Integration of visual information across time

Mordechai Z. Juni[1], Todd M. Gureckis[1], Laurence T. Maloney[1,2]

[1]Department of Psychology, New York University
[2]Center for Neural Science, New York University

Introduction. We examine how observers combine spatial cues to estimate the center of a Gaussian distribution when the cues are presented one at a time in rapid succession. The rule of combination minimizing spatial variance in the estimate is to give equal weight to each cue independent of the order of presentation.

Methods. On each trial, we sampled nine values from a spatial univariate Gaussian (SD = 3.32 cm). The mean of the Gaussian varied from trial to trial. We drew small vertical ticks whose x-coordinate was the sample value and whose y-coordinate was the center of the display marked by a horizontal reference line. Each tick was visible for 150 msec followed by a 150 msec delay between successive ticks. Observers estimated the center of the Gaussian by clicking on the horizontal reference line. Observers completed 200 trials without feedback, followed by 300 trials with corrective feedback indicating the true center of the Gaussian.

Results. For each observer, we estimated the weights assigned to the first, second, etc. tick in the sequence separately for the first 200 trials (no feedback) and the last 200 trials (with feedback). Before feedback, observers assigned unequal weights as a function of temporal order ($F(8,32) = 4.21$, $p < 0.002$). However, after feedback, the weights appeared uniform in time ($F(8,32) = 0.81$, $p > .05$). Crucially, there was a significant interaction between sequence position and the presence of feedback, $F(8,68) = 3.14$, $p < 0.005$, driven primarily by increased weight given to the first three sequence elements prior to feedback, $t(4)=3.166$, $p = 0.03$.

Conclusion. Observers initially assigned more weight to early points than is consistent with minimizing spatial variance. With feedback they moved toward an equal weight minimum variance rule of combination. The temporal integration mechanism used by the visual system appears malleable in the face of corrective feedback.

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