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TO THE EDITOR: Distinguishing targets from distractors is crucial for goal-directed behavior and areas related to visual attention—including the lateral intraparietal area (LIP) and the frontal eye field (FEF)—have robust target-selective neural responses. The onset of significant target-distractor selectivity (target selection time [TST]) strongly correlates with behavioral reaction times (RTs) during visual search (Bichot and Schall 2002; Ipata et al. 2006; Thomas and Paré 2007).

However, a recent study from our laboratory (Balan et al. 2008) reveals a dissociation between TST and RT. We found that increasing the number of distractors (set size) during search lengthened RT and globally lowered firing rates in LIP, but did not affect TST. Subsequently Cohen et al. (2009) showed that increasing set size did in fact elevate TST in FEF. These authors speculated that we failed to find an effect in LIP because the behavioral effect in our study—though significant—was insufficiently large. We believe the data speak against this interpretation and suggest that TST does not capture the RT variability induced by the set-size effect.

In our study the relationship between TST and RT depended not on the range but on the *source* of RT variance. We found no TST–RT correlation *across* set sizes: RT significantly increased with set size, whereas TST remained constant (Fig. 1, *A* and *B*). However, by examining data *within* a set size, we did find the expected correlation: TST was longer on trials with longer RT relative to those with shorter RT (Fig. 1, *C* and *D*). These different outcomes were not due to the range of the RT effect. Across set sizes, the average difference in RT (Fig. 1*B*, large symbols) was nearly identical to the difference that had produced excellent TST–RT correlations in prior experiments (Bichot and Schall 2002; Ipata et al. 2006; Thomas and Paré 2007). Conversely, within a set size, correlations were found even in the subset of the data in which RT differences matched those in the across set-size analysis (Fig. 1, *C* and *D*, dashed lines).

Our results suggest that RT variance arises from multiple sources that have distinct neural signatures in LIP. Variability that is internally generated, within a constant search condition, modifies primarily target-related responses and target–distractor selectivity. In contrast, variability generated by external distractors modifies responses to both targets and distractors without affecting target selectivity (the difference between target and distractor responses). Balan et al. (2008) showed that the set-size effect in RT was significantly correlated with the decline in firing rates across set sizes, upholding the well-established role of LIP in target selection (Gottlieb 2007).

The discrepancy between the FEF and LIP results is not as large as appears at first sight. Cohen et al. (2009) report that firing rates in FEF were suppressed by additional distractors by an amount similar to that in LIP, but these authors did not examine whether this decline correlated with the behavioral set-size effect. The authors also did not report whether the set-size effect was correlated with the increase in TST. Moreover, the TST differences they report were but a small fraction of the RT differences (e.g., ~20 vs. ~100 ms between set sizes 2 and 8), standing in marked contrast with prior studies that found equal and highly correlated changes in the two variables (Bichot and Schall 2002; Ipata et al. 2006; Thomas and Paré 2007). This modest TST effect may be due to any of a number of differences in task design, most notably the fact that their study used a saccade motor report, compared with a bar release in Balan et al. (2008). Thus there is no strong evidence that the TST uniquely captures the set-size effect in either LIP or FEF.

In summary, the best-documented neural correlate of the set-size effect is the decline in firing rates produced by visual clutter, which most likely reflects competitive interactions between simultaneous visual inputs (Kastner et al. 1998). Although the TST is a well-known metric of neural activity, it does not seem equally powerful in capturing all sources of variance in performance.

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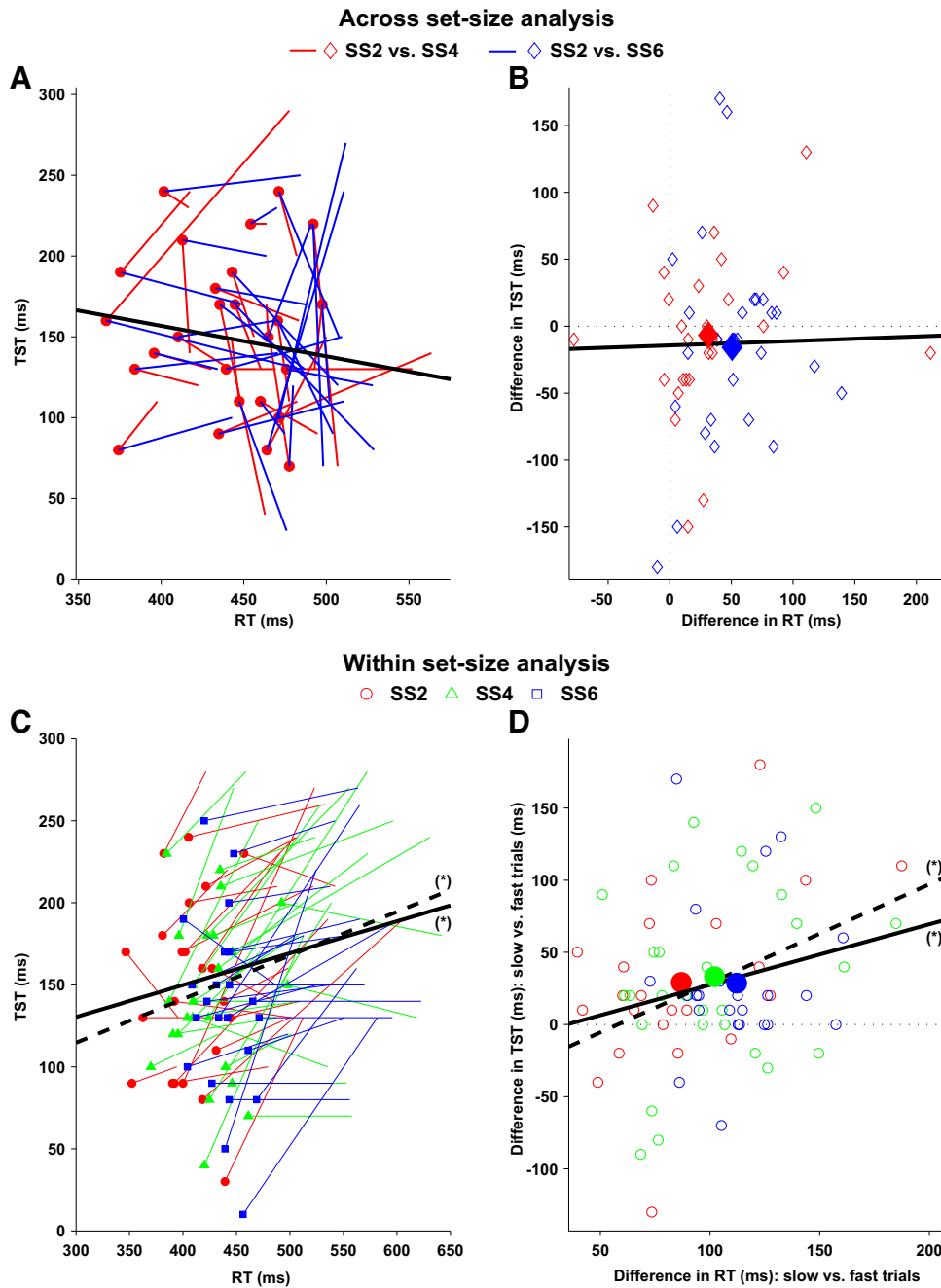
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FIG. 1. Relationship between target selection time (TST) and reaction time (RT) across set sizes (*A*, *B*) and within set size (*C*, *D*). *A*: each neuron is represented by 2 vectors, starting at the coordinates for set-size 2 (dots) and ending at those for set-size 4 (red) or set-size 6 (blue). The solid line is the least-square regression through all data points. There is significant relationship between TST and RT. *B*: the difference in TST as a function of the difference in RT. Large symbols show average data. *C* and *D*: similar to *A* and *B*, but comparing trials with RT above and below the median for each set size. The solid line shows the regression through all data points. The dashed line is the regression among subsets of points where the RT effect was <100 ms (average 50 ms, comparable to the across set-size analysis). Stars in parentheses indicate $P < 0.05$ for the slope and overall regression. The results were similar if the data were expressed as fractional change (difference normalized by average RT and TST).