Characterizing and modeling temporal dynamics of perceptual decision making.

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We combined the external noise method (1) with the cue-to-respond speed accuracy trade-off (SAT) paradigm (2) to characterize the temporal dynamics of perceptual decision making. Observers were required to identify the orientation of one of eight briefly presented peripheral Gabor targets (+/- 12 deg) in both zero and high noise. An arrow, occurring in the center of the display cued the observer to the target location 234 ms before the onset of a brief target display; an auditory beep, occurring at one of eight delays (SOA=25 to 800 ms) after the target onset, cued the observers to respond. Five Gabor contrasts, spanning a wide range of performance levels, were tested in each external noise condition. Increasing accuracy of discrimination (d') was measured over processing times from 210 to 940 ms (as a function of SOA to the cue) in each external noise and Gabor contrast condition. All ten SAT functions were well fit by exponential functions with identical time constant and intercept but different asymptotic levels. This suggests that, despite enormous variation in the external noise and contrast energy in the stimulus, and in the ultimate accuracy of performance, information accumulated with the same rate and starting time across all the external noise and contrast conditions. In addition, we conducted a standard response time version of the experiment both before and halfway through the SAT procedure. Data from the response time version of the experiment were all consistent with the speed-accuracy trade-off data, but primarily differed in response accuracy. A simple elaboration of the perceptual template model (3) with a dynamic decision process in which information accumulates with the same rate but with step sizes proportional to the signal to noise ratio in the perceptual representation of the visual input fully accounts for the results.

(1) Pelli, Dissertation; (2) Dosher, Cognitive Psychology'76; (3) Lu & Dosher, JOSA'99.