

## Supplementary Materials

### S1. Stimulus equation

The stimulus for both experiments was a horizontal sinusoidal grating given by the equation:

$$l(x, y) = \sin(x\omega + \varphi) \cdot \left( K + \Delta K e^{-\left[ \left( \frac{x}{\sigma_x} \right)^2 + \left( \frac{y - \mu_y}{\sigma_y} \right)^2 \right]} \right) \cdot G(x, y) \quad [\text{eq. 1}]$$

Where  $x$  and  $y$  are the spatial coordinates;  $K$  is the pedestal contrast (10%) and  $\Delta K$  is the contrast increment;  $\sigma_x = 1.5^\circ$  and  $\sigma_y = 0.75^\circ$  are the space constant and  $\mu_y = 1.25^\circ$  is the spatial vertical offset;  $\omega = 1 \text{ c/}^\circ$  is the spatial frequency,  $\varphi$  the random phase, and the function  $G(x, y)$  is the circular window of diameter  $5^\circ$  convolved by a Gaussian ( $\sigma = 0.5^\circ$ ) to obtain smooth edges.

### S2. Oscillatory model equation

The psychophysical performance from the aggregate observer in experiment 1, was modeled (as shown in figure 1) by the following equation:

$$f(x) = \mu + \alpha \cos(\omega x) + \beta \sin(\omega x) \quad [\text{eq. 2}]$$

All parameters were free, but frequency  $\omega$  was constrained between 0 and 10 Hz. For permutation testing, the frequency was constrained in the frequency resulting from the best fitting procedure on the aggregate observer data. All the other parameters were free.

Here the results of the best fitting procedure for the three conditions in experiment 1:

Self-HL: adj-R<sup>2</sup>: 0.35; the 95% conf. bounds:  $\alpha$ : 0.03 [0.01 0.05];  $\beta$ : -0.01 [-0.04 0.01];  $\omega$ : 5.09 [4.8 5.3]

Random-HL: adj-R<sup>2</sup>: 0.13; 95% conf. bounds.  $\alpha$ : -0.01 [-0.03 0.002];  $\beta$ : 0.007 [-0.01 0.03];  $\omega$ : 5.9 [5.6 6.3].

Self-LL: adj-R<sup>2</sup>: 0.27; 95% conf. bounds.  $\alpha$ : 0.02 [-0.002 0.04];  $\beta$ : 0.02 [0.002 0.04];  $\omega$ : 7.1 [6.8 7.4].

### S3. Figure S3

Proportion correct in the first 120 ms in experiment 2 for individual subjects for *self-HL* (A, red), *self-LL* (B, blue) and *audio-HL* (C, black) conditions. Bin size 24 ms, 66% overlap; vertical lines represent the s.e.m of the bootstrapped data. The local performance minimum is highlighted by the dashed bars for both *self-HL* and *self-LL* conditions. Bar plot: total number of observations for each bin. The local performance minimum is highlighted by the dashed bars for both *self-HL* and *self-LL* conditions. Bar plot: total number of observations for each bin.

