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A three-stage system is used to characterize the early visual processing of letter arrays within a single eye fixation. Stage 1 represents iconic memory. It acquires information at a rate that depends on retinal location and on the size of and spacing between letters; the contents decay exponentially with a time constant of about 0.3 sec. Stage 2 is an attentional control mechanism that gates the selected information to memory and to other higher-order processes. Stage 3 represents higher-order processes that utilize the outputs of Stage 2. In the paradigms considered here, Stage 3 represents visual short-term memory (VSTM). Additionally, a parallel sequence of processes, not modelled in detail, receives and interprets the cue to attend to a particular location and sends control signals to Stage 2.

To assess the generality of the model, three quite different information-processing paradigms were tested with the same observers and with similar stimulus materials. Exp. 1 introduces a novel choice–attention–reaction paradigm to define the parameters of attentional shifts. A tonal cue instructs observers to switch attention, as quickly as possible, to one of three rows, each of which contains three letter-streams. The observer attempts to report the earliest possible letters from the indicated row. The proportion of letters from a temporal interval Δt_j and location x_i that appears in the report is used to derive a spatio-temporal attention-gating function. Statistically, letters tend to be reported from the same row. Based on a complex correlational analysis, we conclude that attention follows the same time course at all spatial locations (i.e., there is no left-to-right movement of attention even though letters typically are reported from left-to-right).

Exp. 2 uses partial reports and post-exposure masking fields to provide two independent indices of the decay of iconic memory (cf. Gegenfurtner & Sperling, 1993). A tonal cue instructs the observers to report a particular row of a briefly exposed 3x3 letter array which is followed, after a variable interval, by a field of visual noise. The onsets of the tonal cue and of visual noise are independently varied.

Exp. 3 uses whole reports of three-letter rows at different spatial locations in a variety of viewing and cuing conditions to assess visibility as a function of spatial location and neighboring characters.

Stage 1. Let $b(x_i, t)$, $1 \leqslant i \leqslant 9$, represent the information output of Stage 1 at location x_i and time t for a particular type of display; b is a concatenation of four factors: stimulus contrast, local processing rate, letter-adjacency interference, and iconic decay.

Stage 2. Attentional selection is accomplished by multiplying $b(x_i, t)$ by a space-time separable attention function $A_{\text{cue}}(x_i, t) = F_{\text{cue}}(x_i)(G(t - t_{\text{cue}}) - G(t - t_{\text{post}}))$. $F_{\text{cue}}(x_i) = 1$ when x_i is a cued location and $F = 0$ otherwise. $G(t - t_{\text{cue}})$, a function of t that increases monotonically from zero to one, represents the time course of attention being turned on by a cue occurring at time t_{cue}; $G(t - t_{\text{post}})$ represents the time course of attention being turned off at time t_{post}.

Stage 3. VSTM is perturbed by two noise sources: random fluctuations in the internal representation of the current stimulus and residual traces from previous displays. Output is determined by standard signal detection considerations.

For each subject, the three experiments yielded 432 data points based on tens of thousands of observations. The theory, with the same basic parameters for all observations, accounts for 93% of the variance of the data, a very satisfactory prediction considering the range of tasks, spatial locations, and variety of stimuli and of attentional conditions.