Supplementary Material A
Cortical drift and variance calculations

For a given scenario of a predator being present or not, we assume that each signal is an independent, identically distributed random variable from a normal distribution with variance σ^2. When no predator is present the mean is μ_{cort0}, when a predator is present the mean is μ_{cort1}. We assume that $\mu_{cort0} < \mu_{cort1}$.

We let $f_i(x) = \frac{1}{\sigma\sqrt{2\pi}} exp\left(\frac{-(x-\mu_{\mathrm{cort}i})^2}{2\sigma^2}\right)$, where $i = 1$ or 0 denotes the presence or absence of a predator, respectively.

For a given piece of data, x, we can calculate the ratio of likelihoods of the data having come from each of the distributions, $\frac{f_1(x)}{f_0(x)}$. Upon receiving a series of signals, $(x_1, x_2, ..., x_k)$, the ratio of likelihoods will be given by $\frac{f_1(x_1)f_1(x_2)...f_1(x_k)}{f_0(x_1)f_0(x_2)...f_0(x_k)}$. Taking logs, we are able to convert this multiplicative system into an additive one, where at each stage, the movement in log space for a given signal, x_k, is given by $ln\left(\frac{f_1(x_k)}{f_0(x_k)}\right)$.

Let $\quad q = ln\left(\frac{f_1(x)}{f_0(x)}\right) = \frac{\mu_{cort0}^2 + 2(\mu_{cort1}-\mu_{cort0})x - \mu_{cort1}^2}{2\sigma^2}$.

We now calculate the expected movement in log-space due to a single piece of information (i.e., one update) under each of the circumstances (predator present or not):

$$E_{f_0}(Q) = \frac{\mu_{cort0}^2 + 2(\mu_{cort1}-\mu_{cort0})E_{f_0}(X) - \mu_{cort1}^2}{2\sigma^2},$$

$$E_{f_1}(Q) = \frac{\mu_{cort0}^2 + 2(\mu_{cort1}-\mu_{cort0})E_{f_1}(X) - \mu_{cort1}^2}{2\sigma^2}.$$

As $E_{f_0}(X) = \mu_{cort0}$ and $E_{f_1}(X) = \mu_{cort1}$, we obtain:

$$E_{f_0}(Q) = -\frac{(\mu_{cort1}-\mu_{cort0})^2}{2\sigma^2} \quad \text{(is negative)},$$

$$E_{f_1}(Q) = \frac{(\mu_{cort1}-\mu_{cort0})^2}{2\sigma^2} \quad \text{(is positive)}.$$

The variance in each case will be the same:

$$Var(Q) = Var\left(\frac{\mu_{cort0}^2 + 2(\mu_{cort1}-\mu_{cort0})X - \mu_{cort1}^2}{2\sigma^2}\right) = \frac{(\mu_{cort1}-\mu_{cort0})^2}{(\sigma^2)^2} Var(X) = \frac{(\mu_{cort1}-\mu_{cort0})^2}{\sigma^2}.$$

To study the case of numerous updates, we use some work by McNamara *et al.* (2008) with substitutions.

Suppose there are n observations per unit time. When time, t, is a multiple of $1/n$, $Y(t) = Z(nt)$ summarises the information up to t.

Let $\mu_+ = n\frac{(\mu_{cort1}-\mu_{cort0})^2}{2\sigma^2}, \quad \mu_- = -\mu_+, \quad \eta^2 = n\frac{(\mu_{cort1}-\mu_{cort0})^2}{\sigma^2}$.

Then, $E_{f_0}(Y(t)) = \mu_- t, \quad E_{f_1}(Y(t)) = \mu_+ t, \quad Var(Y(t)) = \eta^2 t$.

If we let $n \to \infty$ and allow $(\mu_{cort1} - \mu_{cort0})^2/\sigma^2$ to tend to 0 in such a way that the product, η^2, remains constant, we obtain a diffusion process with drift μ_+ (or μ_- if no predator is present) and variance η^2.