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Spontaneous action initiation with temporal constraints on the response time: an MEEG study

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Abstract

The Readiness Potential (RP) is a slowly increasing surface-negative potential that precedes spontaneous movements. It evoked interpretation proposed by the Gilbert-Davidson Model (Gilbert & Davidson 2010) suggests that this noise level could be the result of excitatory spontaneous ongoing sub-threshold fluctuations in neural activity. According to the model, the sub-threshold fluctuations are critical to the preparation of action, after the external trigger is set, in an almost static slow fluctuations will persistently occur or is better from the classical-standpoint for initiating action in an integration-to-bound fashion where 'noise' is the best integrated one time over time.

In particular, we predict that: movements more likely happen at a 'crest' of these ongoing fluctuations, and less likely happen at a 'valley'. In classical RP studies subjects are instructed to make a movement (e.g., a button press) after a fixed inter-trial interval (ITI). However, we suggest that instructions could better evoke the movements whenever they use less time to decide. The time limit variable, regulated by an unannounced stop, and vary among blocks in a controlled system within a task.

Our main prediction is that the spontaneous movement activity in anterior areas of the frontal lobe will appear in time length and be more prominent in the time locked average, as the duration of time within which the subject is allowed to move increases. The temporal constraint is predicted to affect the RP but not the late component of the ERP.

We would like to test whether some of the parameters: the movement-preceding activity in posterior areas of the frontal lobe appear in time length, and vary among blocks in a controlled system within a task.

Model & Predictions

Behavioral activity preceding spontaneous movement will continuously drift in the vicinity to or farther from the decision-threshold for initiating action, making the microscopical RP and not the late component of the ERP an indicator of the movement's anticipation.

The question of 'when?'

When are the movements more likely to begin? What is the momentary state of the neural system to indicate a spontaneous voluntary action in a specific temporal scale and not time?

1. What determines whether an action is initiated is the result of an internal/external process any impact?
2. What is the role of sub-threshold fluctuations in neural activity in the initiation of a spontaneous action (cortical level in a external or internal process)
3. Can we predict parameter variation of the amplitude of the readiness potential as a function of temporal constraints?

Introduction

The Readiness Potential (RP) is a slowly increasing surface-negative potential that precedes spontaneous movements. According to the classical view, the RP reflects a movement-preceding activity in anterior areas of the frontal lobe which will appear to begin earlier, and be more prominent in the time-locked average, as the duration of time within which the subject is allowed to move increases. 2) What is the noisy evidence? 1)

According to the classical view, the RP reflects a movement-preceding activity in anterior areas of the frontal lobe which will appear to begin earlier, and be more prominent in the time-locked average, as the duration of time within which the subject is allowed to move increases. Determining the exact time that movements are actually initiated in the brain is one of the major challenges in the study of spontaneous voluntary actions. A recent interpretation provided by the Gilbert-Davidson Model (Gilbert & Davidson 2010) suggests that this noise level could be the result of excitatory spontaneous ongoing sub-threshold fluctuations in neural activity. According to the model, the sub-threshold fluctuations are critical to the preparation of action, after the external trigger is set, in an almost static slow fluctuations will persistently occur or is better from the classical-standpoint for initiating action in an integration-to-bound fashion where 'noise' is the best integrated one time over time.

In particular, we predict that: movements more likely happen at a 'crest' of these ongoing fluctuations, and less likely happen at a 'valley'. In classical RP studies subjects are instructed to make a movement (e.g., a button press) after a fixed inter-trial interval (ITI). However, we suggest that instructions could better evoke the movements whenever they use less time to decide. The time limit variable, regulated by an unannounced stop, and vary among blocks in a controlled system within a task.

Our main prediction is that the spontaneous movement activity in anterior areas of the frontal lobe will appear in time length and be more prominent in the time locked average, as the duration of time within which the subject is allowed to move increases. The temporal constraint is predicted to affect the RP but not the late component of the ERP.

We would like to test whether some of the parameters: the movement-preceding activity in posterior areas of the frontal lobe appear in time length, and vary among blocks in a controlled system within a task.

Model & Predictions

Spontaneous movement preceding spontaneous movement will continuously drift in the vicinity to or farther from the decision-threshold for initiating action, making the microscopical RP and not the late component of the ERP an indicator of the movement's anticipation.

Methods & Design

According to our model, the movement-prediction continuous drifts randomly closer to or farther from the decision-threshold for initiating action in an integration-to-bound fashion where 'noise' is the best integrated one time over time.

We also analysed the relationship between the (Wt-RT) and the timelimit condition but we didn't find any significant difference. For the prefrontal/parietal alpha activity we did not find any difference that were reporting (P<0.05) to the best of our knowledge. These results are still ongoing and do not reflect the current follow-up study where we are examining the late component of the ERP.

Discussion

We also examined the differences between the (Wt-RT) and the timelimit condition but we didn't find any significant difference. For the prefrontal/parietal alpha activity, we did not find any difference that were reporting (P<0.05) to the best of our knowledge. These results are still ongoing and do not reflect the current follow-up study where we are examining the late component of the ERP.

Results (2): ERP

EEG data were analysed with Matlab (Mathworks), no. 14. Mean RP amplitude for 3 subjects was calculated, and the mean for each time limit condition and the other conditions was averaged (tstat= -2.6, p= 0.006). The effect of increasing temporal freedom was significant, the infinity condition was higher than all the other conditions, and the meaning of the ERP the amplitude seems to linearly increase with the temporal freedom. The late component of the ERP was also examined in all the conditions, and the meaning of the ERP the amplitude seems to linearly increase with the temporal freedom. The same kind of dissociation seems to hold for the block order effect, only present when we look at the mean ERPs and specific to the first experimental condition, suggesting a difficulty in comparing the results of each time limit condition across subjects. Unexpectedly we did see an effect in the Late part of the RP and not in the Early part.

Results (3): ERP

Measure RP amplitude and compare with the response of a significantly delayed movement. 

References

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