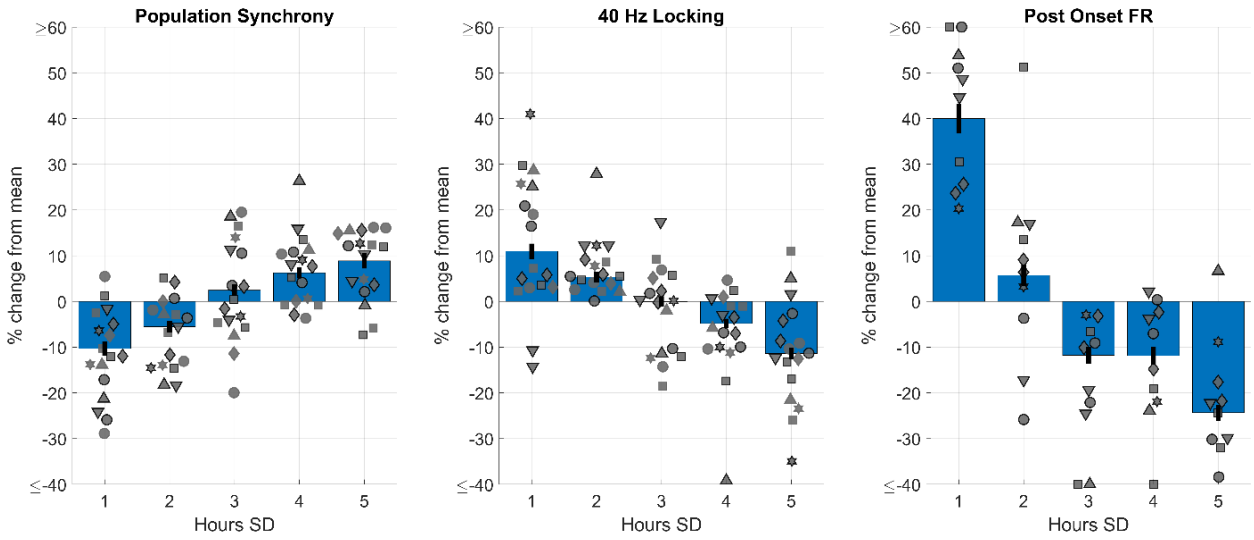
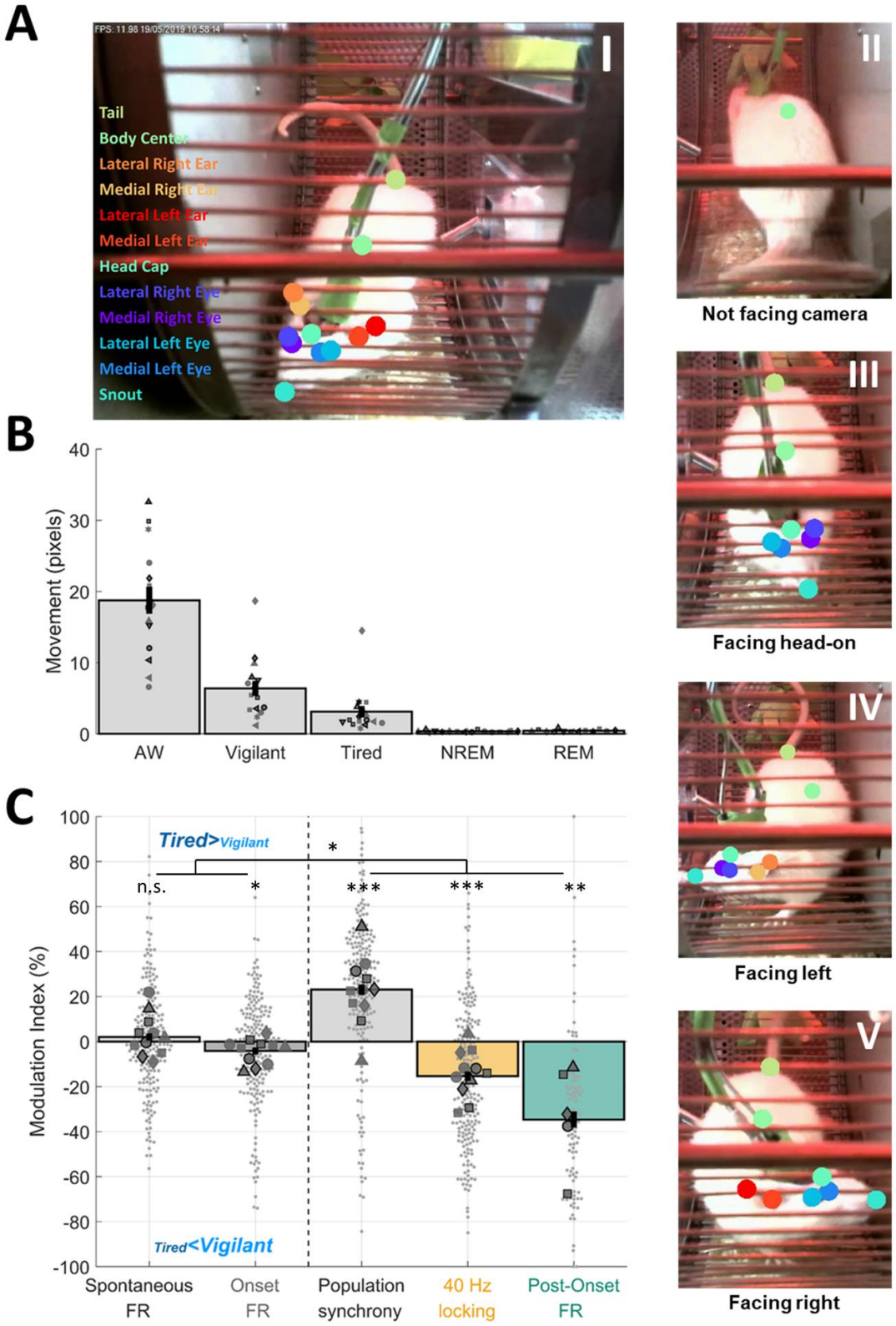
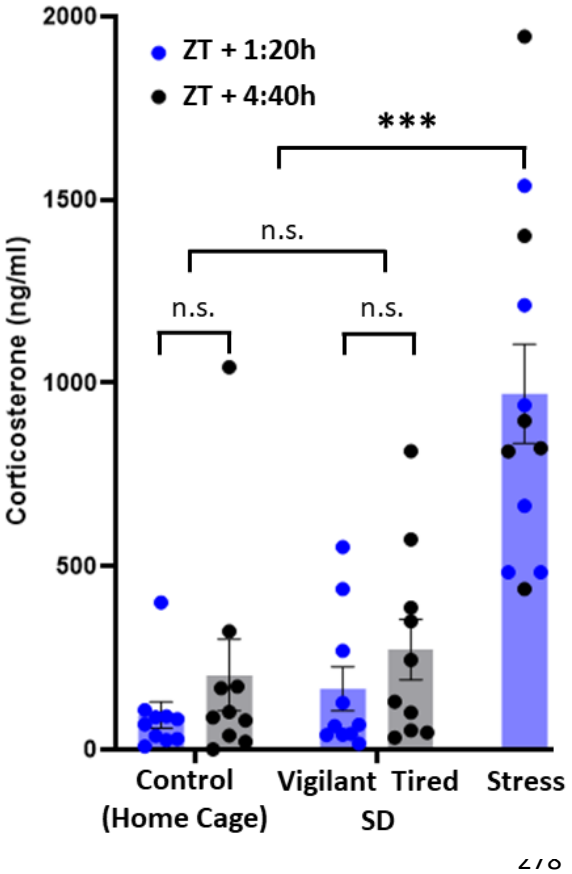


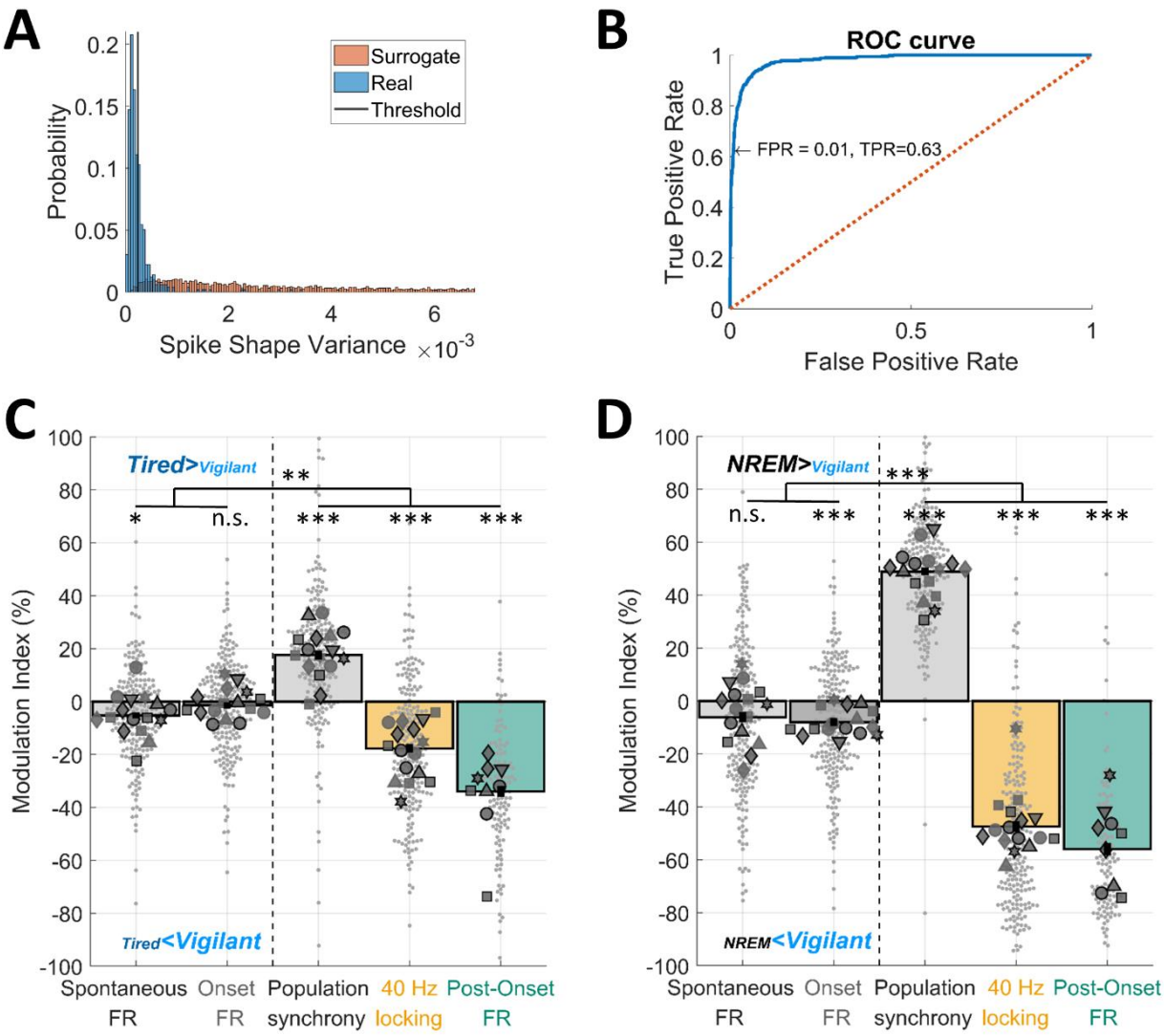
Supplementary Figure 1. Gradual changes in SD-sensitive 'motifs'. Mean % changes at 1-hour time bins (20% of trials) during the SD period for three different sensitive neural processing 'motifs': population synchrony (left), 40-Hz click train locking (middle) and post-onset FR (right). Individual markers depict mean % change of all units is a single session. Different marker shapes represent different animals. Bars and black lines depict the mean and SEM across all sessions, respectively.


A
I
Tail
Body Center
Lateral Right Ear
Medial Right Ear
Lateral Left Ear
Medial Left Ear
Head Cap
Lateral Right Eye
Medial Right Eye
Lateral Left Eye
Medial Left Eye
Snout
II
Not facing camera
III
Facing head-on
IV
Facing left
V
Facing right
B
Movement (pixels)
AW
Vigilant
Tired
NREM
REM
C
Modulation Index (%)
Tired>Vigilant
Tired<Vigilant
n.s.
*
***
***
**
Spontaneous FR
Onset FR
Population synchrony
40 Hz locking
Post-Onset FR

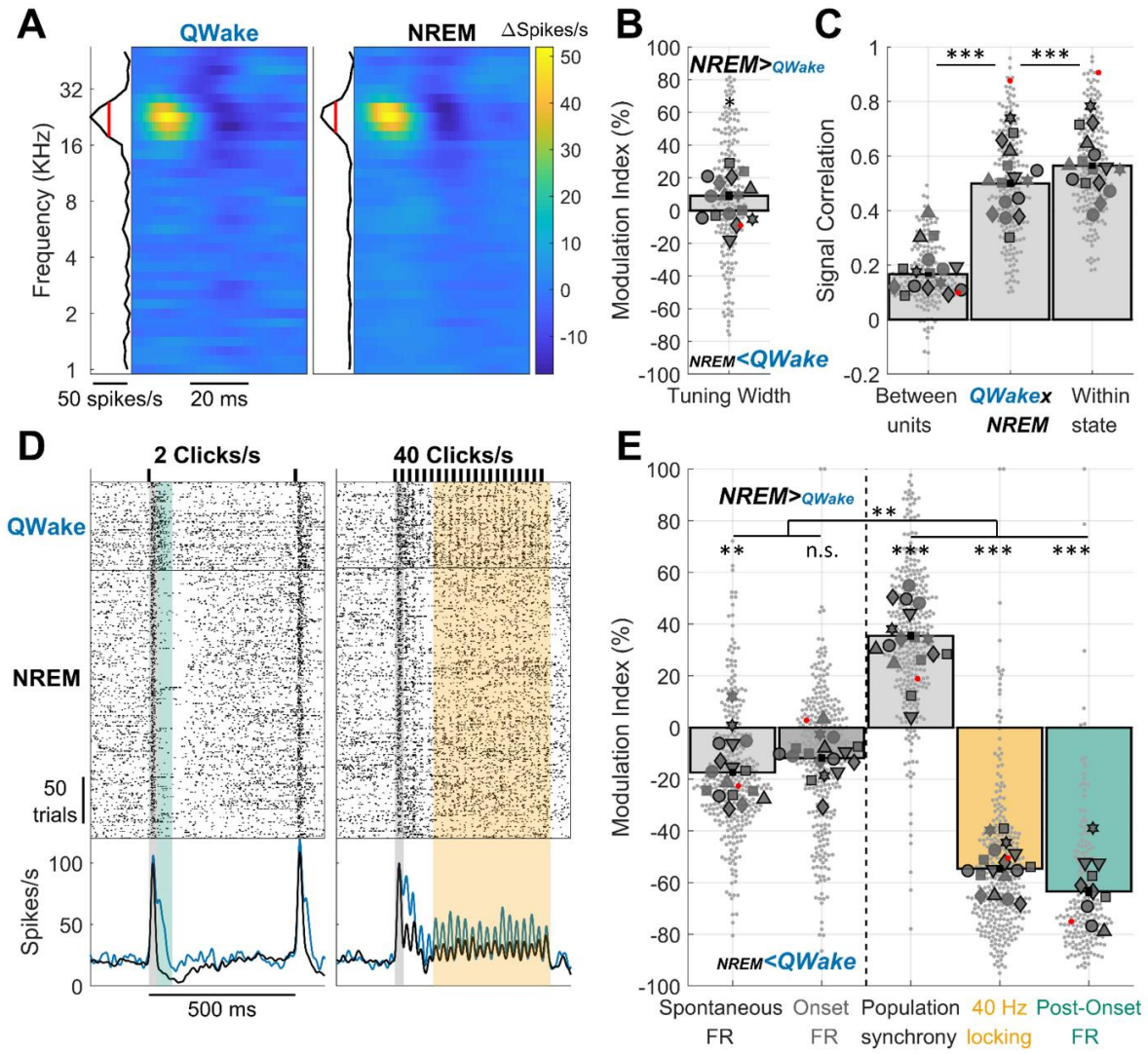
Supplementary Figure 2. Movement and pose estimation using DeepLabCut. A) Video-based pose estimation of different facial features and body parts using DeepLabCut. Panel II: Example trial where the animal was not facing the camera (such trials were excluded from analysis in panel C). Panels III-IV: Different body and head poses were identified by the visibility of different face features (e.g. facing right when left eye is not visible in panel V). B) Mean movement in pixels during and preceding sound presentations in Active Wakefulness (AW), Vigilant, Tired, NREM sleep, and REM sleep conditions. While the Vigilant and Tired conditions had considerably less movement than Active Wakefulness, there was still a difference between the Vigilant and Tired condition. C) To rule out movement as a contributing factor for the observed changes in auditory processing, we removed all trials with movement during/preceding sound presentations, counter-balanced the prevalence of different body poses (panels A III-IV), and repeated the main analysis reported in Fig. 2 for all units and sessions with at least 20 trials in each condition. Results are qualitatively similar to those in Fig. 2 demonstrating that changes in movement and/or body poses are not driving the auditory processing changes between the Vigilant and Tired conditions. Panel depicts modulation of activity/response features between Tired and Vigilant conditions across units (n=213) and sessions (n=11). P≤0.0257, df=212 or 97, LME, for comparing spontaneous and onset firing with population synchrony, 40 Hz locking and post-onset firing. Features (left to right) denote: spontaneous firing rate (FR), onset response FR, population synchrony, 40-Hz locking and post onset FR. 2 click/s train were presented in 11 out of 19 sessions ('auditory paradigm A', green bar, n=98 units, 5 sessions).



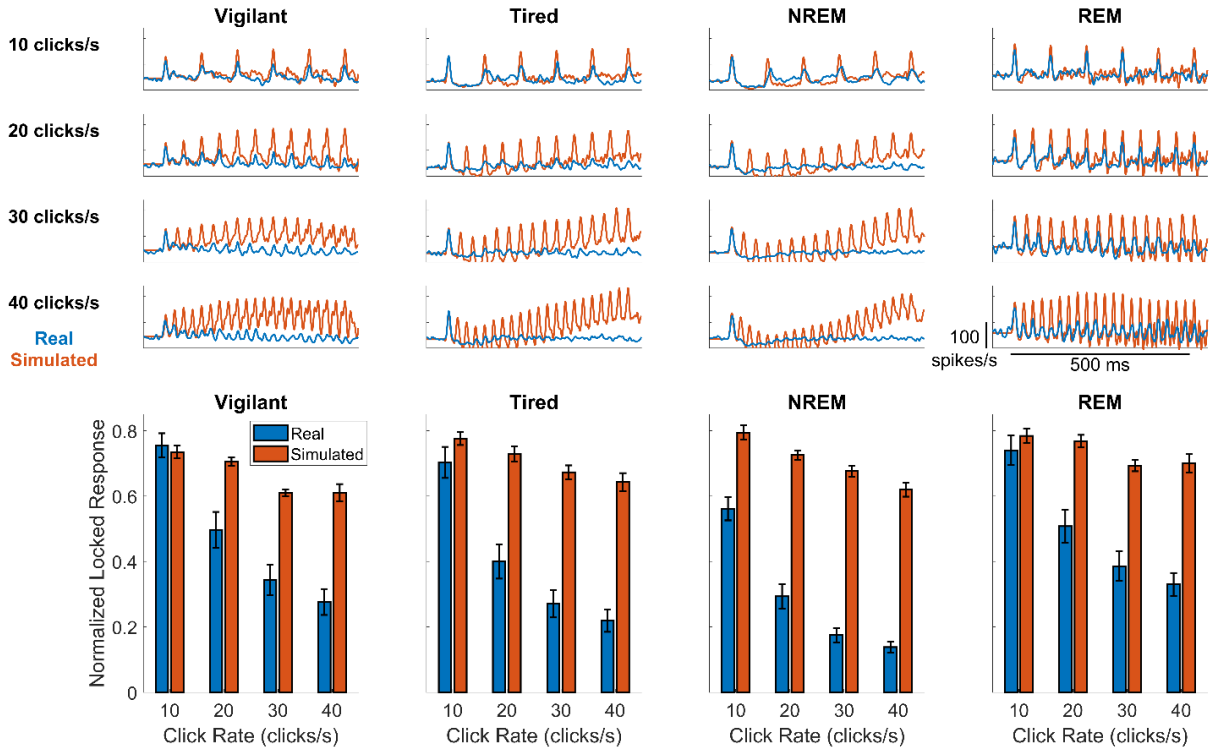
Supplementary Figure 3. Stress assessment via corticosterone measurements. Corticosterone (CORT) plasma levels in three settings: during SD, home cage control, and a stress paradigm. Blue and black circles represent measures at zeitgeber time (ZT) +1:20h and ZT+4:40h, respectively (n=10 animals for SD, n=12, for control and stress conditions). Two-way repeated-measured ANOVA revealed no significant main effects for the time of day (p=0.21, F(1,9)=1.8) or for sleep deprivation (p=0.37, F(1,9)=0.9), and no significant interaction (p=0.98, F(1,9)<0.01). By contrast, following exposure to the wet cage stress paradigm used as 'positive control', a significant 10-fold increase in plasma CORT levels was observed (p<0.0001, Tukey's multiple comparisons test). Although not statistically significant, a trend for slight increase in CORT plasma levels was observed when comparing the early sampling time (ZT+1:20h) to the late sampling time (ZT+4:40h), in line with the expected circadian change in CORT levels. This circadian change was apparent in both the control conditions and the SD conditions. Although the SD conditions induced slightly higher CORT levels (approximately 2-fold), this difference was not statistically significant, but potentially reflected mild stress associated with the SD setting and procedure (i.e. presence in motorized wheel rather than in home cage, and its intermittent rotation). Importantly, such elevated CORT profile was similar in the short and prolonged SD periods and an order of magnitude smaller than the 10-fold increase in CORT levels following the wet cage stress paradigm. Thus, we found no significant differences in CORT levels or CORT response between short or prolonged SD periods, and CORT stress response do not seem to constitute a significant mediating factor of the impact of SD in this experimental paradigm.



Supplementary Figure 4. Unit stability analysis. A) Distribution of normalized spike shape variance (dimensionless) across entire recording session (~10h long) for recorded units ('Real', blue) and surrogate 'unstable' units artificially composed from two different units ('Surrogate', red, Methods). Vast Majority of (real) recorded units showed low spike shape variance throughout the session, which was unlike surrogate 'unstable' units. Based on the surrogate population spike shape variance, a conservative threshold for declaring recorded units as 'stable' was chosen at a false-positive rate of 0.01 (1%, vertical black line). B) ROC curve showing clear separation between the real units and the surrogate 'unstable' units populations. Arrow depicts the chosen threshold at a false-positive rate of 1%. The true-positive rate depicts the proportion of recorded units declared 'stable' at this threshold (63%). C) Same analysis as in Fig. 2 comparing Vigilant and Tired conditions, but restricted to the 63% of units characterized as 'stable'. Modulation of activity/response features between Tired and Vigilant conditions across units (n=219) and sessions (n=16). Features (left to right) denote: spontaneous firing rate (FR), onset response FR, population synchrony, 40-Hz locking and post onset FR. 2 click/s train were presented in 11 out of 19 sessions ('auditory paradigm A', green bar, n=126 units, 9 sessions). D) same as C but comparing Vigilant and NREM sleep conditions (as in Fig. 3). Results in C and D are qualitatively similar to those in Fig. 2,3. For Panels C, D small gray markers represent individual units. Large dark gray markers represent mean of all units in an individual session. Each marker shape represents sessions from an individual animal. Markers with/without black edges represent 'auditory paradigm A' and 'auditory paradigm B' sessions, respectively. Dashed vertical line separates features minimally/not significantly affected by condition (spontaneous FR and onset response FR; on left) vs. features that are significantly disrupted in the Tired/NREM sleep conditions (population synchrony, 40Hz locking, and post-onset FR; on right).



Supplementary Figure 5. NREM compared to Quiescent Wakefulness during recovery sleep periods. Same analysis as in Fig. 3 but comparing NREM sleep to Quiescent Wakefulness (QWake), both obtained during the recovery sleep period (last 5h of experimental session). Results are qualitatively similar to Fig. 3. A) Representative spectro-temporal receptive field (STRF) of a unit in auditory cortex. B) Modulation of frequency tuning width (NREM sleep vs. QWake conditions) for all units (n=198) and sessions (n=16). C) Signal correlations of frequency tuning across the entire dataset between different units in the same session (left bar), between QWake and NREM sleep conditions of the same individual units (middle bar) and between 1st and 2nd halves of trials in the same condition for the same individual units (right bar). D) Representative raster and peri-stimulus time histogram (PSTH) for a unit in response to 2 and 40 clicks/s click trains (left and right, respectively). Gray shading marks the onset response [0-30]ms period. Green shading represents the post-onset [30-80]ms period. Yellow shading represents the [130-530]ms period where sustained locking to the 40 click/s train was attenuated. E) Modulation of activity/response features between NREM sleep and QWake conditions across units (n=324) and sessions (n=17). Features (left to right) denote: spontaneous firing rate (FR), onset response FR, population synchrony, 40-Hz locking and post onset FR. 2 click/s train were presented in 11 out of 19 sessions ('auditory paradigm A', green bar, n=196 units, 10 session). For Panels B,C,E, small gray markers represent individual units. large dark gray markers represent mean of all units in an individual session. Each marker shape represents sessions from an individual animal. Markers with/without black edges represent 'auditory paradigm A' and 'auditory paradigm B' sessions, respectively. Red dots point to the representative unit presented in panels A and D. Dashed vertical line separates features minimally/not significantly affected by condition (spontaneous FR and onset response FR; on left) vs. features that are significantly disrupted in the NREM sleep condition (population synchrony, 40Hz locking, and post-onset FR; on right).



458 **Supplementary Figure 6. Post-onset FR reduction doesn't explain reduced locking to rapid click trains.** We
459 examined if decreased locking to rapid click trains may be trivially explained by post-onset FR suppression that may
460 coincide with the evoked response to subsequent clicks. We constructed a simple linear model aiming to predict
461 the response to different click trains by shifting in time and summing up the average response to an individual click
462 (Methods). Top) an example of individual unit locked response to different click rates (rows) across different
463 conditions (columns). Blue traces represent the actual response while red traces represent the linear model. For
464 this unit the model predicts much stronger locking to fast click trains than that is observed in practice (compare
465 red to blue traces at the bottom row). Bottom) mean normalized locked response for different conditions
466 (columns) and click rates (different bars). Blue and red bars represent the mean real and modeled response across

all units, respectively. The large gap for fast click trains (especially for NREM and Tired conditions) demonstrates that post-onset FR reduction seen in response to individual clicks doesn't trivially explain reduced locking to fast click trains.