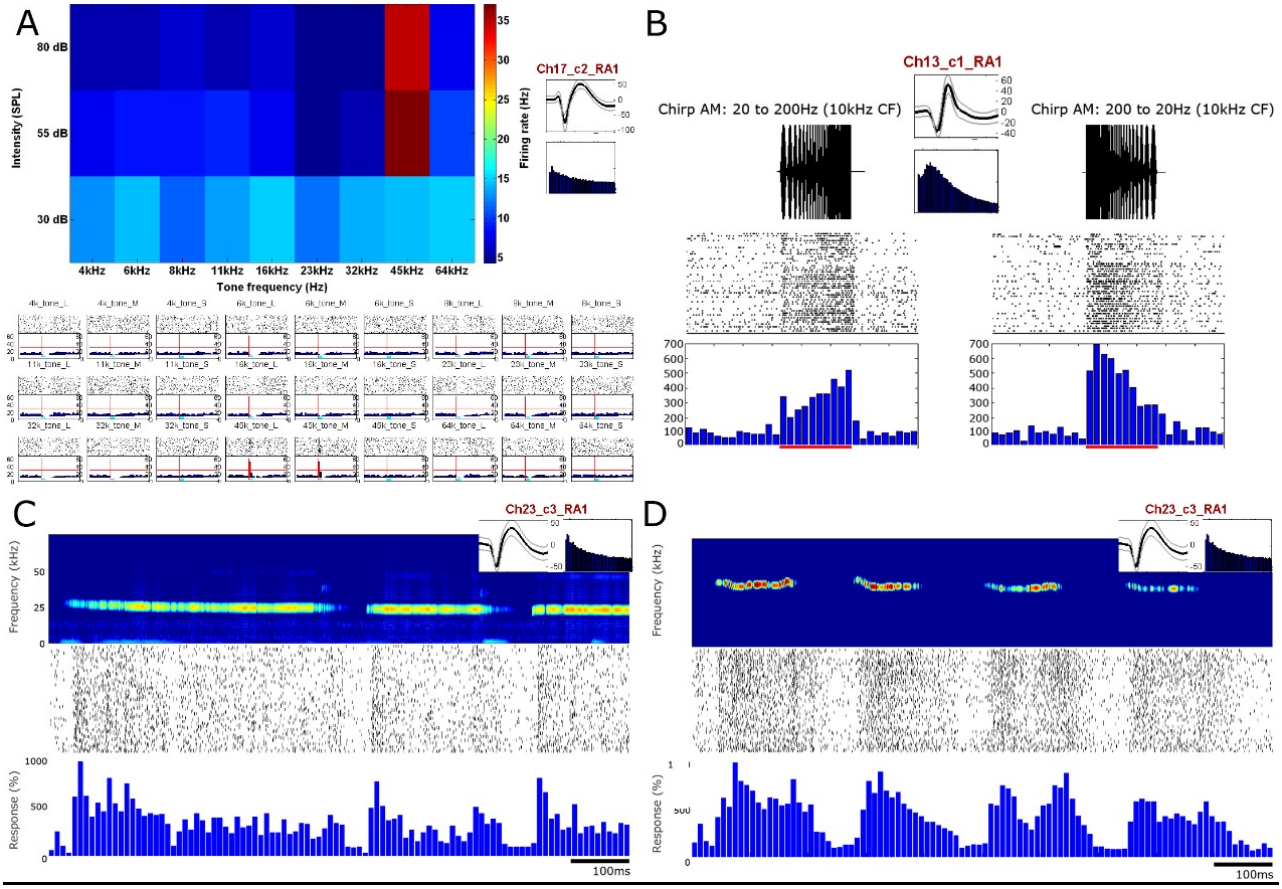
Supplementary Figure 2. (A-C) Representative 10sec data snapshots acquired during wakefulness (A, top left), NREM sleep (B, top right) and REM sleep (C, bottom). Data in each example show (top to bottom) EEG from frontal and parietal screws (top two traces), LFPs from early auditory cortex (A1) and motor cortex (M1), MUA from the same channels, putative action potentials (AP) from the same channels, and EMG. Arrows on top show times of low intensity (white) and high intensity (cyan) auditory stimuli. Note that in wakefulness, tonic unit activity is accompanied by low-amplitude high-frequency oscillations in LFP and EEG in the presence of high muscle tone (EMG, bottom). In NREM sleep, bistable unit activity is accompanied by high-amplitude slow oscillations in LFP and EEG in the absence of movement (EMG, bottom). In REM sleep, activity is much like that in wakefulness in the absence of movement (EMG, bottom). Gray boxes illustrate how high-intensity stimuli elicit robust evoked potentials and unit discharges in auditory cortex that may be discernible in individual trials and do not occur in the control motor cortex.

Supp Figure 3. Overview of evoked responses in motor cortex



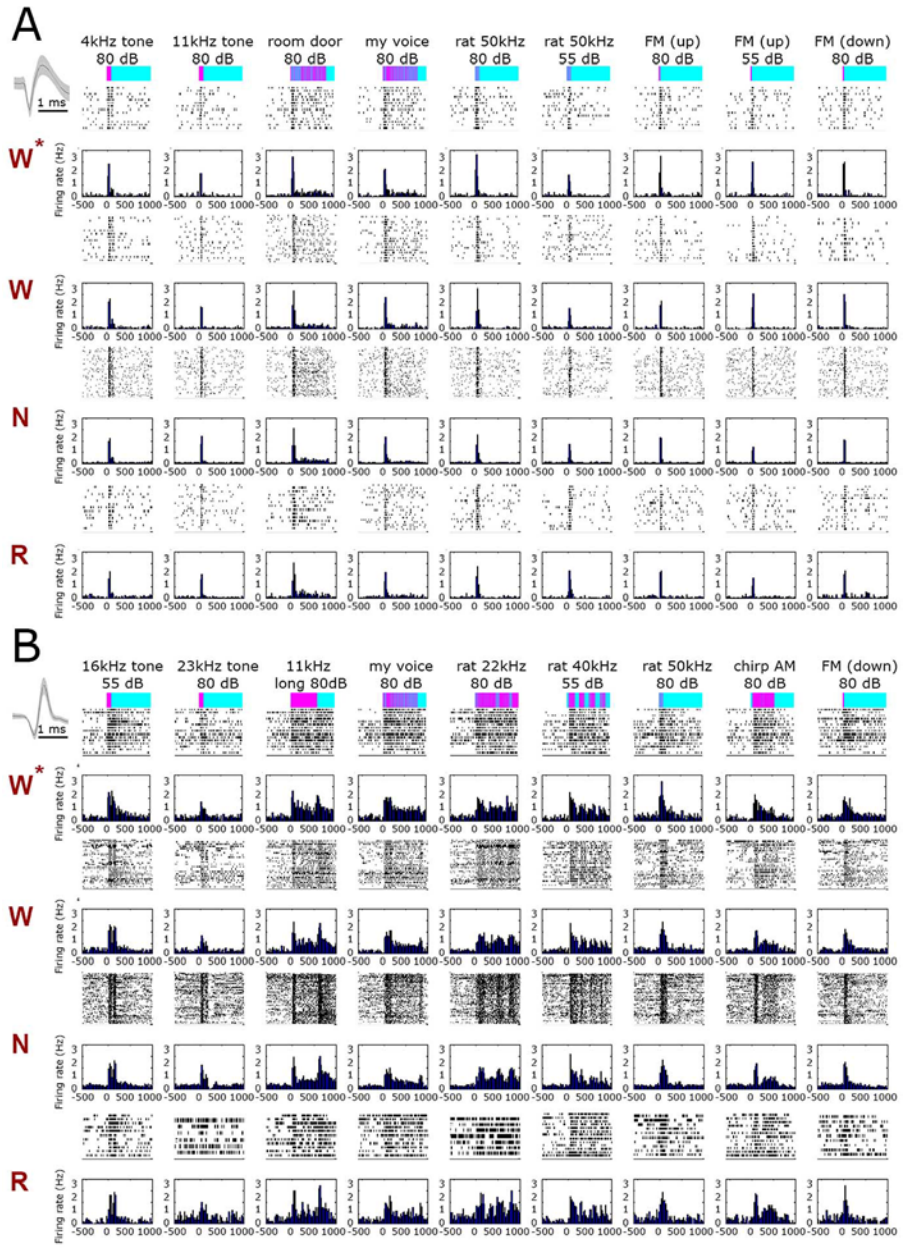
Supp Figure 3. Overview of evoked responses in motor cortex to 100ms tones across vigilance states (n=7 sessions in 4 animals). (A) Average event-related LFP responses recorded in motor cortex (n=112 channels) in response to high-intensity (80dB) tones. Horizontal green bars mark stimulus duration. Vertical green lines mark tone onset. Note that in comparison to auditory cortex (Fig. 2), LFP responses in motor cortex are much weaker, lack the strong negative components. Note that the positive peak around 240ms post-stimulus is still evident in NREM sleep (red asterisk). (B) Evoked multi-unit activity from the same channels in motor cortex in response to tones does not exhibit significant modulations.

Supp Figure 4: Responses to acoustic features of auditory stimuli



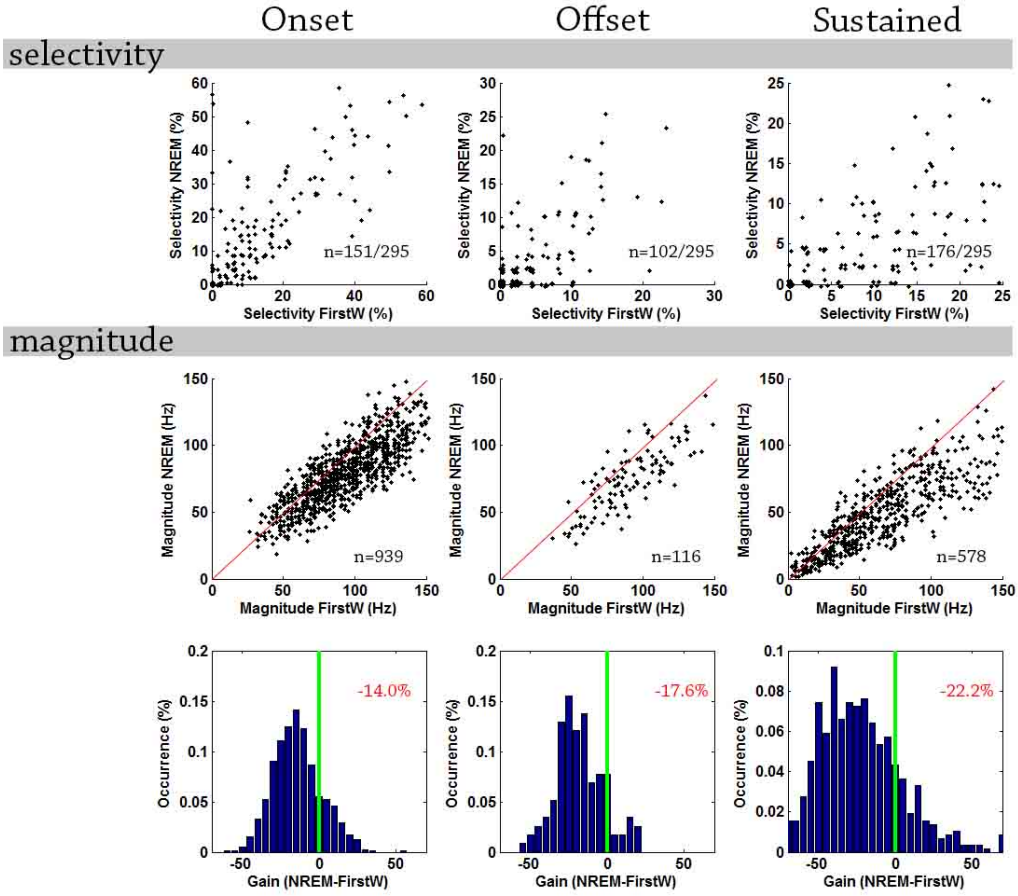
Supplementary Figure 4. (A) An example neuron showing narrow frequency tuning. Top panel shows response intensity (color coding in legend on right) as a function of stimulus intensity (y-axis) and frequency (x-axis). Bottom panel shows raster plots and PSTHs for all pure tone stimuli. Note that this neuron responded selectively to 45 kHz tones at medium (55dB) and high (80dB) intensities. (B) An example neuron showing preference for fast amplitude modulation rates. Left and right sub-panels show stimulus waveform (top), raster plot (middle) and PSTH (bottom) for chirp AM sounds with increasing and decreasing modulation rates, respectively. (C, D) An example neuron showing responses that closely follow the temporal envelope of ultrasonic rat vocalizations with carrier frequencies around 22kHz (C) and 40 kHz (D). Insets in all panels show mean action potential waveform and inter-spike-interval distribution.

Supp Figure 5: Additional examples of auditory single-unit responses across vigilance states



Supplementary Figure 5. Examples of auditory responses for two additional single-units in different animals (A, B) across vigilance states (rows) for nine different stimuli (columns). In each panel, rows (top to bottom) correspond to stimuli names and intensities, spectrogram of acoustic stimulus, followed by raster plots and PSTHs for each vigilance state. Inset on upper left shows mean ± SEM of action potential waveform. W*, first wake trials; W, wakefulness trials; N, NREM sleep trials; R, REM sleep trials. In each panel, firing rate in all bar graphs is expressed in terms of percent of wakefulness baseline and is shown with the same scale across all states and stimuli. Note that neuronal responses are nearly indistinguishable visually across vigilance states, despite a very different profile of activity consisting of mainly onset responses (A) vs. sustained responses (B).

Supp Figure 6. Quantitative comparison of auditory single-unit responses between 'first wakefulness' epochs and NREM sleep



Supp Figure 6. (A) Quantitative comparison of auditory single-unit responses (n=230) in 'first wake' epochs (forced wake in the beginning of the experiment constituting the first exposure to stimuli) and NREM sleep epochs throughout the experiment. Columns (left to right) depict results for onset, offset, and sustained responses. Top row: scatter plot of selectivity (number of stimuli that trigger a response) in NREM (y-axis) vs. first wake (x-axis). Each dot denotes one auditory neuron (n=169, 120 and 161 for onset, offset, and sustained responses in first wake interval, respectively). Middle row: scatter plot of response magnitudes (spikes/sec) in NREM sleep (y-axis) vs. first wake (x-axis). Each dot denotes the response of one neuron to a specific stimulus for which significant responses were identified in both vigilance states of interest (n=1394, 200 and 447 conditions for onset, offset, and sustained responses, respectively). Note that vast majority of values lie below diagonal red lines (unity) showing that response magnitudes are typically higher in first wake compared to NREM sleep. Bottom row: distribution of gain factors computed for each stimulus separately. Vertical green line marks zero gain while percentage at top right corner shows the mean gain factor (colored in red whenever distribution mean is significantly different than zero, $p < 0.01$). Importantly, in contrast to comparable responses seen in Figure 5, we here apply the same analysis while considering the first exposure to the stimulus and quantifying the response in spikes/sec rather than that state's baseline and the response magnitudes are clearly weaker in sleep, thereby demonstrating that this analysis is effective in revealing differences when those are present.