

Response to Weinberg Journal Club

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Here, Weinberg proposes that the ability to flexibly vary reaction times according to task difficulty requires movement initiation to depend, at least in part, on the state of movement preparation; consequently, contrary to our claim, these two processes may not be independent. We contend that this theory is difficult to reconcile with our empirical findings. In particular, we found that subjects occasionally initiated their movements prematurely, committing spontaneous errors. Such errors would seem unlikely to occur if movement initiation were contingent on movement preparation. The apparent correlation in our data between preparation time and initiation time (which is not in fact significant; $\rho = 0.43$, $p = .20$) is just as in-keeping with our independence model as with the alternative theory; if a given subject is generally slow to prepare movements then the average time of movement initiation should also be slower.

How could movement initiation be flexibly adjusted according to task difficulty, if not through an interaction between movement preparation and movement initiation? We suggest that the apparent difficulty arises from a conflation of the process of forming a decision and the process of preparing the associated action. Although a complex decision must ultimately be registered through movement, the movement itself is usually a trivial one. We propose an alternative link between decision making and movement preparation in which the motor system continuously tracks the current state of the decision and maintains a prepared movement that is appropriate given current beliefs (Haith et al., 2015). Indeed, there is a large body of evidence that the state of on-going decisions is reflected in motor areas (Gold and Shadlen, 2000; Selen et al., 2012; Kaufman et al., 2015). This prepared movement is ready to be initiated as soon as a commitment is made on the decision, however long that may take. Critically, movement preparation does not influence either the decision itself, or the time at which the movement is initiated. Thus, preparation and initiation of the movement associated with a decision depend on different aspects of the decision; preparation depends on currently available evidence, while initiation depends on the time of commitment. According to this view, therefore, flexible decision times should not be viewed as a counterexample to independent preparation and initiation of movement. On the contrary, they are *enabled* by it.

In support of this framework, models of decision-making attribute around 100-300 ms of the reaction time to 'non-decision time'. We suggest that this delay may be related to the systematic 78 ms delay we identified between preparation and initiation. Interestingly, a study by Resulaj and colleagues (Resulaj et al., 2009) assessed decision-making in a pair of conditions directly analogous to our "Free RT" and "Forced RT" conditions. Their results show that, within-subject, non-decision times were 82 ms longer in Free RT conditions than in Forced RT conditions - a remarkable agreement with our findings for reaching movements to spatial targets. Therefore, the seemingly unnecessary delay in initiation that we observed appears to be preserved regardless of decision difficulty.

References

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