Corticospinal excitability while acting jointly: A registered TMS study

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Introduction

Acting together is a pervasive feature of human sociality.
It has been suggested that when people act together, their actions can be coordinated in virtue of a shared intention. Alternatively, collective goals may be represented motorically, so that motor representations may enable joint actions and provide interpersonal coordination around goals [1].

However, despite behavioral evidence suggests that agents' motor plans might be related to collective goals [2], direct neurophysiological evidence of whether collective goals are motorically represented is still scarce.

Objective

Here, we aim at assessing whether collective goals are represented within the cortical motor system, in a neurophysiological study.

Methods

The study has been submitted as Registered Report (RRs) [3] and granted In Principle Acceptance. https://osf.io/hjvcm

Paradigm: A participant and a confederate are asked to sequentially perform a two-choice reaction time task in which they shoot a ball to a target. Participant's motor-evoked potentials (MEPs) are collected during the confederate's turn (Fig 1).
Three relationships are being compared:
Joint: players work together to shoot the ball to a common target
Parallel: each player play independently of each other
Competitive: the outcome of the game depends on the other player performance (as in Joint), but without the collective goal.

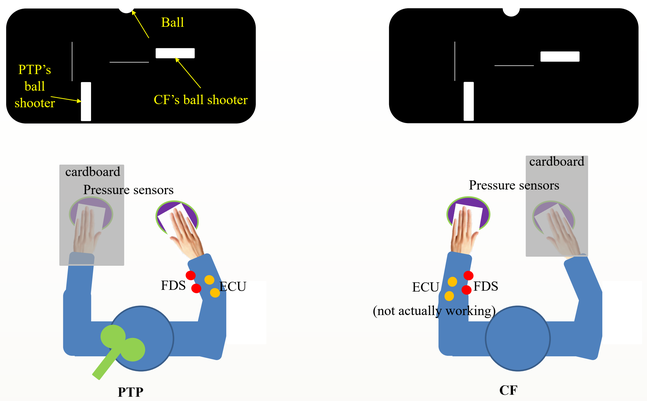
Procedure and exclusion criteria: Registered as in Fig.2

Sample size: 40 participants. Estimated with alpha = 0.02 and power = 0.90 from [4].

Positive control: In a pilot experiment (12 healthy right-handed participants), we showed evidence that MEPs can be manipulated in our experimental setting, exploiting a motor imagery version of our task. Specifically, instead of watching the confederate's performance, we asked participant to imagine performing the correct response with his/her own hand.

Figures

Figure 1. A participant and a confederate sit alongside, watching the same scene on two separate screens. They are asked to sequentially perform a two-choice reaction time task either by extending or flexing the fingers on pressure sensors. With these movements they control pistons on the screen to shoot a ball to a target as fast as possible.
Instructions and feedback on task performance are varied in blocks to create three relationships:
Joint
Parallel
Competitive.
During the first part of the trials, the CF's turn, a single TMS pulse is delivered onto PTP's left motor cortex in order to evoke MEPs in his/her right Extensor Carpi Ulnaris muscle (ECU).
50 MEPs at 120% of rMT are recorded for each movement and for each condition.



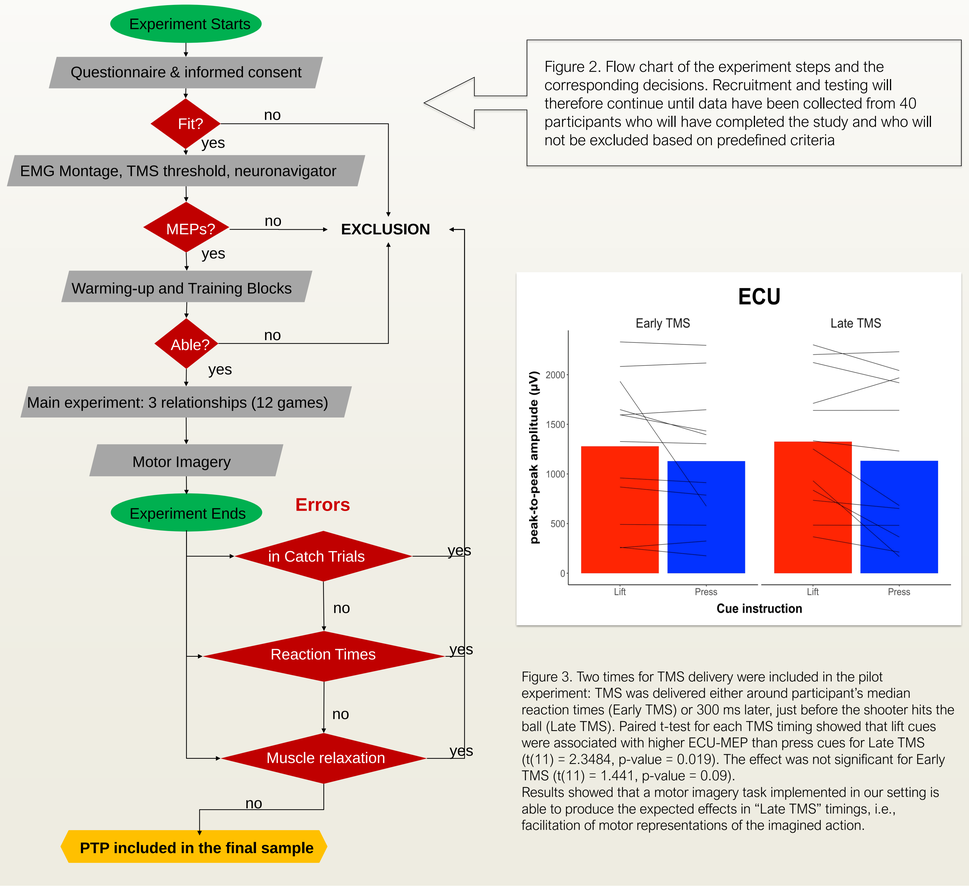


Figure 2. Flow chart of the experiment steps and the corresponding decisions. Recruitment and testing will therefore continue until data have been collected from 40 participants who will have completed the study and who will not be excluded based on predefined criteria

Figure 3. Two times for TMS delivery were included in the pilot experiment: TMS was delivered either around participant's median reaction times (Early TMS) or 300 ms later, just before the shooter hits the ball (Late TMS). Paired t-test for each TMS timing showed that lift cues were associated with higher ECU-MEP than press cues for Late TMS ($t(11) = 2.3484$, p-value = 0.019). The effect was not significant for Early TMS ($t(11) = 1.441$, p-value = 0.09).
Results showed that a motor imagery task implemented in our setting is able to produce the expected effects in "Late TMS" timings, i.e., facilitation of motor representations of the imagined action.

Analyses

Hypotheses:
If a motor representation of joint actions is present in M1:
- Participants' MEPs should be modulated according to the action of the confederate.
- MEPs modulation should be greater in the Joint condition than in the Parallel and Competitive conditions.

Planned analyses:
- One-tail paired t-test: ECU-MEPs in "lift" trials higher than ECU-MEPs in "press" trials in the Joint condition
- rm-ANOVA: the "lift-press" difference in ECU-MEPs higher in the Joint condition compared to both Parallel and to Competitive
- One-tail paired t-test: ECU-MEPs higher in motor imagery for lift than press movements (positive control)

Exploratory analyses:
Not defined yet, but still allowed in RRs.

Conclusions

The RRs format increased the quality of the study before data collection, by allowing us to:
- Create precise hypotheses and tailor the experimental design
- Individuate the variable that is most supported in literature
- Define a-priori objective criteria for subject exclusion
- Define sample size
- Provide evidence that MEPs can be modulated in our paradigm before running the main experiment

1) Critically RR allow the publication of any result from the registered analyses, reducing publication bias.
2) RRs still allow us to explore data with unregistered analyses

References

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