Response to Shepherd

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Summary of response. In our recent work (Isham et al., 2017), we examined Benjamin Libet's hypothesis that consciousness has a causal role in cognition. Libet offered that the deliberation window, which takes place between the time of conscious intent (W) and the time of the motor response (MR), is a period in which to deliberate and cancel a decision to act. In our study, we compared the duration of the W-MR window when making easy and difficult decisions. We found the window in the easy decision trials longer than the time window in the difficult trials. These results suggest several interpretations including the idea that consciousness may have a causal role. However, such involvement may not be as straightforward as assumed by Libet's theory. The discussion in this forum is to further speculate on our findings and alternative explanations, and to urge further empirical investigation of this time window.

According to Libet's perspective, the temporal window between the moment of conscious awareness to act (time W) and the time of action (motor response, MR) is when consciousness can provide a functional contribution to action. Specifically, Libet's theory posits that this is the period in which an unconscious decision is made conscious and the decision undergoes deliberation and potential cancellation (e.g., Libet, 2005). Libet coined the term "veto window" to reflect the cancellation process. However, it is unclear exactly whether the veto window exists and if so, how it works. Therefore, in our study, we used the term "W-MR period" to refer to the onset and offset of the temporal window rather than as a label of its (potential) function as a veto window.

The goal of our study (Isham, et al., 2017) was to test whether Libet's postulate that the W-MR window serves the purpose of decisional cancelation. If true, the effect could potentially speak to the function of consciousness such that conscious thought is needed to alter behavior.

We employed a task that required participants to make decisions of varying degree of difficulty, and measured the length of the W-MR window. Based on Libet's theory and decision-making literature, one would anticipate a shorter deliberation period for easy decisions and longer deliberation period for difficult decisions. However, this is not what we observed. Our results showed that the temporal window is *longer* in the easy-decision condition than in the difficult-decision condition.

One of several interpretations of the results posits that deliberation in the "veto window" is only necessary for the easy (and perhaps automatic) decisions. In such cases, easy decisions are likely made unconsciously and automatically, thus entering the conscious window W-MR, at which time the decision is rechecked and redeliberated. On the other hand, the difficult decisions are handled differently and are reached only after active, conscious deliberation. Therefore, W-MR is minimized as this time window is not necessary to verify the decision that has already been consciously made.

Such interpretations raise questions about Libet's deliberation theory and the role of consciousness in decision making more generally. However, we can only speculate on these issues as alternative interpretations that potentially challenge our results. These alternative explanations are described in detail in the original paper, and some are highlighted below. The

discussion here also addresses some of the constructive comments raised by Joshua Shepherd in this forum. I hope that our original findings along with healthy discussion in this forum will lead to a better understanding of the mechanisms of the W-MR and the role of consciousness.

Other interpretations of the results.

As discussed in our original paper, the shorter W-MR in the difficult trials may reflect the process in which the deliberative process begins before the participants commit to the decision time (i.e., time W). In this manner, participants perform minimum deliberation after the moment W; consequently, the temporal window between W and MR becomes shortened. This model would be similar to what Shepard proposed in the commentary.

To investigate this possibility, one could examine brain activity prior to time W as a measure of deliberation. If so, one would be able to conclude that at least some deliberation occurs outside of the W-MR window. Along these lines, one could also try to restrict the deliberation process prior to time W. This restriction would facilitate deliberation within the W-MR window, and subsequently could result in the W-MR window of the difficult decision trials being the same length, or possibly longer than the W-MR window of the easy decision trials. Such results would support the possibility that deliberation can occur outside of the W-MR window in our original research. Subsequently, this would add additional evidence to challenge Libet's view that the W-MR window is the ultimate time period for deliberation and cancelation. Experimental paradigms mentioned here are under development in our lab.

In our manuscript (Isham et al. 2017), we have also offered retrospective construction as a possible explanation as to why the W-MR window might be more compressed in the difficult decision trials. It could be the case that the judgment of difficulty retrospectively influenced the W reports such that the perceived difficult decisions resulted in later W judgments and perceived easy decisions resulted in earlier W judgment. The reverse could also be true: an early W prompted an easy rating and a later W prompted a difficult rating. Unpublished preliminary data suggest the latter as a strong possibility. However, this does not mean that it is the only explanation.

Methodological concerns.

Our study was a starting point in an attempt to ecologically examine the veto window, causality, and intention. To meet the ecological requirement, our participants performed a decision making task and the stimuli varied in terms of decisional difficulty. In this way, our task better represented real world decision making compared to Libet's wrist flexion task. In our paradigm, the participants judged whether they agreed or disagreed with the statements shown on the screen, and indicated their decision using a button on the keyboard. Shepard pointed out that our paradigm might not reflect a decision to act and instead represented a decisional judgment of agreement or disagreement. Responding to Shepard, one could say that the motor response in our study is part of the decision process. Despite the fact that it indicates an agreement decision, it is part of the decision to act. However, I do agree with Shepard that the decision to act could be further isolated from the decision to agree to act. We are currently pursuing this in the laboratory so that a decision requires an action (e.g., one explores and navigates a novel environment and decides on which path to take).

In response to Shepard's concern about language use and the intructions given to subjects, the word "inklings" and the word "decision" did not make a difference in our pilot

data. Given our goal of closely representing Libet's original work, we chose the word "inklings" in our instructions.

Final remarks.

Our results and a set of alternative interpretations of what the W-MR window may represent call for further investigation, particularly when examined in the context of complex decisions. We continue to investigate the involvement of W-MR in decision making and our paradigms and results are encouraging in that the W-MR window has the potential of shedding new light on the function of consciousness.