Timecourse and Temporal Dynamics of Attention in Visual/Auditory Central/Peripheral Cuing

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Timecourse is a performance signature of attention systems [1]. In this study, an attention reaction paradigm[2] measures the timecourse of attention in visual central (VC), visual peripheral (VP), auditory central (AC), and auditory peripheral (AP) cuing of visual spatial attention. Observers viewed four synchronized letter streams at the corners of a 28 by 28 deg box, while fixating at the center. In each stream, an independent random permutation of 22 letters appeared at 10 /s. Observers were instructed to report the earliest three letters available from the target stream, with payoffs decreasing with cue-report SOA. Four types of cues were used: an arrow at fixation (VC), an arrow adjacent to the target (VP), a tone coming from behind the target location (AP), and tones of four different frequencies at fixation (AC). Experiments were blocked by cue type, in Latin Square order. For VP and VC conditions, the first reported items occurred at about 100 ms and item report peaked around 200 ms post- cue (median 171 ms). In the AC condition, the reported items were from 100 ms to 400 ms (median 226 ms). Most interestingly, in the AP condition, the earliest reported items were simultaneous with the cue and the peak was at 100 ms post-cue (median 96 ms)! The full timecourse functions, or report distributions, were well described by gamma functions: the same shape for VC, VP and AP, a different shape for AC. Moreover, while VC and VP were fit with exactly the same parameters, the best fitting gamma function for AP was shifted backward (started earlier) by 75 ms relative to VC/VP. We conclude that the time courses of VC, VP and AP share the same distribution, but differ in offsets: completely equal for VC and VP and 75 ms faster for AP. AC is qualitatively different.

Interestingly, the differences between cuing conditions were resolved by an analysis that considered report probability as a function of temporal position, relative to the first reported item (rather than the cue). A computation model of attention demonstrates that the timecourse function observed in each cuing condition can be accounted for by two temporal functions (1) a general attention gating function, describing the temporal dynamics of attention across all cuing conditions, and (2) an opening time distribution, specific to each cuing condition, describing the probability of opening the attention gate as a function of time. These results suggest that, as previously shown[3], but contradictory to common belief, the same temporal characteristics underlie performance in different cuing conditions.

1. Posner (1980), QJEP, 32, 3-25.
2. Reeves & Sperling (1986), Psych Rev, 93, 180-206.
3. Lu & Dosher (2000), JEPHPP, 26, 1534–1548.
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