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Evidence is most heavily weighted in the middle of predictable intervals: testing a behavioural prediction of a neural circuit model of timing and decision making

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It is widely believed that decision makers accumulate evidence until the running total for one of the alternatives (a decision variable) reaches a criterion bound. This bounded accumulation (BA) hypothesis accounts for a large volume of behavioural data from a broad repertoire of visual choice tasks. The underlying premise of BA is that accumulation filters noise, so choices are not based on moment-to-moment fluctuations in evidence or its neural representation. However, the weighting of evidence during accumulation is poorly understood.

We investigated the weighting of evidence by fitting BA models to behavioural data from a two-alternative forced choice (2AFC) task. The models are variants of the Orstein-Uhlenbeck (OU) equation $dx/dt = yx + m + n$, where x is the decision variable, m is evidence and n is white noise with 0 mean. For $y = 0$, this equation predicts that evidence is uniformly weighted in time. For $y > 0$ and $y < 0$, it predicts that early and late evidence is more heavily weighted respectively. Alternatively, y may progress from a negative value to a positive value when decision makers can estimate their temporal constraints, predicting that evidence is most heavily weighted in the middle of decisions (Standage et al, PLOS Comput Biol, 2013).

In our 2AFC task, participants were instructed to indicate whether the direction of coherent motion in a random dot kinematogram was to the left or right, responding on cue after 1s. On half of the trials, coherence was reduced by 50% for 300ms at one of six onset times (100ms, 250ms, 400ms, 550ms, 625ms and 700ms). The results were qualitatively consistent with the prediction of the time-dependent model. We quantified this observation numerically with a Bayesian model comparison, based on approximated Bayesian computation.