Supplemental Information:

Signaling of the strongest stimulus in the owl optic tectum

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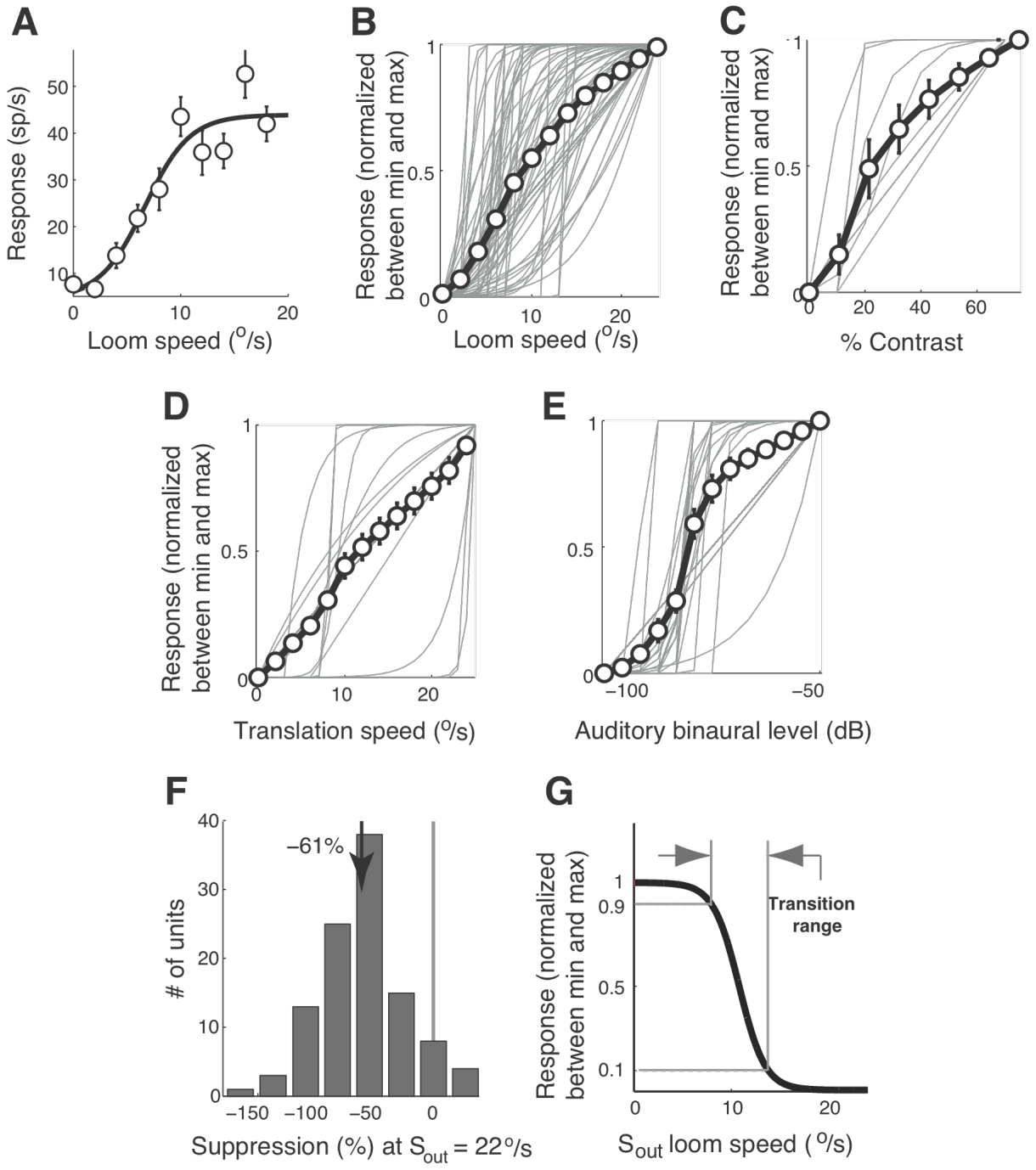

Figure S1. Responses of OTi-d units to single and paired stimuli

(A-E) Excitation-response functions: Responses to single visual or auditory stimuli centered in the receptive field.

(A) Response firing rates (Experimental Procedures) from an OTi-d unit in response to a looming, full contrast visual dot, as a function of increasing loom speeds. (B) Average normalized response to increasing loom speeds from 86 OTi-d units. Open circles: population average, gray curves: best sigmoidal fits to responses from individual units. All data show mean

± s.e.m. (C-E) Similar to B, obtained by varying different properties of a stimulus: contrast of a visual dot of radius 1°, (C, 8 units); speed of translational motion of a visual dot of radius 1° in the downward direction, (D, 12 units); and average binaural level of a noise burst (E, 31 units).
(F, G) Responses to paired stimuli
(F) Distribution of the maximum suppression of responses to the S_{in} stimulus by a looming S_{out} stimulus. Median speed of S_{in} stimulus = 7.6 °/s (95 % confidence interval of [6 °/s, 9°/s]), and speed of S_{out} = 22 °/s (maximal speed). Suppression plotted as % change in the response to the paired stimuli with respect to the response to S_{in} alone. Mean = -61 ± 7% ($p < 10^{-4}$, t-test against 0, n=107 units)
(G) Definition of the transition range of a competitor strength-response profile (CRP). The schematic of a CRP representing the responses to the simultaneous presentation of S_{in} and S_{out} as a function of S_{out} strength. The responses are normalized such that 0 corresponds to the minimum firing rate, and 1, to the maximum firing rate. The transition range, defined as the range of S_{out} loom speeds over which the suppression drops from 10% to 90% of the total change in suppression is shown. Note that the transition range does not depend on the values of the minimum and the maximum responses, or on the responses to S_{in} alone. It is a measure of how abruptly the responses change from the maximum to the minimum values.

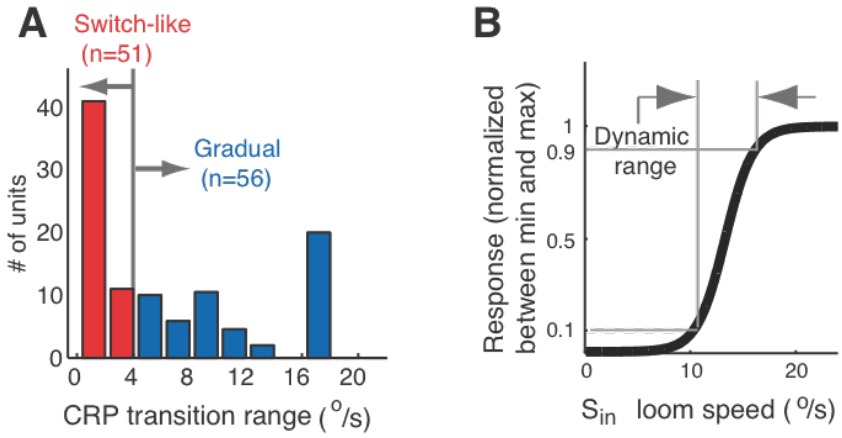

Figure S2. Distribution of non rounded-up CRP transition ranges and definition of dynamic range of loom speed-response functions.
(A) The distribution is for the same 107 units shown in Figure 2. The plotted transition range values were those estimated directly from the fits, before rounding-up with respect to the sampling increment in loom speed.

(B) Definition of the dynamic range of a loom speed-response function, measured using a single stimulus centered in the receptive field. The schematic of a loom speed-response function with responses normalized such that 0 corresponds to the minimum firing rate, and 1, to the maximum firing rate. The dynamic range is defined as the range of S_{in} loom speeds over which the responses change from 10% to 90% of the total change in responses. The dynamic range does not depend on the values of the minimum and the maximum responses. It is a measure of how abruptly the responses change from the minimum to the minimum values.

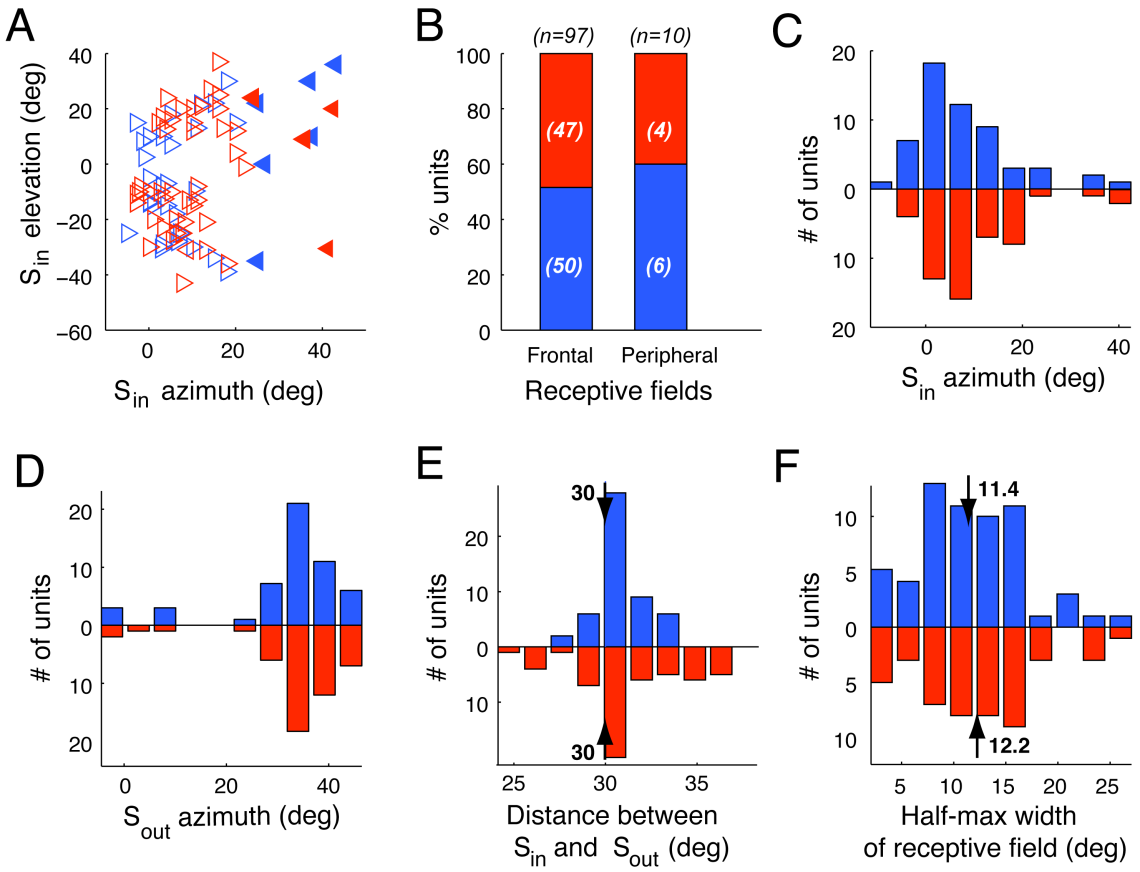

Figure S3. Nature of CRP (switch-like or gradual) is independent of receptive field location, S_{out} location, or receptive field size.

(A) Distribution of receptive field locations of 51 units with switch-like CRPs (red) and 56 units with gradual CRPs (blue). Open, rightward pointing arrowheads indicate frontally located receptive fields (with azimuth < contralateral 20°). For these CRPs, the S_{out} stimulus was located laterally with respect to the receptive field. Filled, leftward pointing arrowheads indicate peripherally located receptive fields with azimuth ≥ 20°). For these CRPs, the S_{out} stimulus was located medially with respect to the receptive field. The most medial S_{out} location was 6° ipsilateral. Since the barn owl OT represents locations up to 15° into ipsilateral space, S_{out} locations in our experiments were always represented in the same hemisphere as the S_{in} locations.

(B-C) There was no systematic effect of the location of a unit's receptive field on the nature of the CRP. (B) The percentage of units with switch-like CRPs (red bars) was nearly the same for units with either frontal or peripheral RFs. The same was true for units with gradual CRPs (blue bars). (C) The distribution of receptive field azimuths for units with switch-like CRPs (red) was not distinguishable from the distribution of receptive field azimuths for units with gradual CRPs (blue; p=0.186, ranksum test).

(D-E) There was no systematic effect of the location or distance of the S_{out} stimulus with respect to a unit's receptive field on the nature of the CRP measured at that unit. (D) The distribution of S_{out} stimulus azimuths for units with switch-like CRPs (red) was not distinguishable from the distribution of S_{out} stimulus azimuths for units with gradual CRPs (blue; p=0.32, ranksum test).

(E) The distributions of distance between the S_{out} stimulus location and the receptive field center were indistinguishable for units with switch-like or gradual CRPs (p=0.494, ranksum test).
(F) There was no systematic effect of the size of a unit's receptive field on the nature of the CRP measured at that unit. The distributions of receptive field sizes, estimated as the half-max width of the best fitting Gaussian to the azimuthal tuning curve, were indistinguishable for units with switch-like or gradual CRPs (p=0.549, ranksum test).

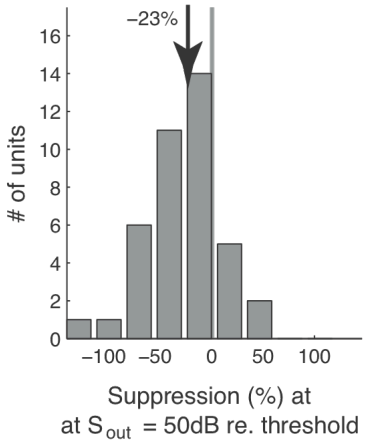

Figure S4. Distribution of the maximum suppression of responses to the S_{in} stimulus by an auditory S_{out} stimulus.
Median speed of S_{in} stimulus 6.4 °/s with a 95% confidence interval of [6.4 °/s, 9.6 °/s], and ABL of S_{out} = 50 dB relative to threshold. Suppression plotted as % change in the response to the paired stimuli with respect to the response to S_{in} alone. Mean = -23% ± 8% (p =0.006, t-test against 0, n=40 units).

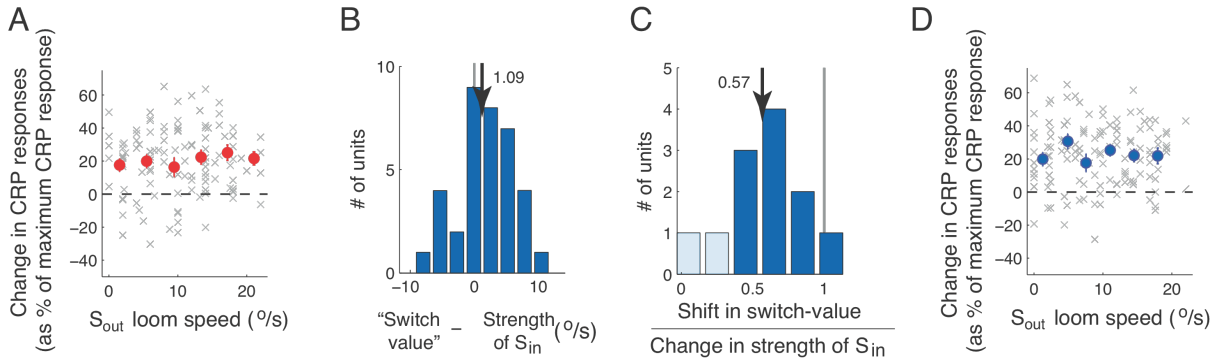

Figure S5. Effect of S_{in} strength on CRPs
(A) Increase in S_{in} strength increases the overall level of CRP responses for units with switch-like CRPs. Crosses indicate the differences between the CRP responses obtained with the stronger S_{in} stimulus and those obtained with the weaker S_{in} stimulus, at all values of S_{out} strength, across all units tested with two S_{in} strengths (n=16). The difference values from each unit are plotted as % of the maximum response for that unit to paired stimuli. The filled circles indicate the average values of the difference in responses computed after binning the data along

the x-axis. Mean ± s.e.m is indicated. Analysis of variance yielded a significant increase in responses (difference > 0) for all bins of S_{out} strength (ANOVA followed by a correction for multiple comparisons at the 0.05 level of significance).
(B-D) Data from units with gradual CRPs for which the switch value is well defined. Note that the switch value (the strength of the S_{out} stimulus which caused the responses to change from high to low values) is well defined only for those gradual CRPs that are best fit by a sigmoidal function. It is not defined for gradual CRPs that are best fit by a linear function. (B) Distribution of (switch value – strength of S_{in}) in blue. Average (1.09 °/s ± 0.69 °/s, n=35) was not significantly different from 0 (p=0.11, t-test). (C) Distribution of the shift ratio (shift in switch value divided by change in the strength of S_{in}). The light shading indicates units for which the shift in the switch value was deemed to be not significant (Experimental Procedures). Average shift ratio (0.57 ± 0.09, n=12) was not significantly different from the average shift ratio for switch-like CRPs (p=0.11, t-test against distribution in Fig. 5E). (D) Increase in S_{in} strength increases the overall level of CRP responses. Crosses indicate the differences between the CRP responses obtained with the stronger S_{in} stimulus and those obtained with the weaker S_{in} stimulus at all values of S_{out} strength, across all units tested with two S_{in} strengths (n=12 units). The difference values from each unit are plotted as % of the maximum response of that unit to paired stimuli. The filled circles indicate the average values of the difference computed after binning the data along the x-axis. Mean ± s.e.m is indicated. Analysis of variance yielded a significant increase in responses (difference > 0) for all bins of S_{out} strength (ANOVA followed by a correction for multiple comparisons at the 0.05 level of significance).

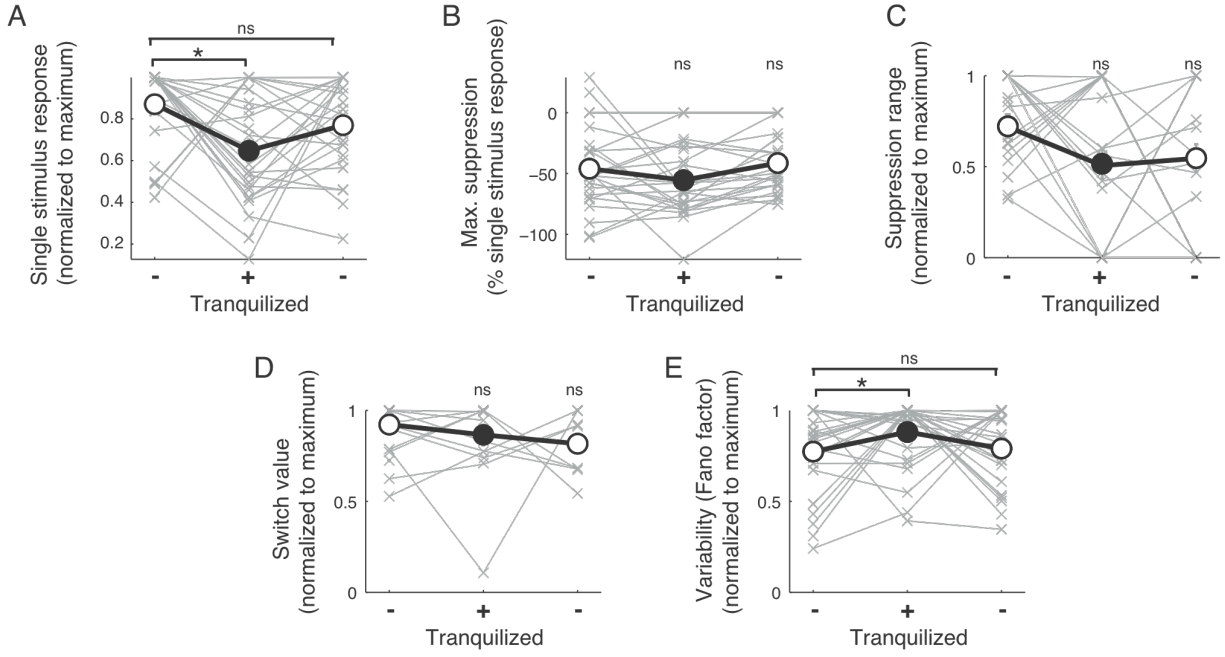

Figure S6. Effect of nitrous oxide tranquilization on unit responses.
The effect of nitrous oxide tranquilization on responses to single stimuli and CRPs was tested for 49 units. Of these, responses were recorded first without tranquilization, then with tranquilization, and finally without tranquilization again, for 35 units. S_{in} and S_{out} stimuli were

both chosen to be looming visual dots. For each unit the following response metrics were calculated for each of the sedation conditions: single stimulus responses (A), maximum CRP suppression (% of single stimulus response; B), suppression range of CRP (maximum – minimum suppression; C), switch-value (for switch-like CRPs; D) and CRP Fano factor (E). The Fano factor for a CRP was calculated as the average Fano factor across all S_{out} strengths; Fano factor at a single S_{out} strength was defined as the ratio of the variance divided by the mean of the responses to that stimulus strength. Each metric was normalized (where indicated) to the maximum value for that unit across the three tranquilization conditions, and the data from all the units were plotted (gray crosses and lines). The mean ± s.e.m for each tranquilization condition are shown as circles, with open circles corresponding to the non-tranquilized case and closed circles, to the tranquilized case. '*' indicates significance, and 'ns', no significance at the 0.05 level (t-test followed by Holm-Bonferroni correction for multiple comparisons). Note that CRP metrics were calculated only for those CRPs that showed a significant correlation of responses with the strength of S_{out}.