«Role of the dopaminergic system during motor interactions in patients with Parkinson's Disease»

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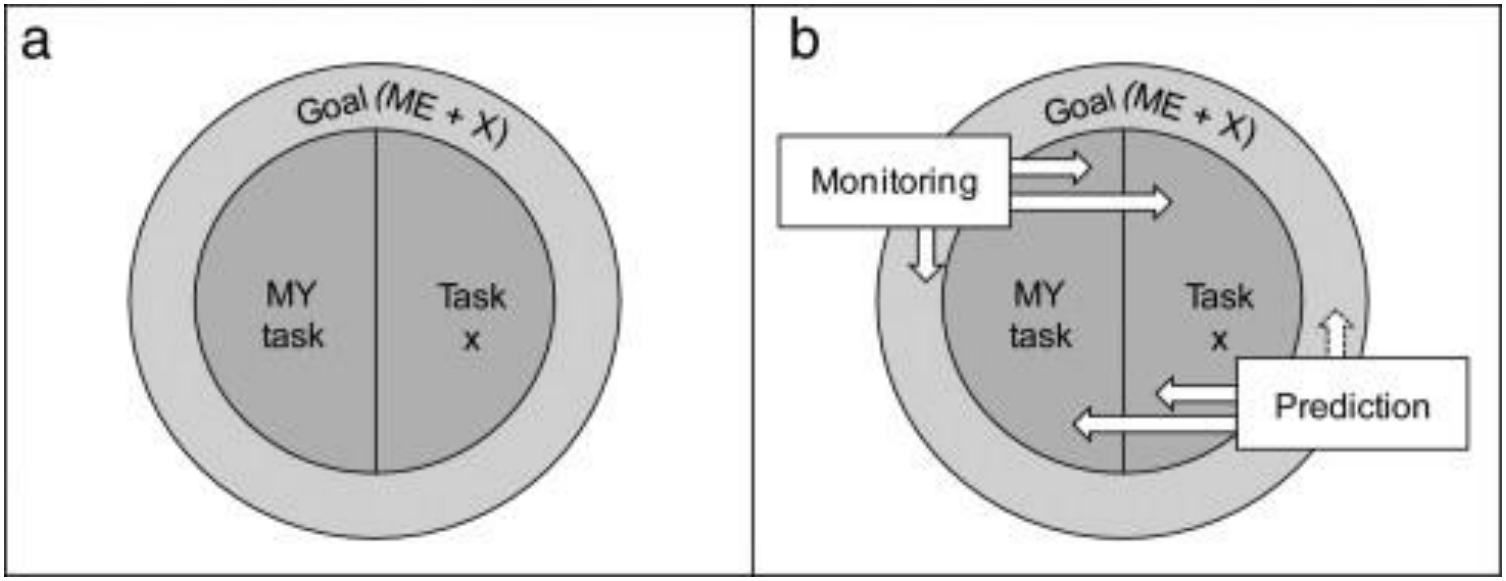
Joint-actions: acting together towards a shared goal

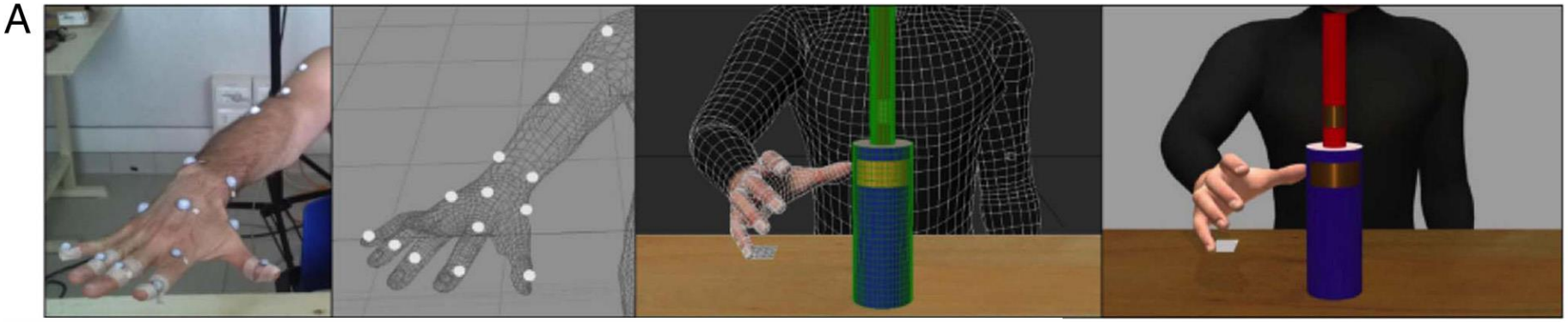


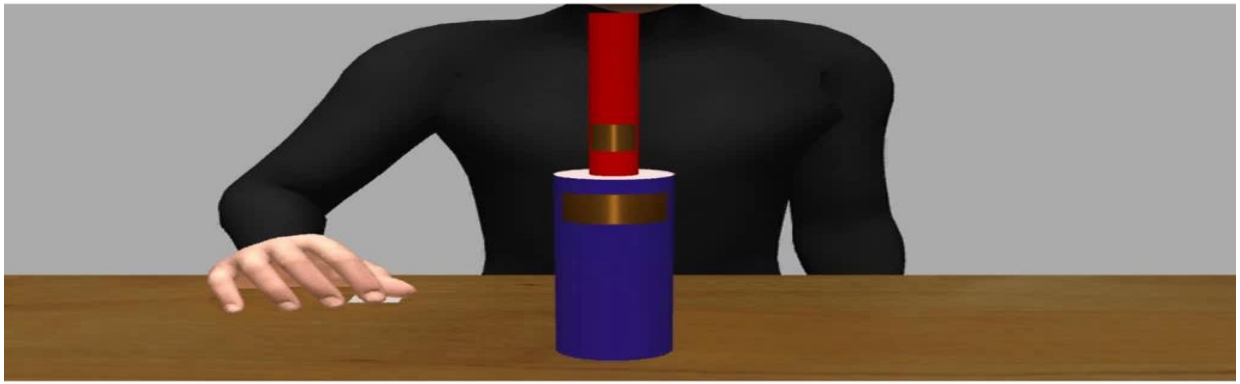
- Any form of interaction in which two or more agents coordinate their actions to achieve the same goal (shared goal) (Butterfill 2012)
- Depends on the abilities: i) to share representations, ii) to predict and monitor actions, and iii) to integrate predicted effects of one's own and others' actions (Sebanz et al., 2006; Vesper et al., 2010).

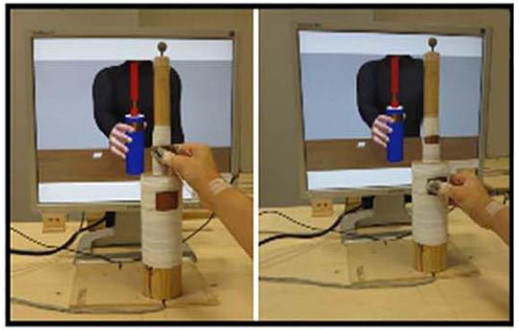
Realistic dynamic contexts in well-controlled laboratory scenarios

Joint-Grasping Task: participants need to predict and monitor their partner’s action to perform their own

Realistic dynamic contexts in well-controlled laboratory scenarios



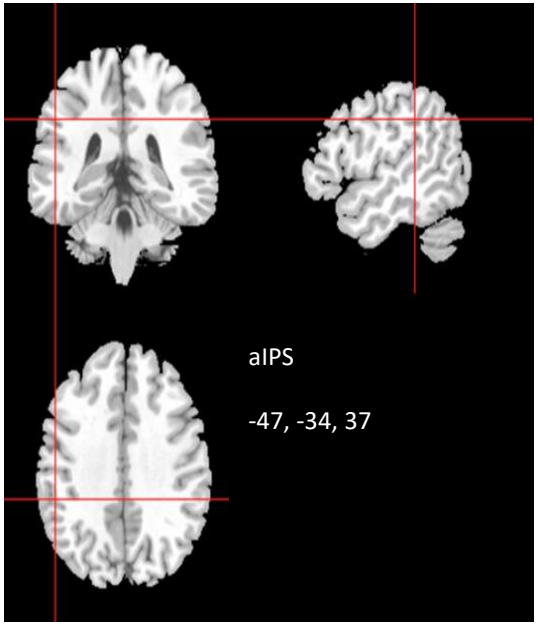


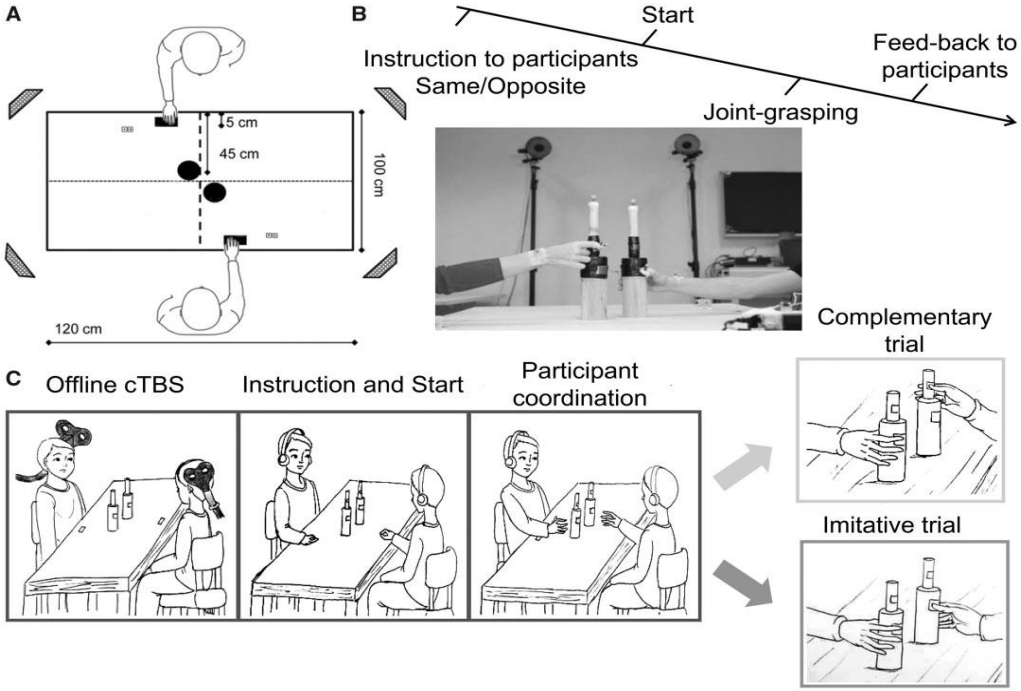


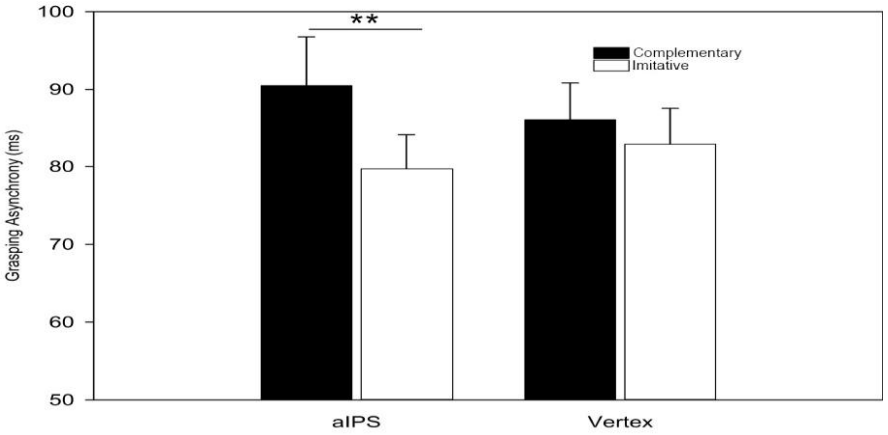
Human-avatar Joint-Grasping Task: participants need to predict and monitor the virtual partner's action to perform their own

Pro: the virtual partner's actions can be controlled by the experimenter

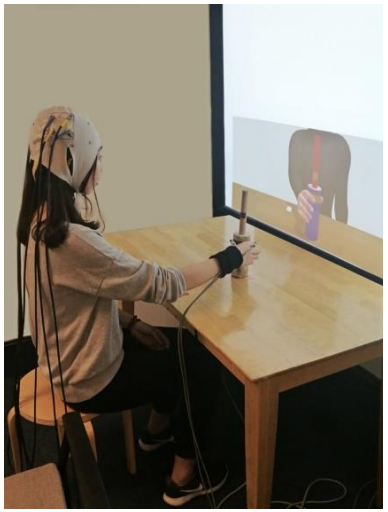
Parietal cortex activity supports the ability to integrate predictions about one's own and others' actions during complementary interactions







Era et al., 2018 SCAN; 2020 Cer Cor
Sacheli et al., 2015 Nat Commun; 2018, JCN

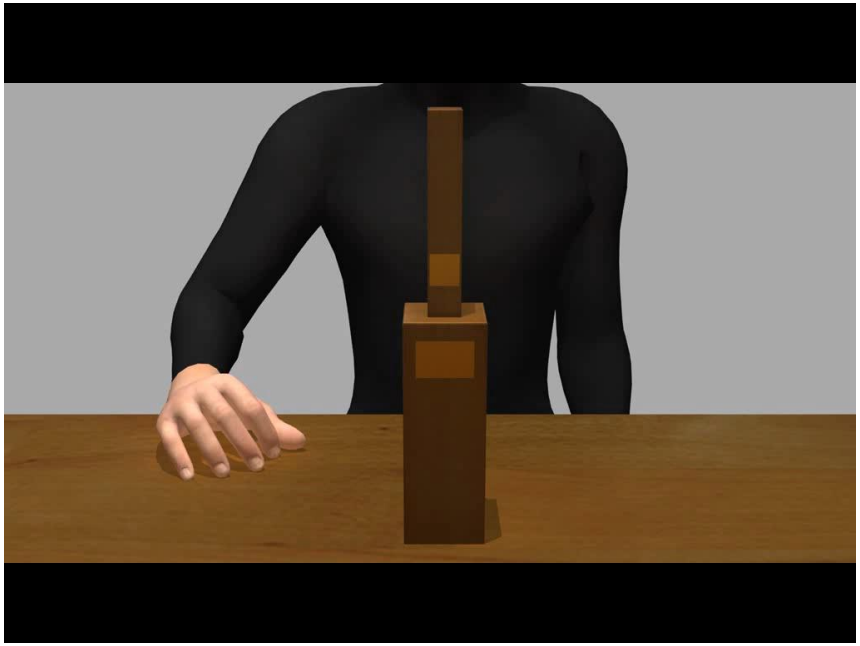


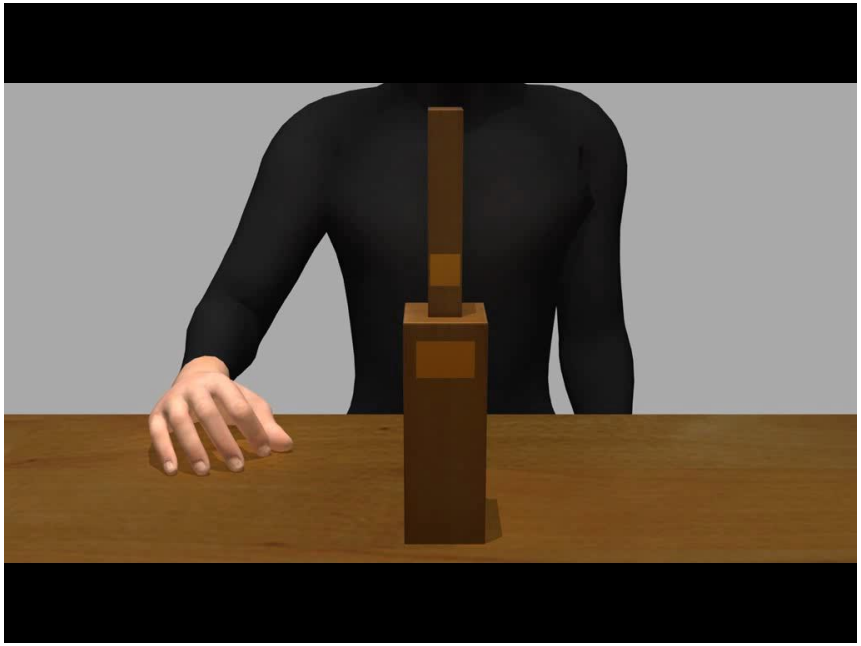
Era and Hamilton, in prep

Action monitoring in interactive scenarios

Dealing with others' errors, by quickly implement new motor plans to avoid unexpected outcomes

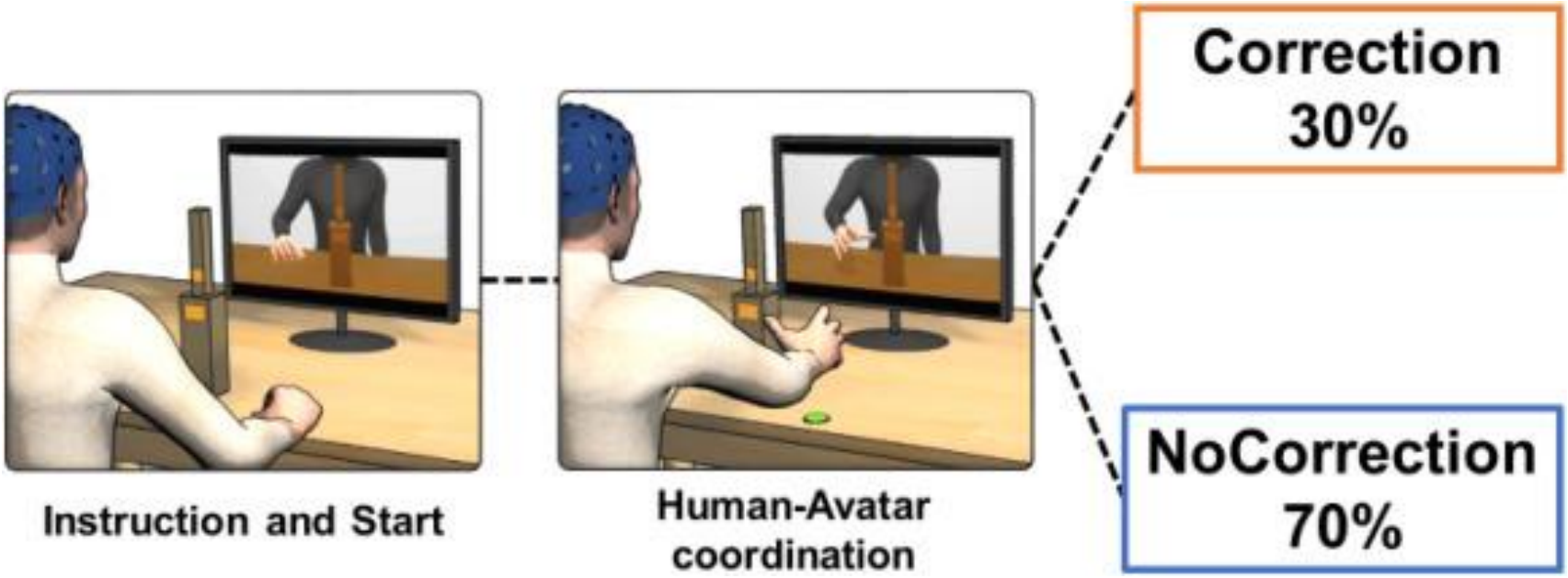
Introducing unexpected changes in the avatar's movement to increase participants' need to monitor its action





What are the behavioural and neurophysiological markers of action monitoring during motor interactions?

Midline frontal and occipito-temporal activity during error monitoring in dyadic motor interactions



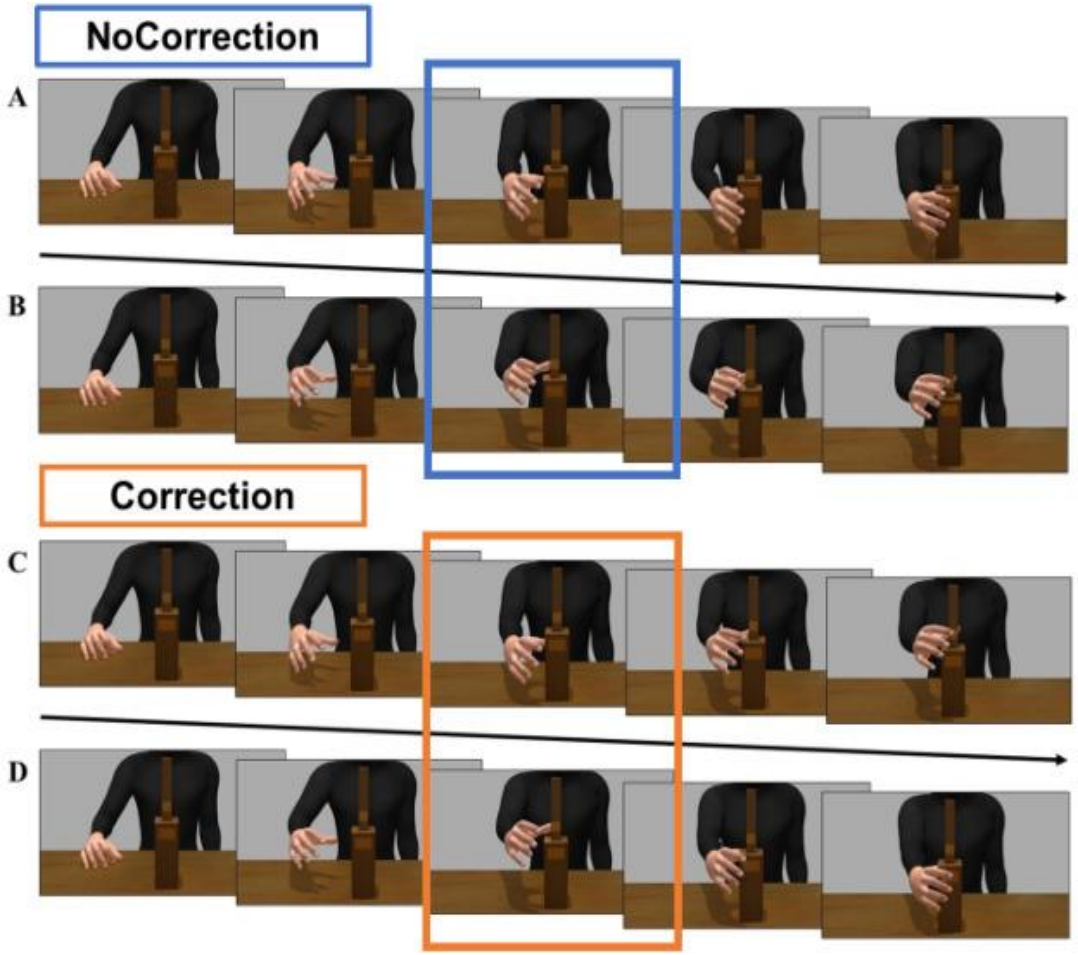
Moreau et al., 2020 Cortex

Midline frontal and occipito-temporal activity during error monitoring in dyadic motor interactions

Cued condition
They know where to grasp the bottle, they only need predict when to grasp it.

Interactive condition
They do not know where to grasp the bottle, they need to predict and monitor what the partner is doing to perform their action.

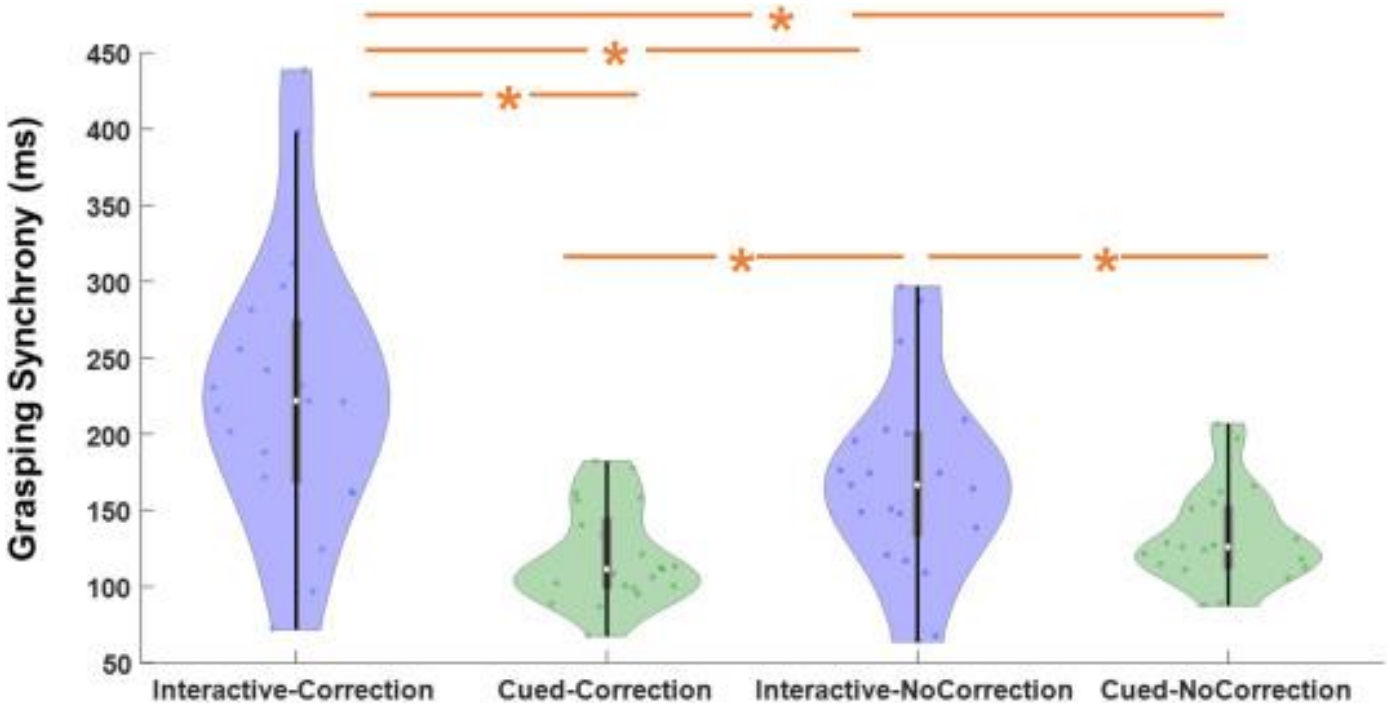
In 30% of the trials the Avatar perform an unexpected trajectory change along the reaching phase and grasped the other site of the bottle-shape object **(Correction)**



Moreau et al., 2020 Cortex

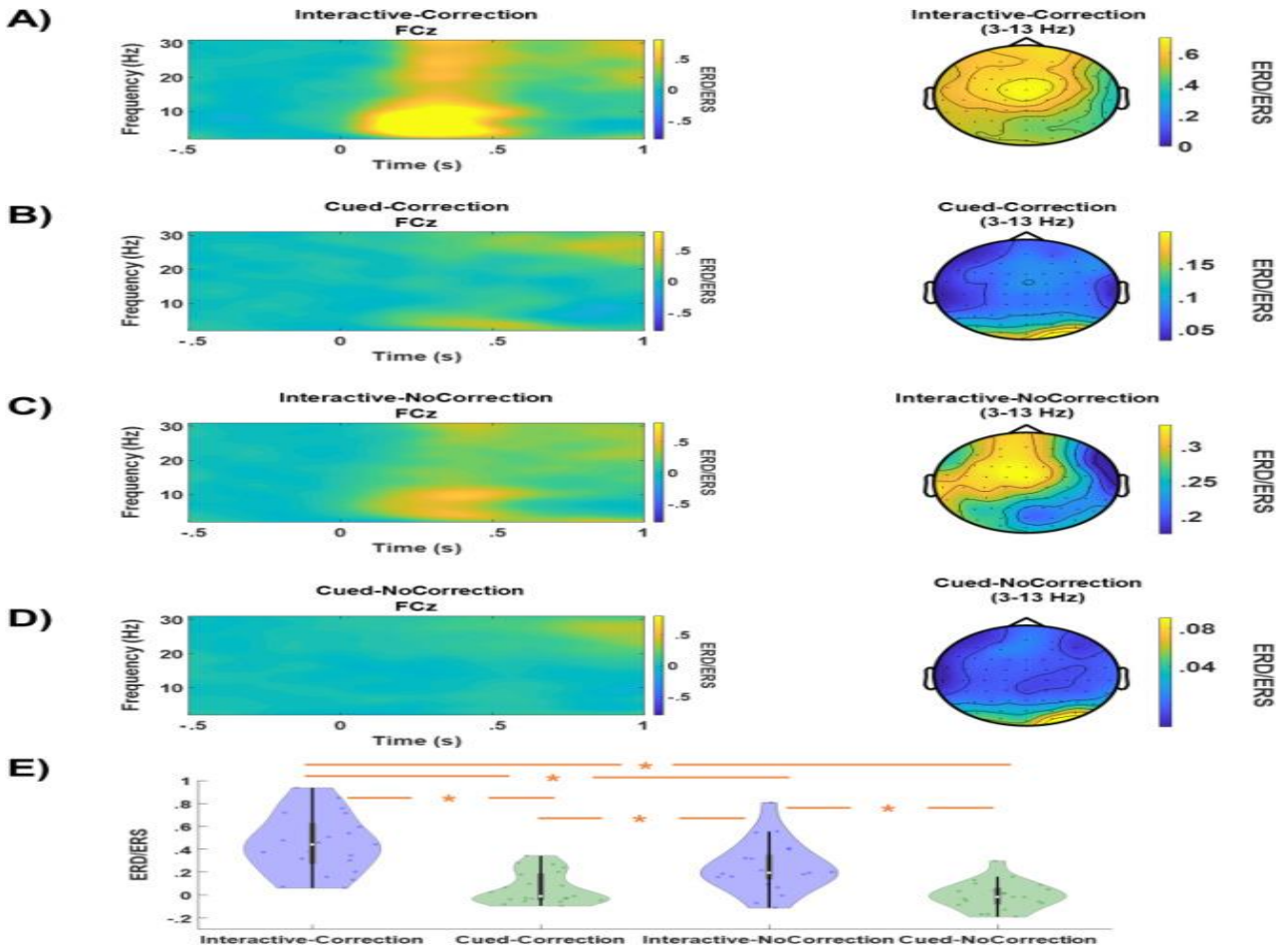
Midline frontal and occipito-temporal activity during error monitoring in dyadic motor interactions

Behavioural performance



Midline frontal and occipito-temporal activity during error monitoring in dyadic motor interactions

EEG activity (Alpha/Theta Power)



Alpha/Theta activity may represent a neural marker of action monitoring during motor interactions.

Moreau et al., 2020, Cortex

Parkinson's disease (PD) as candidate model to investigate the role of the dopaminergic (DA) system in interpersonal motor interactions

- Loss of DA neurons within the BG (Kalia & Lang, 2015), affecting the functional activity of the fronto-striato-thalamo-cortical circuits

- Motor (resting tremor, bradykinesia, muscular rigidity) (Goetz, 2011), cognitive (Cools et al., 2011) and reward-related deficits (Schott et al., 2007)

Parietal and motor regions showing differences in activation between PD and HC during motor tasks

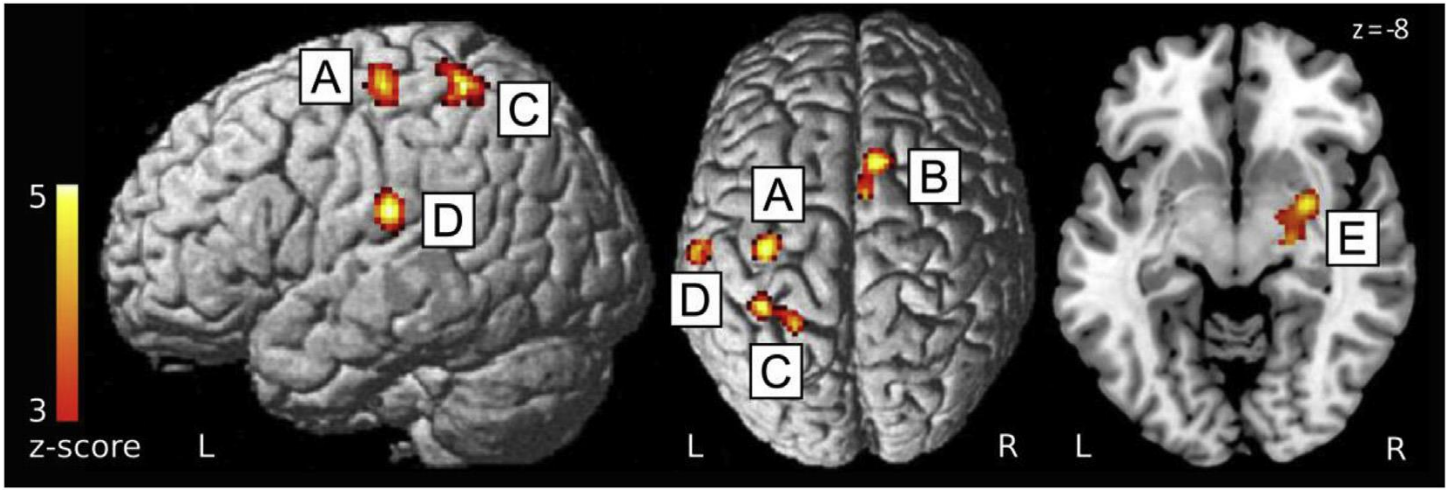


Fig. 1. Convergence of activation maxima for the comparison between PD patients off medication and healthy controls reported in previous functional neuroimaging studies during motor tasks. Activation differences were consistently observed in M1 (A), a cluster spanning preSMA and SMA (B), superior parietal lobule (C), inferior parietal cortex (D) and posterior putamen (E). Activation of posterior putamen was also consistently increased by dopaminergic medication and correlated with differences in PD severity across studies (not shown, see Herz et al., 2014b for more details).

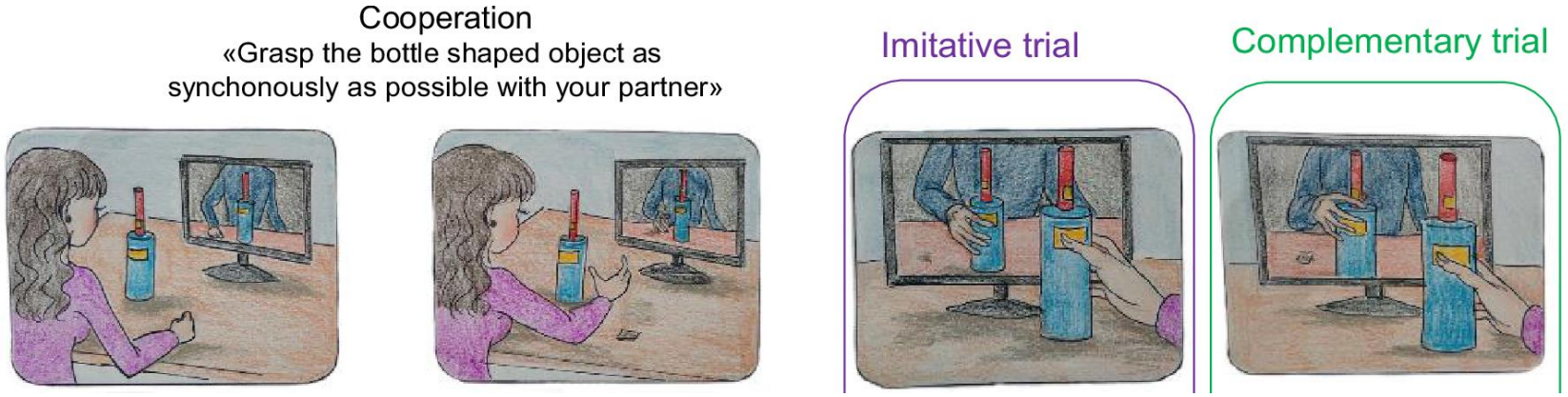
Meder et al., 2019, NI

Parkinson's disease (PD) as candidate model to investigate the role of the dopaminergic (DA) system in interpersonal motor interactions

- PD patients (especially in off-medication condition) show reduced error-related EEG markers (theta power) during performance monitoring tasks (Cools et al., 2011; Pezzetta et al., in prep)
- The role of the dopaminergic system in supporting motor interactions' abilities has never been explored.
- Being performance monitoring a fundamental mechanism for successful motor interactions, we expect PD in Off medication to show worse behavioural performance compared to PD in On medication and HC.

Role of the dopaminergic system in interpersonal motor interactions in PD

The task

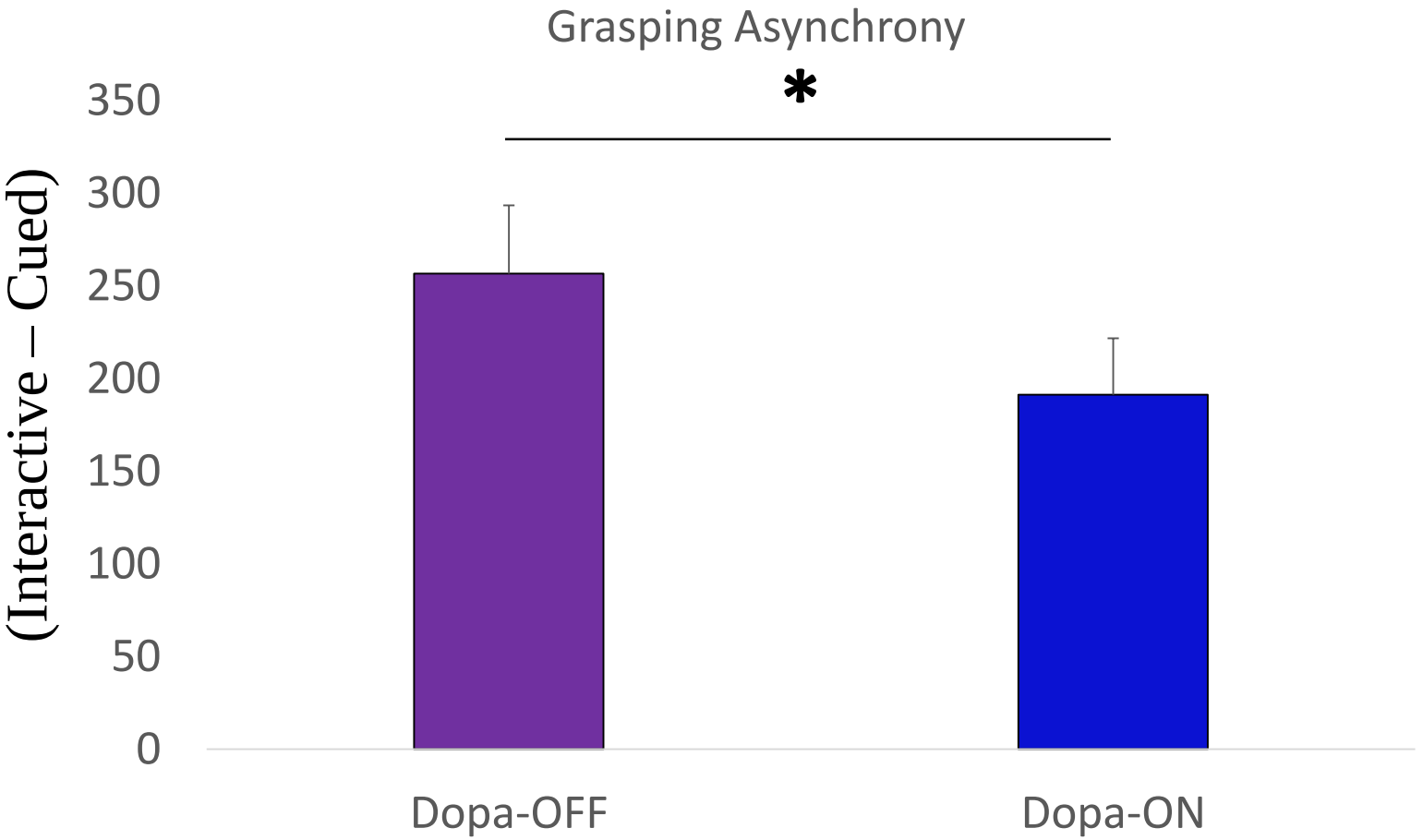


Cued condition
They know where to grasp the bottle, they only need predict when to grasp it.
Interactive condition
They do not know where to grasp the bottle, they need to predict and monitor what the partner is doing to perform their action.
In 36% of the trials the Avatar perform an unexpected trajectory change along the reaching phase and grasped the other site of the bottle-shape object **(Correction)**

Sample
15 Parkinson, 16 HC matched for age and education.
PD patients tested in Dopa-ON and Dopa-OFF. All PD without dementia. All PD were tested with the UPDRS-Motor Scale in Dopa-ON and Dopa-OFF
Interactive-Cued Index on Grasping Asynchrony: measures the ability to coordinate one's own action with the one of the avatar, net of baseline motor abilities
Design 2 (Imitative/Complementary) x 2 (Correction/NoCorrection) x 2(On/Off)

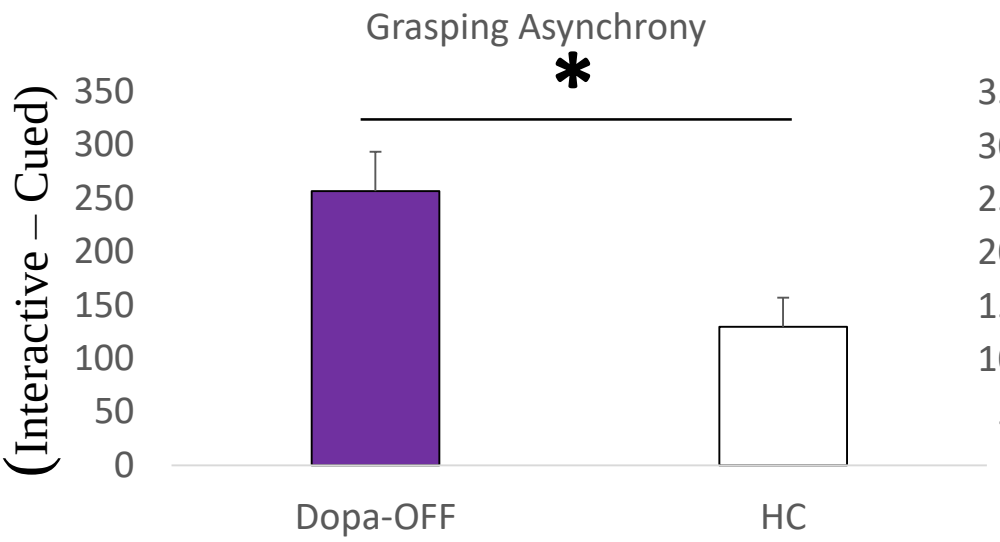
Role of the dopaminergic system in interpersonal motor interactions in PD

Reapeted Measure ANOVA (Within subjects)
Significant main effect of Dopa-ON/OFF
F(1, 14)=7.4, p=.016

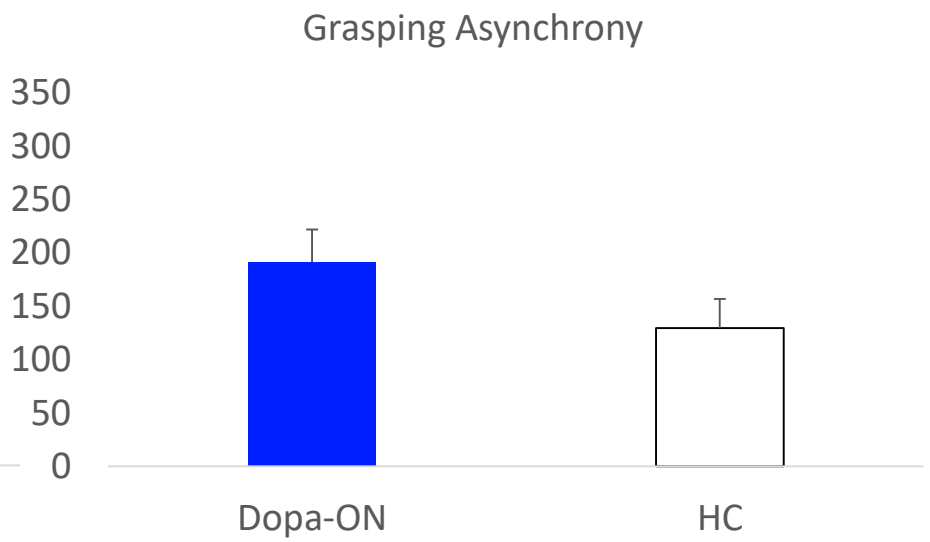


Role of the dopaminergic system in interpersonal motor interactions in PD

Reapeted Measure ANOVA (Between subjects)
Significant main effect of Dopa-OFF/HC
F(1, 29)=7.9, p=.008



Reapeted Measure ANOVA (Between subjects)
Significant main effect of Dopa-ON/HC
F(1, 29)=2.3, p=.14



Role of the dopaminergic system in interpersonal motor interactions in PD

- PD patients show diffuculties in performing motor interactions with a virtual Partner, especially when they need to predict and monitor its motor performance

- Dopaminergic medication restores PD ability to perform motor interactions

- The dopaminergic system may play a role in supporting cognitive-motor functions dedicated to processing the partner's actions (monitoring and prediction) and integrating it with one's own action.

Era et al., in prep

THANK YOU!

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