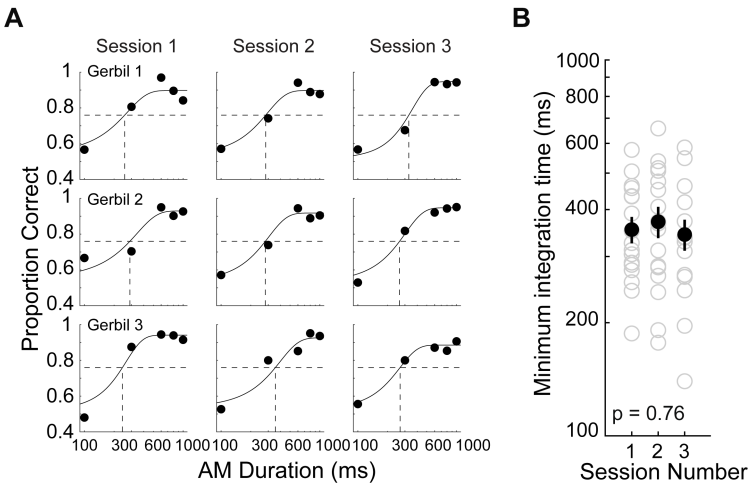

Figure S1. Psychometric performance across each session, Related to Figure 1. A) Psychometric functions from 3 gerbils across 3 test sessions. Vertical dashed lines correspond to the stimulus duration at which proportion of correct trials = 0.76 (horizontal dashed lines) and is defined "minimum integration time". B) Distribution of minimum integration time across test session number. Performance across all 3 test sessions remained stable as minimum integration times did not change significantly (One-way repeated measures ANOVA; $F_{(2,32)} = 0.28$, $p = 0.76$).

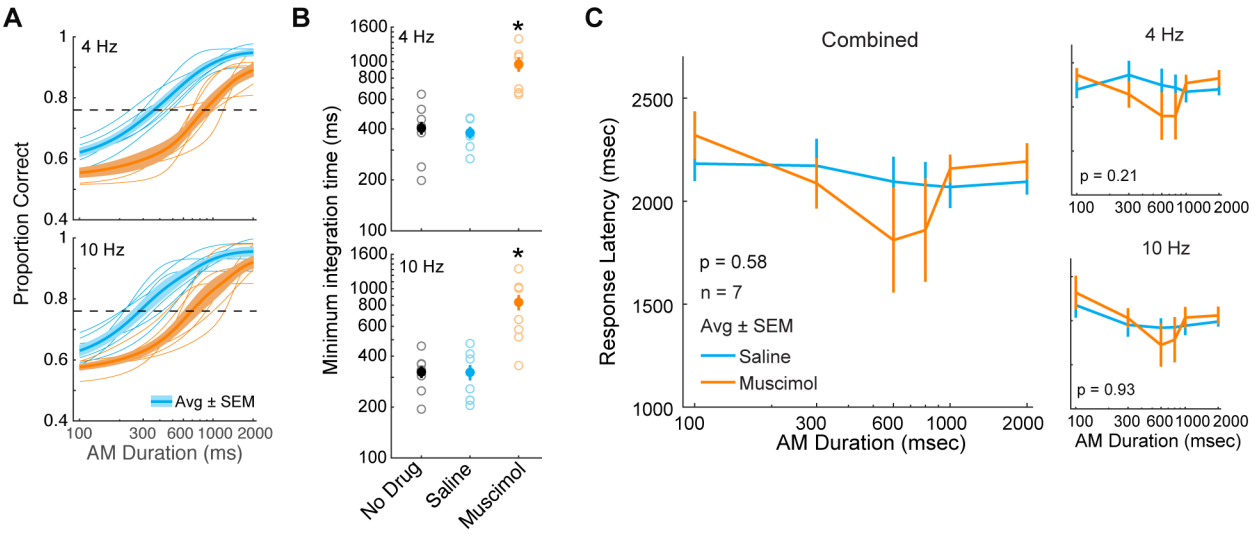

Figure S2. Supplementary analysis of task performance while inactivating parietal cortex, Related to Figure 3. A) Average psychometric functions across all animals (thick lines) and average psychometric functions from each animal during muscimol (orange) and saline (blue) infusion sessions (thin lines) for 4 Hz (top) and 10 Hz (bottom) trials. Task performance for both trial types were significantly different between infusion groups (two-way mixed model ANOVA; 4 Hz: $F_{(1,6)}$ = 26.5, p = 0.002; 10 Hz: $F_{(1,6)}$ = 23.1, p = 0.003). For 4 Hz trials, post-hoc analyses revealed significant differences in performance between infusion groups for stimulus durations of 300, 600, 1000, and 2000 ms (two-tailed t-tests; Holm-Bonferroni-corrected; 300 ms: p = 0.02, t = 2.82; 600 ms: p = 0.0002, t = 5.47; 1000 ms: p = 0.006, t = 3.78; 2000 ms: p = 0.01, t = 3.33). For 10 Hz trials, post-hoc analyses revealed significant differences in performance between infusion groups for stimulus durations of 300, 600, 800, and 2000 ms (two-tailed t-tests; Holm-Bonferroni-corrected; 300 ms: p = 0.005, t = 3.89; 600 ms: p < 0.0001, t = 6.20; 800 ms: p = 0.008, t = 3.63; 2000 ms: p = 0.03, t = 2.58). B) Distribution of calculated minimum integration times from each animal as a function of infusion condition for 4 Hz (top) and 10 Hz (bottom) trials. For both trial types, minimum integration times were significantly different across groups (one-way repeated measures ANOVA; 4 Hz: $F_{(2,18)}$ = 18.5, p < 0.0001; 10 Hz: $F_{(2,18)}$ = 10.9, p < 0.0001). Post-hoc analyses revealed minimum integration times under muscimol (orange) were significantly different from no drug (black) (two-tailed t-tests; Holm-Bonferroni-corrected; 4 Hz: p = 0.005, t = 4.33; 10 Hz: p = 0.01, t = 3.45) and saline (blue) (two-tailed t-tests; Holm-Bonferroni-corrected; 4 Hz: p = 0.006, t = 4.2; 10 Hz: p = 0.007, t = 4) sessions. C) Average response latency across all animals as a function of stimulus duration for muscimol (orange) and saline (blue) infusion sessions. No significant main effect of infusion group was demonstrated (two-way mixed model ANOVA; Combined trials: $F_{(1,6)}$ = 0.34, p = 0.58; 4 Hz: $F_{(1,6)}$ = 1.98, p = 0.21; 10 Hz: $F_{(1,6)}$ = 0.01, p = 0.93).

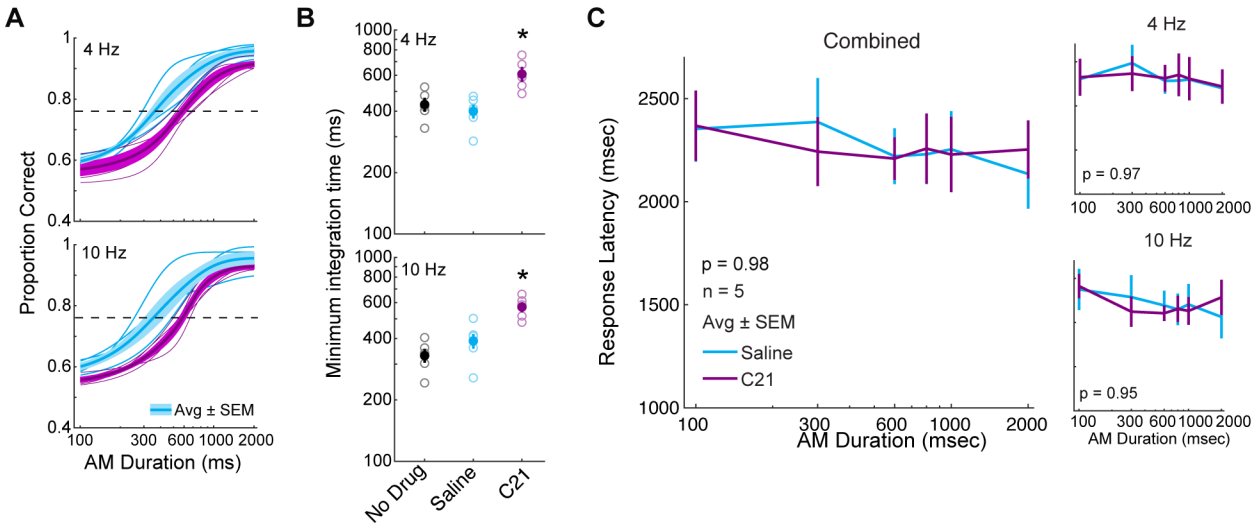

Figure S3. Supplementary analysis of task performance while perturbing auditory cortex inputs into parietal cortex, Related to Figure 4. A) Average psychometric functions across all animals (thick lines) and average psychometric functions from each animal during C21 (purple) and saline (blue) infusion sessions (thin lines) for 4 Hz (top) and 10 Hz (bottom) trials. Task performance for both trial types were significantly different between infusion groups (two-way mixed model ANOVA; 4 Hz: $F_{(2,8)} = 58.5$, $p = 0.002$; 10 Hz: $F_{(1,6)} = 66.9$, $p = 0.001$). For 4 Hz trials, post-hoc analyses revealed significant differences in performance between infusion groups for stimulus durations of 300 and 600 ms (two-tailed t-tests; Holm-Bonferroni-corrected; 300 ms: $p = 0.012$, $t = 3.2$; 600 ms: $p = 0.005$, $t = 4.14$). For 10 Hz trials, post-hoc analyses revealed significant differences in performance between infusion groups for stimulus durations of 300 and 600 ms (two-tailed t-tests; Holm-Bonferroni-corrected; 300 ms: $p = 0.016$, $t = 3.17$; 600 ms: $p = 0.02$, $t = 3.04$). B) Distribution of calculated minimum integration times from each animal as a function of infusion condition for 4 Hz (top) and 10 Hz (bottom) trials. For both trial types, minimum integration times were significantly different across groups (one-way repeated measures ANOVA; 4 Hz: $F_{(2,8)} = 17.47$, $p = 0.001$; 10 Hz: $F_{(2,8)} = 15.86$, $p = 0.002$). Post-hoc analyses revealed minimum integration times under C21 (purple) were significantly different from no drug (black) (two-tailed t-tests; Holm-Bonferroni-corrected; 4 Hz: $p = 0.03$, $t = 3.43$; 10 Hz: $p < 0.0001$, $t = 14.8$) and saline (blue) (two-tailed t-tests; Holm-Bonferroni-corrected; 4 Hz: $p = 0.005$, $t = 5.59$; 10 Hz: $p = 0.04$, $t = 3.04$) sessions. C) Average response latency across all animals as a function of stimulus duration for C21 (purple) and saline (blue) infusion sessions. No significant main effect of infusion group was demonstrated (two-way mixed model ANOVA; Combined trials: $F_{(1,4)} = 0.0006$, $p = 0.98$; 4 Hz: $F_{(1,4)} = 0.001$, $p = 0.97$; 10 Hz: $F_{(1,4)} = 0.005$, $p = 0.95$).

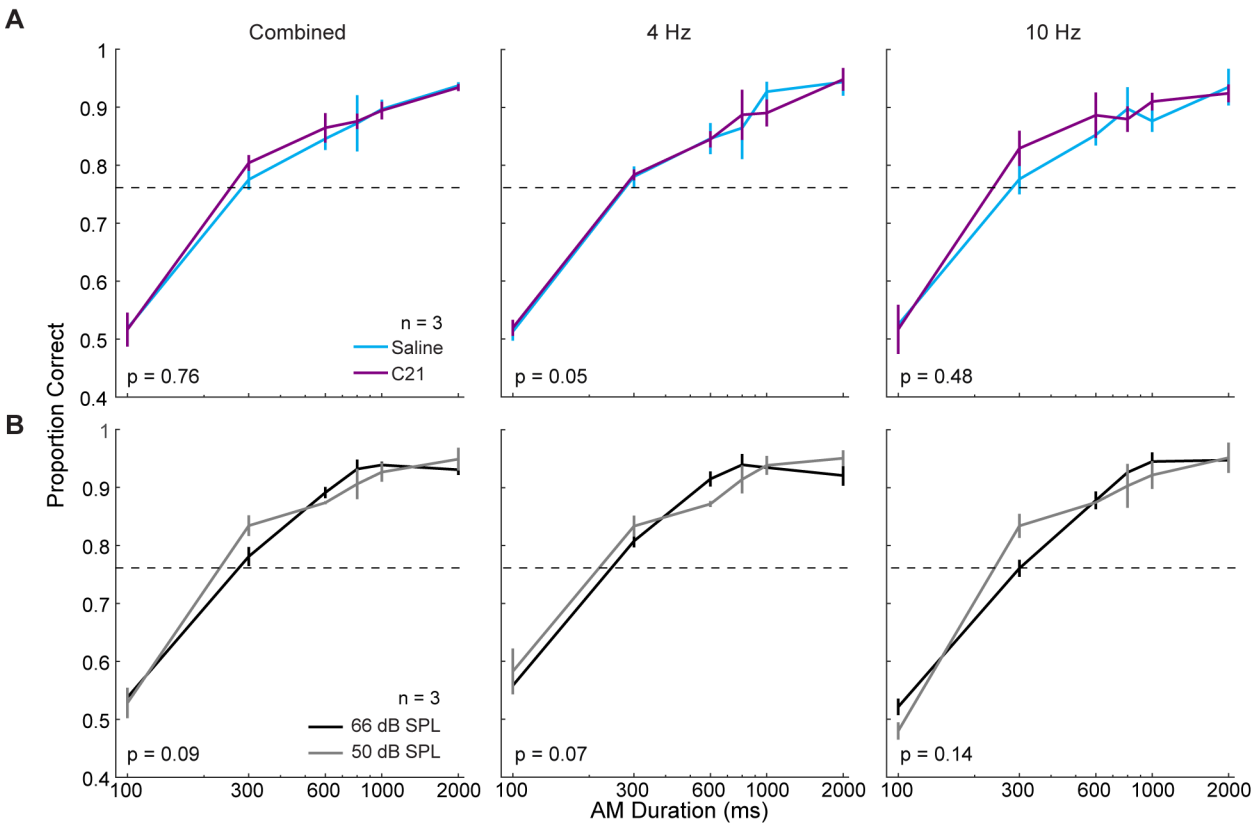

Figure S4. Testing two potential alternative explanations for impaired task performance while perturbing auditory cortex inputs into parietal cortex, Related to Figure 4. A) Average psychometric functions during C21 (purple) and saline (blue) infusions sessions without bilateral injections of pAAV-CaMKIIa-hM4D(Gi)-mCherry into auditory cortex. We found no difference in task performance between infusion groups (two-way mixed model ANOVA; Combined trials: $F_{(5,10)}$ = 0.51, p = 0.76; 4 Hz: $F_{(5,10)}$ = 3.24, p = 0.05; 10 Hz: $F_{(5,10)}$ = 0.96, p = 0.48). B) Average psychometric functions during 50 (gray) and 66 (black) dB SPL sound level sessions. We found no difference in task performance between sound levels (two-way mixed model ANOVA; Combined trials: $F_{(5,10)}$ = 0.51, p = 0.76; 4 Hz: $F_{(5,10)}$ = 2.95, p = 0.07; 10 Hz: $F_{(5,10)}$ = 3.14, p = 0.14).

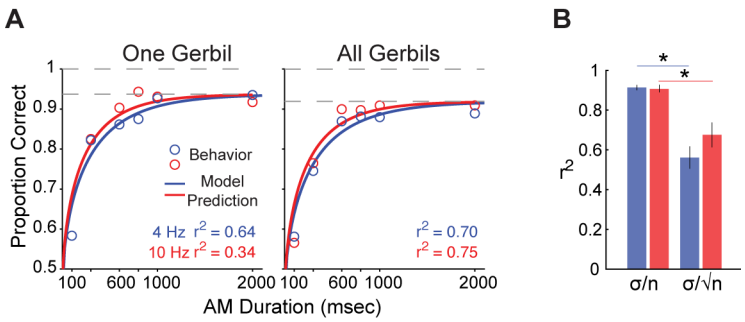

Figure S5. Signal detection theory-based model predictions under the assumption of independent noise, Related to Figure 5. A) Comparison of the behavioral data (symbols) with model predictions (lines) for held-out data (5-fold cross validation) from one animal (left) and all animals (right) under the assumption of independent noise (i.e., standard deviation divided by square root of the number of samples). B) Average goodness-of-fit (± SE) for 4 (blue) and 10 (red) Hz trials under the separate noise scaling frameworks. Goodness-of-fit values were significantly worse under the assumption of independent noise compared with the assumption that noise grows linearly with the number of samples (two-tailed t-test, 4 Hz trials: $p < 0.001$, $t = 6.30$; 10 Hz trials: $p < 0.001$, $t = 3.69$).