LETTER

REPLY TO DEECKE AND SOEKADAR:

Do conventional readiness potentials reflect true volitionality?

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We would like to thank Deecke and Soekadar (1) for their insightful comments on our paper (2). We agree that the voluntary movements in our study were not fully unconstrained. A green light was used to indicate to the participant that a trial had started. This indeed raises the question whether our results generalize to movements without external cueing. Please note that, in our study, the green light is not a response trigger. It indicates the onset of a self-timed waiting period that is followed by an open-ended period during which movements could be freely made. In contrast to many studies on the readiness potential (RP), our study did not require participants to move within a specific time. Thus, there are still considerable degrees of freedom in action timing.

The presence of external stimuli has previously been argued by Deecke to disturb "volitionality" (3). Although we share the desire to study true volitionality, it is unclear whether this has been achieved in any previous experiments on RPs (3–6). The main target of our study (2) was the experiment by Libet et al. (4). There the time window where participants could move began immediately following a cue (the completion of one rotation of the dot clock). In contrast, in our study, participants had to wait at least 2 s after the last cue before being allowed to move at any time. Thus, in the Libet et al. experiment, the response window is more directly triggered by external stimuli than in our case.

Consider another typical RP experiment (6): Participants were instructed to move irregularly with a minimum delay of 3 s between movements. This is similar to our case: An event is defined (in their case, a previous movement; in our case, a green light), which is followed by a delay of a few seconds after which the participant is allowed to move. Thus, upon closer inspection, the timing constraints here are very similar to our work. The only experiments we can think of with truly unconstrained movements are those on free behaving patients with implanted electrodes during presurgical diagnostics, where "real-life," "nonexperimental" behavior is observed (7). Most other studies on RPs involve explicit requirements (or implicit demand characteristics) for the timing of movements. Importantly, in stop-signal experiments as ours, it is largely impossible to avoid imposing temporal structure on movements. The offset of the red stop signal after a trial provides an external cue that the next movement window has started. Such temporal structure is unavoidable as long as stop signals are involved. Finally, we would like to point out that our data do not reflect a contingent negative variation (CNV) (8) triggered by the light that starts a trial (for details, see Fig. 1).

Thus, taken together, we share the authors' (1) ultimate ambition to study true volitionality; however, this sets a goal post that has not been reached by previous work on the RP, and it is unclear whether it is obtainable at all in studies involving stop signals.

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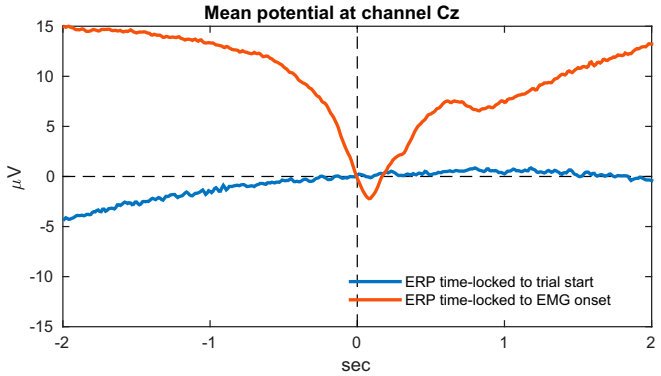

Fig. 1. Reanalysis of event-related potentials from our study (2) time locked to either movement onset (red) or the trial start with onset of the green light (blue) and baseline corrected at time 0 ms and averaged across participants. Within the first 2 s of the trial (before participants are allowed to move), there is no evidence of a negative-going EEG signal in the blue trace as would be expected in the case of a CNV (8).

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