Temporal Selection is Continuous and Deterministic; Responses are Probabilistic.

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Experiments investigating attentional selection average across trials to infer the distribution of selection on one trial (Botella & Eriksen, 1992; Shih & Sperling, 2002). It is often assumed that the frequency with which a particular item is reported across trials is the same as the degree to which that item is selected on every trial. Others question this assumption, arguing that only a single item is selected on any given trial, and the distribution observed across trials results from intertrial variability (Nieuwenstein, Chun, van der Lubbe, & Hooge, 2005). Here we test between the discrete versus continuous models of attention by asking subjects to make multiple guesses of each target so that we could quantify both the between-trial variance and within-trial spread, of attentional selection.

Within-trial spread (or diffuseness) refers to the properties of selection on any one trial. That is, on a given trial, do subjects select one, and only one letter (zero within-trial spread), or do they select several letters to varying degees (non-zero within-trial spread)? Between-trial variance corresponds to the noise in position of selection between trials: given the spread of selection on each trial, is the location of this selection function identical across trials (zero between-trial variance) or does it vary?

We investigated reports of the identity of one cued letter in a rapid serial visual presentation (RSVP) stream. Subjects reported letters distributed around the cue. Given this distribution of reports across trials, there is a continuum of possible contributions of between and within trial variance, each implying different dynamics of attention. If all of this variance is between trials, and there is no within trial variance, then selection is discrete on any given trial. This result would undermine all previous research using the distribution of reports across trials to infer that attention operates continuously, i.e. with varying strengths of attentional allocation or dynamics of selection. Similarly, any finding of within-trial spread would have important ramifications. Bimodal ratings of conscious perception (Sergent & Dehaene, 2004) suggest that conscious access may be a discrete phenomenon. However, these results will need to be reevaluated, if our analyses show any within trial variance: this will suggest that the 'reportability' of items on a given trial is not discrete, but continuous.

In the present experiment, because there were no repeated letters on any trial, we could identify the exact serial position of the reported letters. From this, we could compute the distribution of the letters guessed on each of four sequential guesses.

All guesses 1-4 appeared to be distributed roughly identically, with increasing levels of chance reports on later guesses. Moreover, second guesses were usually adjacent to first guesses. This reliable relationship between the first and second guess indicates that the distribution of reports around the cue on the second guess is not simply due to trials where subjects made a motor error and pressed the wrong button for the first guess: on any one trial, more than one letter is selected. Therefore, at least some of the total variance we see in the distribution of second guess reports is attributable to within-trial spread.

To measure how much of the variance is between-trials, we exploited the idea that any between-trial variance should affect Guess 2 reports and Guess 1 reports similarly, such that Guess 2 reports should depend on the serial position of Guess 1 reports. So we computed the distribution of guess 2 reports separately for each guess 1 serial position. The resulting distributions of guess 2 reports did not depend on the serial position of Guess 1. Instead, Guess 2 reports appeared to be sampled from the same distribution as Guess 1 reports. This indicates little if any between-trial variance, since variability in the serial position of the within-trial spread of selection would manifest itself as dependence of the guess 2 distribution on the serial position of guess 1. Thus, it seems that temporal attention selects not a single letter, but a a subset of letters, from the RSVP stream. The subset that is selected, and the degree to which each letter in that subset is selected, appear to be determined by the position of the cue, with little, if any noise across trials. Responses (guesses) are then sampled independently from the probability density corresponding to this 'selection'. A model based on this account provides a good fit to the observed data.

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