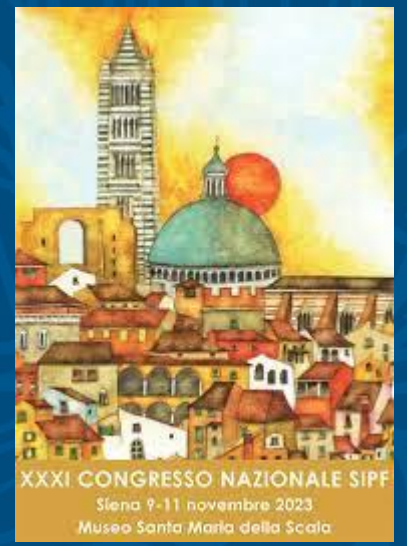
UNIVERSITÀ DEGLI STUDI FIRENZE

Impulsive personality trait, intentional inhibitory control and motor awareness: a complex relationship

Fabio Giovannelli

Sezione di Psicologia - Dipartimento NEUROFARBA



Outline

Awareness of motor intention & Impulsivity

- 'Delayed' subjective experience of volition
- Impulsivity traits and awareness of motor intention in healthy individuals and in patients with Parkinson's disease

Proactive inhibitory control & Impulsivity

- Brain activity during the proactive phase of Go/No-go task as a function of the impulsive personality traits

Libet's clock task

Brain (1983), **106**, 623–642

TIME OF CONSCIOUS INTENTION TO ACT IN RELATION TO ONSET OF CEREBRAL ACTIVITY (READINESS-POTENTIAL)

THE UNCONSCIOUS INITIATION OF A FREELY VOLUNTARY ACT

by BENJAMIN LIBET, CURTIS A. GLEASON, ELWOOD W. WRIGHT *and* DENNIS K. PEARL[1]

(*From the Neurological Institute, Department of Neuroscience, Mount Zion Hospital and Medical Center, the Department of Physiology, School of Medicine, University of California, San Francisco, CA 94143 and the Department of Statistics, University of California, Berkeley, CA*)

Neuroscience and Biobehavioral Reviews 128 (2021) 182–198

Contents lists available at ScienceDirect

Neuroscience and Biobehavioral Reviews

journal homepage: www.elsevier.com/locate/neubiorev

A meta-analysis of Libet-style experiments

Moritz Nicolai Braun *, Janet Wessler, Malte Friese

Neuroscience and Biobehavioral Reviews 151 (2023) 105199

Contents lists available at ScienceDirect

Neuroscience and Biobehavioral Reviews

journal homepage: www.elsevier.com/locate/neubiorev

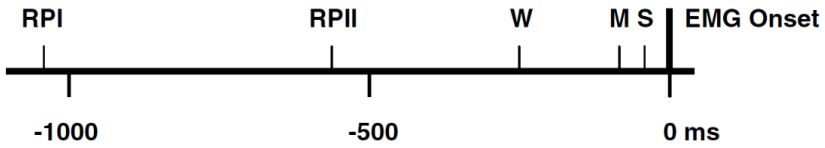
Review article

What is the intention to move and when does it occur?

Antonio I. Triggiani [a], Gabriel Kreiman [b], Cara Lewis [a], Uri Maoz [c,d,e,f], Alfred Mele [g], Liad Mudrik [h], Adina L. Roskies [i], Aaron Schurger [j,k,l], Mark Hallett [a,*]

‘Veto’ hypothesis

The interval between conscious intention and movement onset seems to be sufficient to allow a **conscious ‘veto’** of the impending action (Brass & Haggard, 2007; Matsuhashi & Hallett, 2008; Kühn et al., 2009; Walsh et al., 2010).

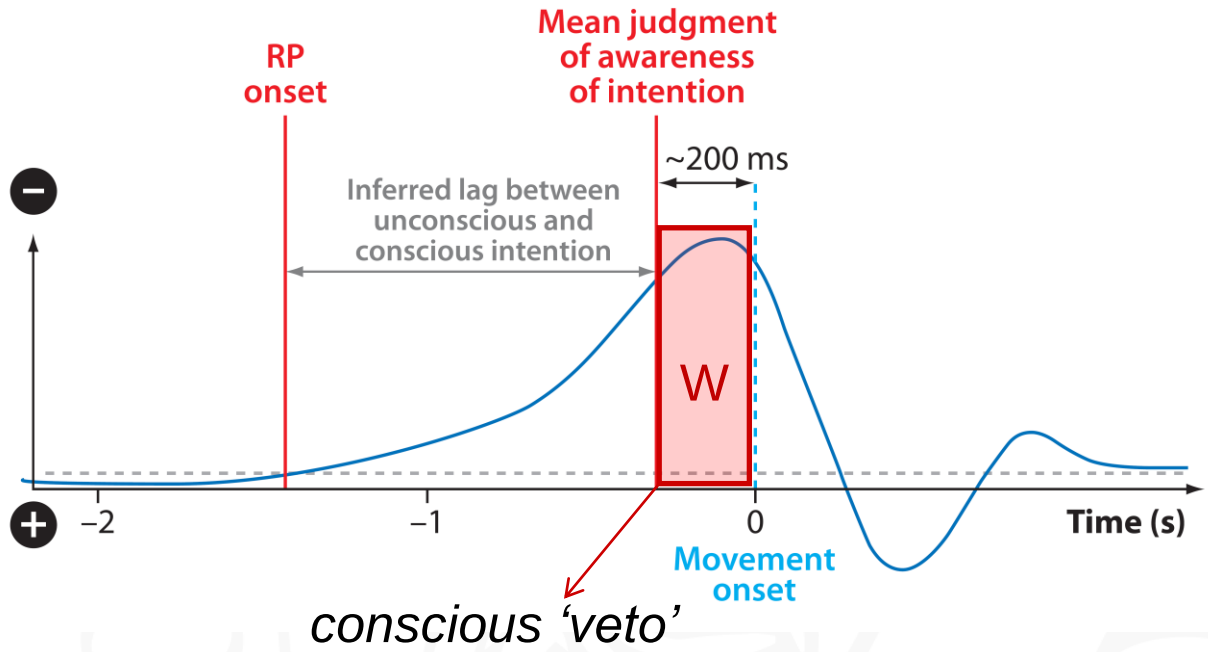


W = subjective timing of the will to move,

M = subjective timing of the onset of movement

S = subjective timing of a shock to the finger.

Libet et al., 1983; Hallett, 2007,2016; Haggard et al., 2008



Hypothesis: **impulsivity** could be related to a delayed awareness of voluntary action, i.e. conscious intention to move closer to the actual execution of a self-initiated movement.

Awareness of motor intention & Impulsivity

EJN European Journal of Neuroscience FENS

European Journal of Neuroscience, pp. 1–5, 2016 doi:10.1111/ejn.13359

Relationship between impulsivity traits and awareness of motor intention

F. Giovannelli,[1,2] B. Mastrolorenzo,[2] A. Rossi,[2] G. Gavazzi,[2] S. Righi,[2] G. Zaccara,[1] M. P. Viggiano[2,*] and M. Cincotta[1,*]

[1]SC di Neurologia di Firenze, AUSL Toscana Centro, Ospedale San Giovanni di Dio, Via di Torregalli, 3, 50143 Florence, Italy

[2]Department of Neuroscience, Psychology, Drug Research, Child Health, University of Florence, Florence, Italy

74 healthy volunteers

(54 women; mean age 24.8 years, range 19–48)

Impulsivity and inhibitory control assessment

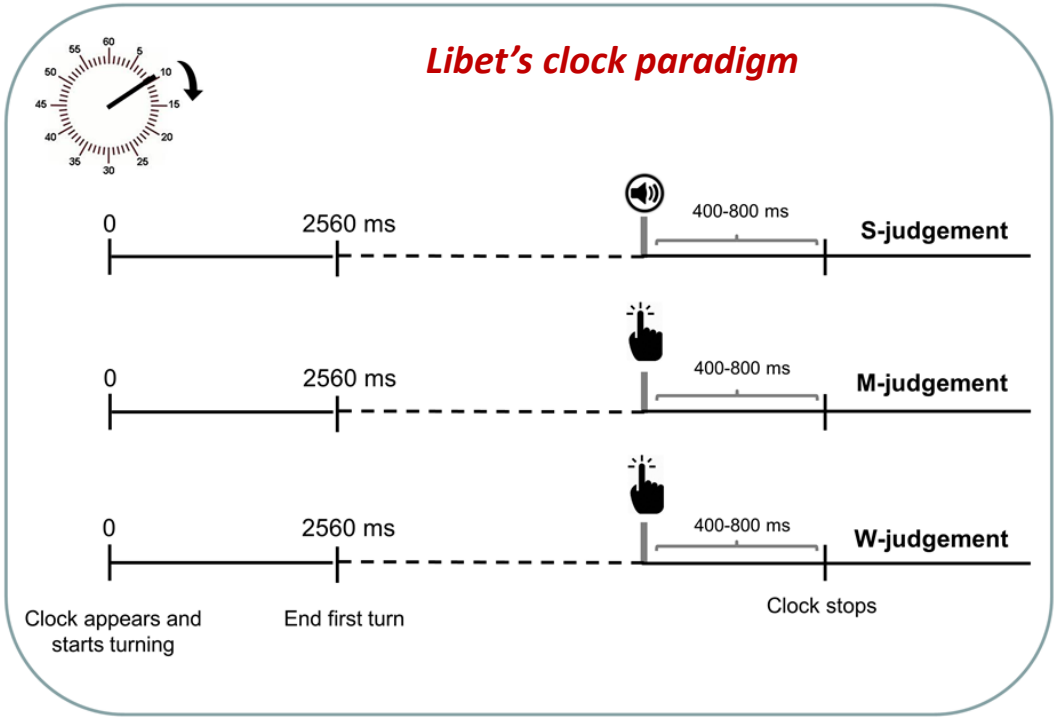
- Barratt Impulsiveness Scale (BIS-11)

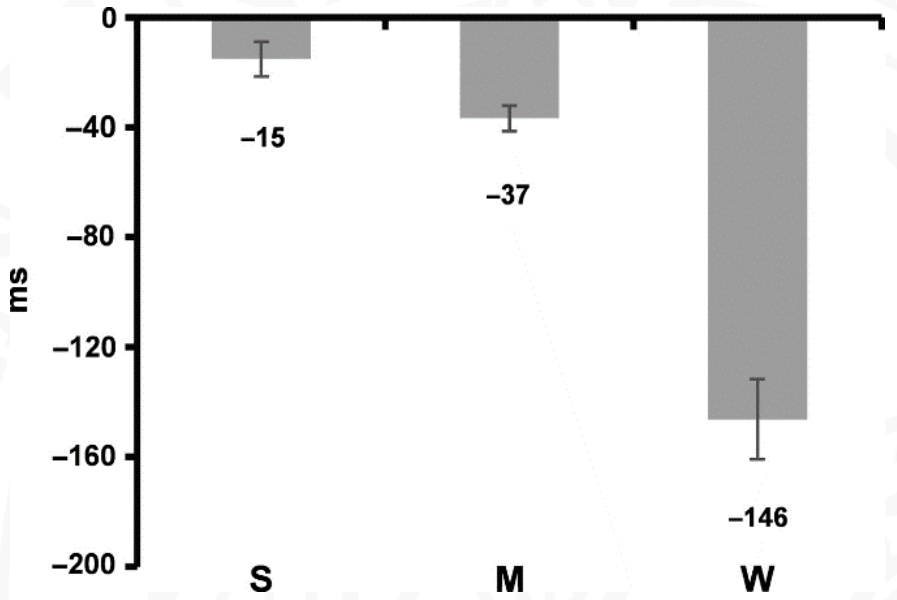
3 subscales:

1) attentional impulsivity
2) motor impulsivity
3) non-planning impulsivity

- **Visual cued go/no-go task**

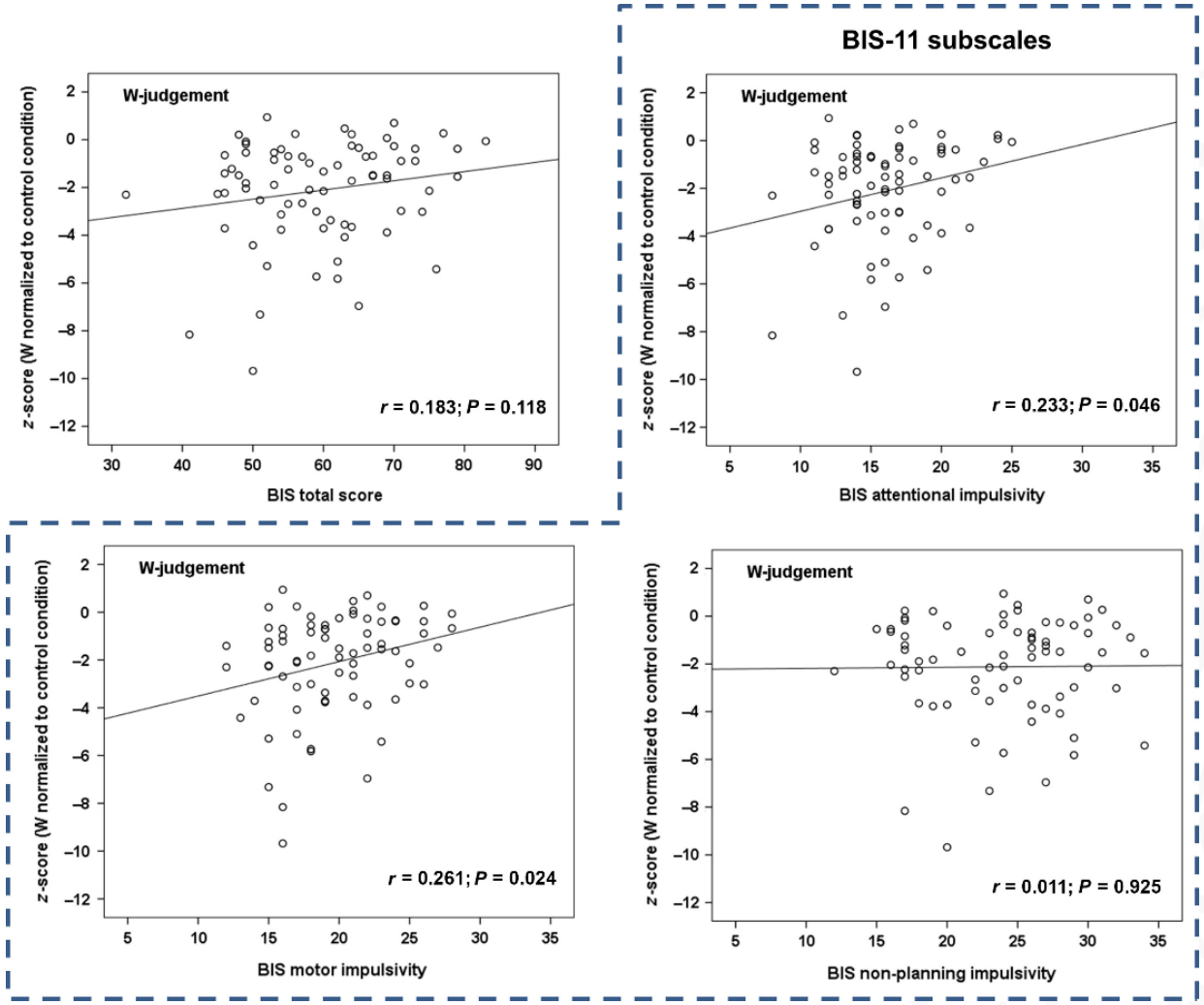
Awareness of motor intention & Impulsivity

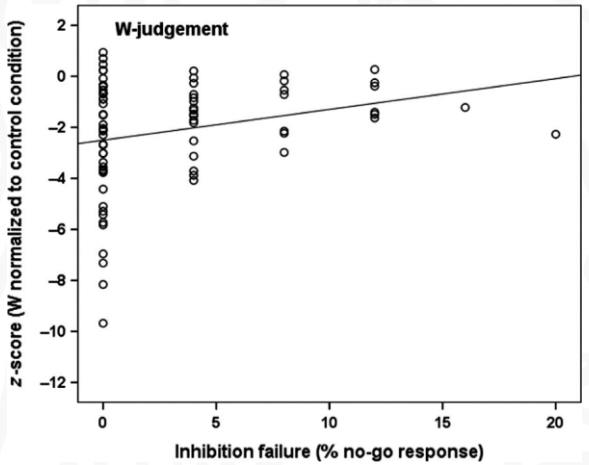




Giovannelli et al., 2016

Awareness of motor intention & Impulsivity





Giovannelli et al., 2016

Caspar & Cleeremans, 2015

Abnormal ('delayed') subjective experience of volition

Study	*Condition*	*M-judgement*	*W-judgement*
Moretto et al., 2011	Gilles de la Tourette syndrome	Similar to healthy controls	**Delayed** compared to healthy controls
Ganos et al., 2015	Gilles de la Tourette syndrome (adolescent)	Similar to healthy controls	Similar to healthy controls; but patients who were more able to voluntarily suppress their tics showed significantly earlier conscious intention.
Mainka et al., 2020	Gilles de la Tourette syndrome (5 y follow-up Ganos 2015)	Similar to healthy controls	The longer was the disease duration, the less was the developmental increase in the W-M gap.
Triggiani et al., 2023	Tic disorders and Tourette syndrome	Similar to healthy controls	The sense of volition for tics is similar to that of their voluntary movements which is similar to healthy controls
Edwards et al., 2011	Psychogenic tremor	Similar to healthy controls	**Delayed** compared to healthy controls
Baek et al., 2017	Functional neurological disorder	Similar to healthy controls	**Delayed** compared to healthy controls
Jungilligens et al. 2020	Dissociative seizures (psychogenic nonepileptic seizures)	Similar to healthy controls	**Delayed** compared to healthy controls
Doñamayor et al., 2018	Binge drinking	Similar to healthy controls	**Delayed** compared to healthy controls
Richardson et al., 2020	Schizophrenia	Similar to healthy controls	**Delayed** compared to healthy controls
Tabu et al., 2015	Parkinson's disease	Similar to healthy controls	**Delayed** compared to healthy controls
Di Costa et al., 2020	Parkinson's disease	Similar to healthy controls	Similar to healthy controls; but dopaminergic medication boosted anticipatory awareness of both intentions and actions in PD patients, relative to an unmedicated condition.

Action awareness in PD patients

Neuroscience Research 95 (2015) 74–77

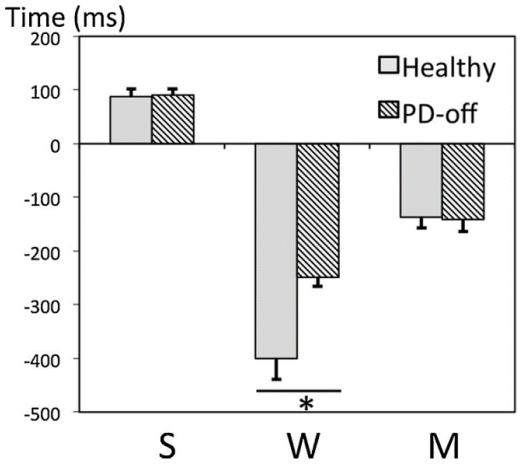
Contents lists available at ScienceDirect

Neuroscience Research

journal homepage: www.elsevier.com/locate/neures

Parkinson's disease patients showed delayed awareness of motor intention

Hayato Tabu[a,b,c], Toshihiko Aso[b], Masao Matsuhashi[b], Yoshino Ueki[b,d], Ryosuke Takahashi[c], Hidenao Fukuyama[b], Hiroshi Shibasaki[b,c,e], Tatsuya Mima[b,*]



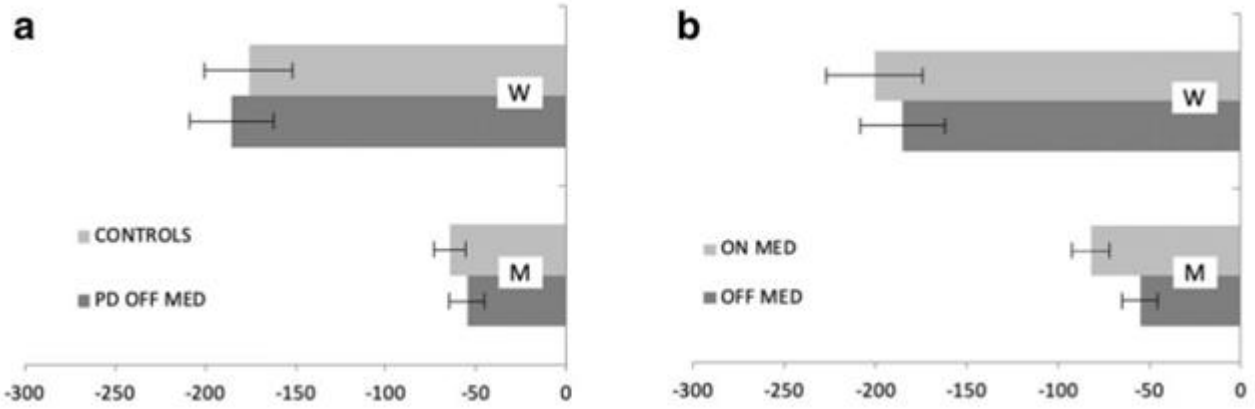
Tabu et al., 2015

Experimental Brain Research (2020) 238:1989–1995
https://doi.org/10.1007/s00221-020-05847-2

RESEARCH ARTICLE

Dopamine boosts intention and action awareness in Parkinson's disease

Steven Di Costa[1] · Ewgenia Barow[2] · Ute Hidding[2] · Tina Mainka[3] · Monika Pötter-Nerger[2] · Carsten Buhmann[2] · Christian K. E. Moll[4] · Patrick Haggard[1] · Christos Ganos[3]



Di Costa et al., 2020

UNIVERSITÀ DEGLI STUDI FIRENZE

Impulsivity trait in PD patients

Movement Disorders CLINICAL PRACTICE

REVIEW

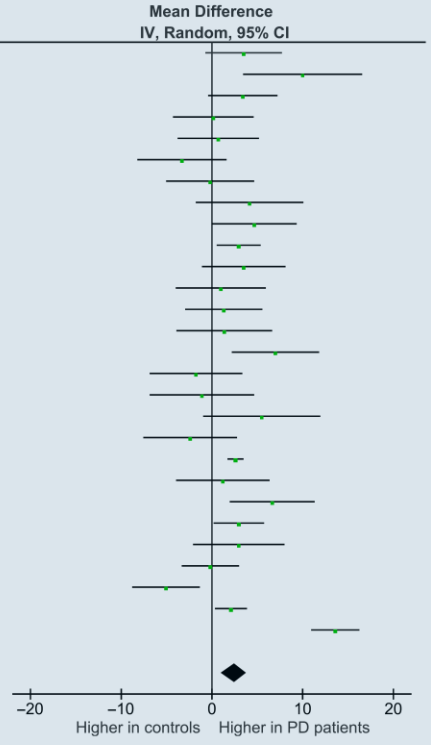
Impulsivity Traits in Parkinson's Disease: A Systematic Review and Meta-Analysis

Fabio Giovannelli, PsyD, PhD,[1] Gioele Gavazzi, PsyD, PhD,[1] Chiara Noferini, PsyD,[1,2] Pasquale Palumbo, MD,[3] Maria Pia Viggiano, PsyD, PhD,[1] and Massimo Cincotta, MD[4,*]

PD patients *vs* controls

Study or Subgroup	PD patients Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI	Year
Isaias 2008	47.6	11.3	36	44.1	9.3	80	3.6%	3.50 [−0.72, 7.72]	2008
Cools 2010	65	9.4	15	55	8.6	14	2.5%	10.00 [3.45, 16.55]	2010
Canesi 2012	60.7	8.9	36	57.3	7.6	36	3.9%	3.40 [−0.42, 7.22]	2012
Poletti 2012	64.83	9.24	42	64.67	9.65	30	3.5%	0.16 [−4.28, 4.60]	2012
van der Vegt 2013	66	5.6	13	65.3	5.8	12	3.5%	0.70 [−3.78, 5.18]	2013
Leroi 2013	56.04	10.49	55	59.35	9.24	20	3.3%	−3.31 [−8.22, 1.60]	2013
Florin 2013	59.2	6.8	29	59.4	10.2	23	3.3%	−0.20 [−5.05, 4.65]	2013
Rustamov 2013	43.8	11.15	20	39.65	7.65	20	2.8%	4.15 [−1.78, 10.08]	2013
Nombela 2014	64.07	9.8	30	59.4	8.6	30	3.4%	4.67 [0.00, 9.34]	2014
Piray 2014	57.1	4.5	40	54.15	4.51	20	4.7%	2.95 [0.53, 5.37]	2014
Herz 2014	56.5	7.5	26	53	6.6	13	3.4%	3.50 [−1.10, 8.10]	2014
Schomaker 2014	59.25	6.55	21	58.27	9.58	21	3.2%	0.98 [−3.98, 5.94]	2014
Grogan 2015	63.4	6.51	15	62.1	5.31	15	3.6%	1.30 [−2.95, 5.55]	2015
Fonoff 2015	63.04	9.33	28	61.68	10.75	28	3.1%	1.36 [−3.91, 6.63]	2015
Sharp 2016	61	9	22	54	7	21	3.3%	7.00 [2.19, 11.81]	2016
Aiello 2017	60.94	6.8	18	62.7	8.7	18	3.2%	−1.76 [−6.86, 3.34]	2017
Duprez 2017	44.3	11.7	32	45.4	11.8	32	2.8%	−1.10 [−6.86, 4.66]	2017
Picazio 2018	63.39	9.56	28	57.9	8.72	10	2.5%	5.49 [−0.97, 11.95]	2018
Girard 2019	54	8.7	14	56.4	4.6	14	3.1%	−2.40 [−7.56, 2.76]	2019
Kubera 2019	62.82	1.12	22	60.22	1.6	18	5.3%	2.60 [1.73, 3.47]	2019
Hammes 2019	57.6	13.6	62	56.4	8.4	18	3.1%	1.20 [−3.95, 6.35]	2019
Pickering 2020	57.89	9.54	25	51.24	7.17	25	3.4%	6.65 [1.97, 11.33]	2020
Aumann 2020	59.36	8.46	68	56.39	9.39	93	4.5%	2.97 [0.20, 5.74]	2020
Koh 2020	59.56	7.49	45	56.6	10.6	21	3.2%	2.96 [−2.07, 7.99]	2020
Hlavatá 2020	54.14	5.6	22	54.31	6.48	36	4.3%	−0.17 [−3.33, 2.99]	2020
Izzo 2020	56.51	9.71	47	61.57	8.2	42	3.9%	−5.06 [−8.78, −1.34]	2020
de Chazeron 2021	57.1	9.4	200	55	8.5	200	5.0%	2.10 [0.34, 3.86]	2021
Chen 2022	68.1	7.8	50	54.5	7.5	90	4.6%	13.60 [10.94, 16.26]	2022
Total (95% CI)			**1061**			**1000**	**100.0%**	**2.43 [1.03, 3.83]**	

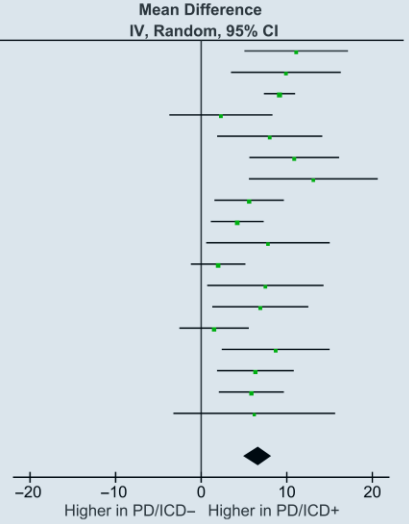
Heterogeneity: Tau² = 9.29; Chi² = 116.54, df = 27 (*P* < 0.00001); I² = 77%
Test for overall effect: Z = 3.41 (*P* = 0.0006)



PD/ICD+ *vs* PD/ICD-

Study or Subgroup	PD/ICD+ Mean	SD	Total	PD/ICD- Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI	Year
Voon 2007	65.2	12.2	21	54.1	10.1	42	4.5%	11.10 [5.05, 17.15]	2007
Isaias 2008	57.5	10	14	47.6	11.3	36	4.2%	9.90 [3.49, 16.31]	2008
Voon 2011	66.63	11.08	282	57.48	10.91	282	10.6%	9.15 [7.34, 10.96]	2011
Antonini 2011	65.6	12.4	18	63.3	8.8	85	4.5%	2.30 [−3.73, 8.33]	2011
Ray 2012	65	7	7	57	4.43	7	4.4%	8.00 [1.86, 14.14]	2012
Leroi 2013	66.91	13.41	35	56.04	10.49	55	5.3%	10.87 [5.63, 16.11]	2013
Bentivoglio 2013	71.9	13.02	17	58.8	9	17	3.3%	13.10 [5.58, 20.62]	2013
Pettorruso 2014	66.5	11	34	60.9	9.3	120	6.9%	5.60 [1.55, 9.65]	2014
Piray 2014	61.88	4.56	16	57.67	4.18	15	8.5%	4.21 [1.13, 7.29]	2014
Ruitenberg 2018	61.9	15.16	21	54.1	8.85	30	3.5%	7.80 [0.58, 15.02]	2018
Marín-Lahoz 2018	58.33	7.72	31	56.35	7	69	8.3%	1.98 [−1.20, 5.16]	2018
Balconi 2018a	70.6	10.5	15	63.1	8.9	17	3.9%	7.50 [0.71, 14.29]	2018a
Balconi 2018b	69.2	9.2	17	62.3	8	20	4.9%	6.90 [1.29, 12.51]	2018b
Lee 2019	60.8	9.9	50	59.3	11.8	60	6.9%	1.50 [−2.56, 5.56]	2019
Girard 2019	62.7	8	13	54	8.7	14	4.3%	8.70 [2.40, 15.00]	2019
Hlavatá 2020	60.47	7.54	15	54.14	5.6	22	6.3%	6.33 [1.85, 10.81]	2020
Aumann 2020	65.22	10.77	43	59.36	8.46	68	7.3%	5.86 [2.06, 9.66]	2020
Ricciardi 2021	63.3	10.1	6	57.1	10.3	17	2.4%	6.20 [−3.25, 15.65]	2021
Total (95% CI)			**655**			**976**	**100.0%**	**6.62 [5.01, 8.23]**	

Heterogeneity: Tau² = 5.52; Chi² = 35.76, df = 17 (*P* = 0.005); I² = 52%
Test for overall effect: Z = 8.05 (*P* < 0.00001)



Impulsivity, as a personality trait, may characterize patients with PD, even in the absence of ICDs.

Impulsivity trait in PD patients

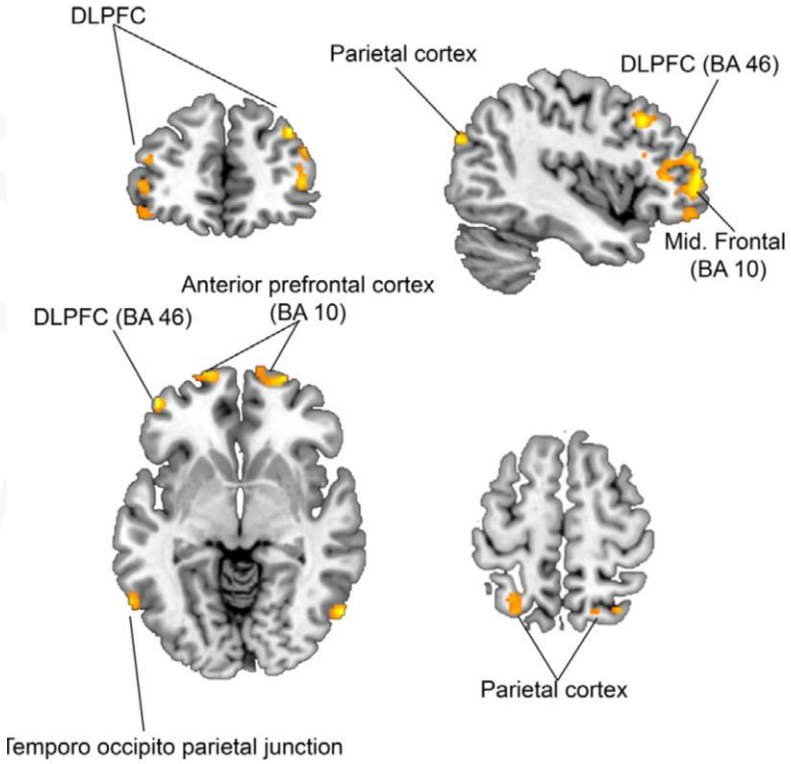
ORIGINAL ARTICLE

Measuring impulsivity in Parkinson's disease: a correlational and structural neuroimaging study using different tests

J. Marín-Lahoz[a,b,c,d], S. Martínez-Horta[a,b,d,*], F. Sampedro[a,b,d,*], J. Pagonabarraga[a,b,c,d], A. Horta-Barba[a,b,d], H. Bejr-kasem[a,b,c,d,e], M. Á. Botí[e,f], R. Fernández-Bobadilla[g], B. Pascual-Sedano[a,b,d,e], J. Pérez-Pérez[a,b,d], I. Aracil-Bolaños[a,b,d], A. Gironell[a,b,d], B. Gómez-Ansón[b,c,h] and J. Kulisevsky[a,b,c,d]

European Journal of Neurology 2020, **27:** 1478–1486

BIS-11



Reduction in GMV with increasing impulsivity

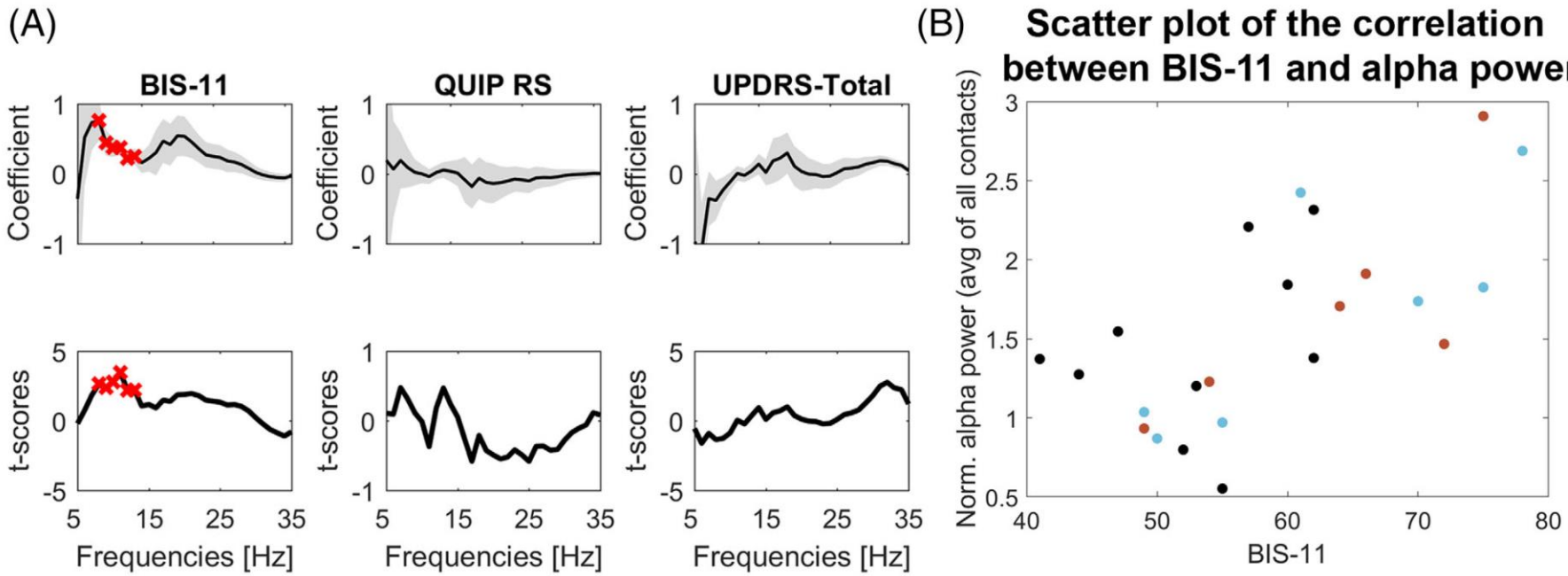
Impulsivity trait in PD patients

RESEARCH ARTICLE

Neurophysiological Correlates of Trait Impulsivity in Parkinson's Disease

Lucia Ricciardi, MD, PhD,[1,2] Petra Fischer, PhD,[2] Abteen Mostofi, MD, PhD,[1] Gerd Tinkhauser, MD, PhD,[3] Flavie Torrecillos, PhD,[2] Fahd Baig, MD, PhD,[1,2] Mark J. Edwards, MD, PhD,[1] Erlick A.C. Pereira, MD, PhD,[1] Francesca Morgante, MD, PhD,[1,4*] and Peter Brown, MD[2]

Data suggest a link between **α power** and **trait impulsivity** in PD, irrespective of the presence and severity of ICB



Impulsivity traits and awareness of motor intention PD

Neurological Sciences
https://doi.org/10.1007/s10072-021-05325-9

ORIGINAL ARTICLE

Impulsivity traits and awareness of motor intention in Parkinson's disease: a proof-of-concept study

Fabio Giovannelli[1,2] · Chiara Menichetti[3] · Lorenzo Kiferle[4] · Laura Maria Raglione[2] · Stefania Brotini[5] · Paola Vanni[6] · Duccio Bacci[6] · Mariella Baldini[5] · Alessandra Borgheresi[2] · Alessandra Del Bene[3] · Enrico Grassi[4] · Leonello Guidi[5] · Lucia Toscani[6] · Gino Volpi[3] · Pasquale Palumbo[4] · Maria Pia Viggiano[1] · Massimo Cincotta[2]

Main inclusion criteria:

- mild-moderate disease severity (stage I-III on the Hoehn & Yahr scale)
- MOCA score > 25
- stable antiparkinsonian medication for at least 1 month before the enrolment
- absence of overt ICD at the time of testing

All patients were on dopaminergic therapy and were **tested ON medication**.

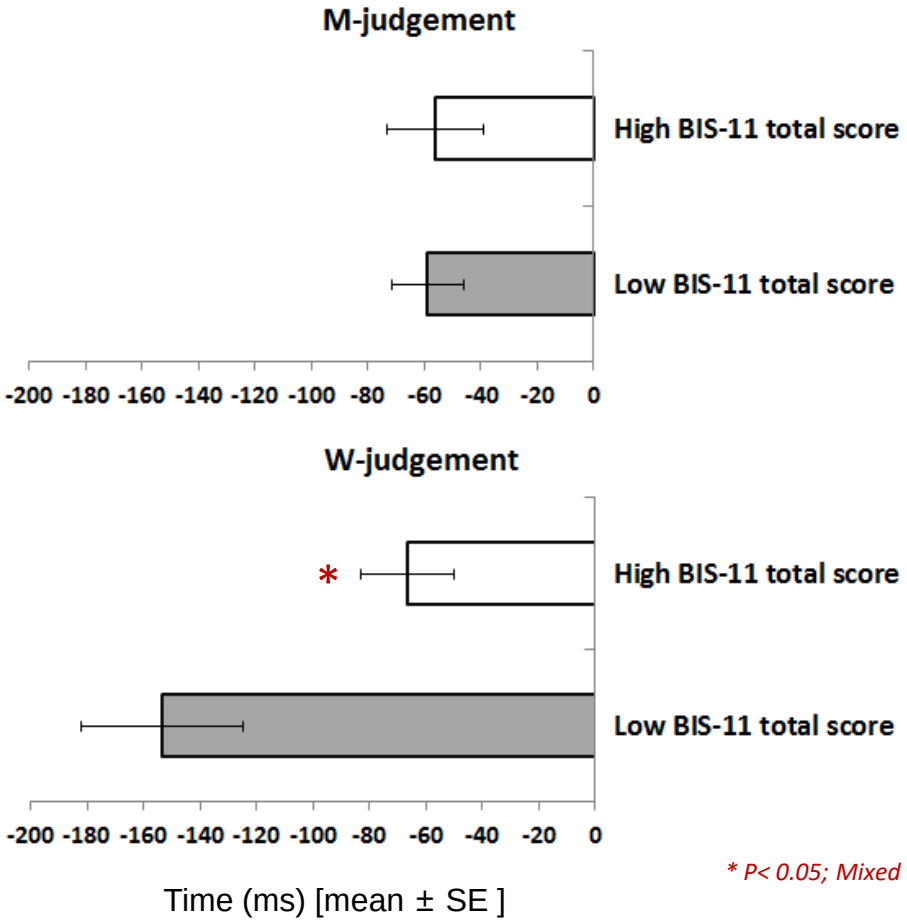
Table 1 Demographic and clinical data (mean ± SD)

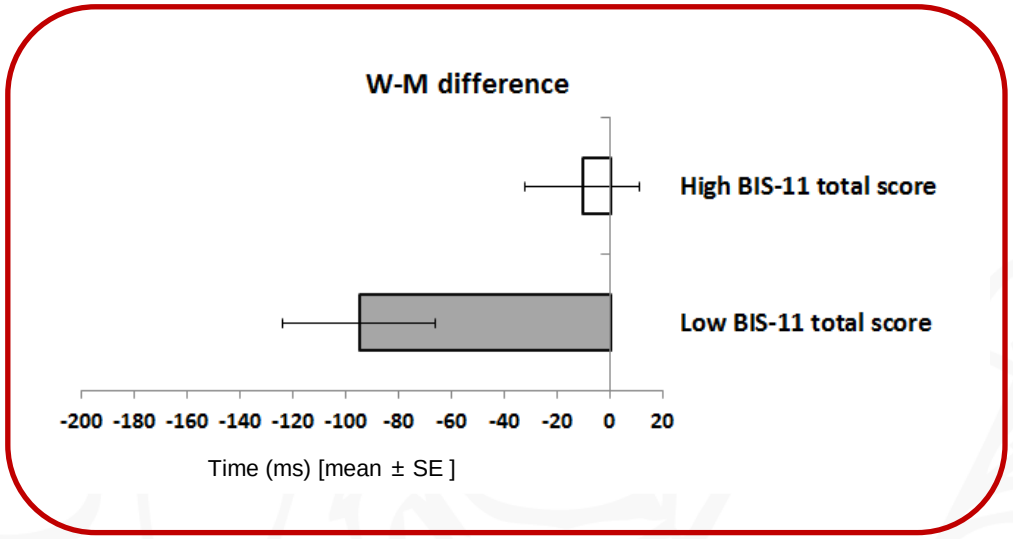
	Low BIS-11 total score (n = 14)	High BIS-11 total score (n = 14)	** P value
Age (years)	68.5 ± 9.1 (range 46-85)	69.6 ± 8.1 (range 55-85)	0.727
Gender (F/M)	4/10	7/7	/
Education (years)	10.7 ± 4.7	8.9 ± 3.8	0.277
Disease duration (years)	4.6 ± 2.6 (range 2-10)	6.4 ± 5.0 (range 1-16)	0.230
H&Y (range)	1.7 ± 0.7 (range I-III)	1.6 ± 0.7 (range I-III)	0.897
Unified Parkinson's Disease Rating Scale (UPDRS-III) ON med	14.5 ± 7.6 (range 5-31)	11.9 ± 8.7 (range 3-37)	0.414
Mean levodopa equivalent daily dose (LEDD), mg	380 ± 266	509 ± 332	0.277
Non-Motor Symptoms Scale (NMSS)	50.6 ± 38.1	52.6 ± 25.5	0.872
Geriatric Depression Scale (GDS)	7.8 ± 6.8	5.3 ± 3.6	0.236
Montreal Cognitive Assessment (MOCA)*	27.0 ± 2.6	27.2 ± 2.5	0.880
Frontal Assessment Battery (FAB)*	16.2 ± 2.3	15.8 ± 1.7	0.649
Visual simple reaction times, ms	316.2 ± 33.6	313.0 ± 37.5	0.813

*Scores have been adjusted for each subject's age and education level

**Unpaired sample t-test

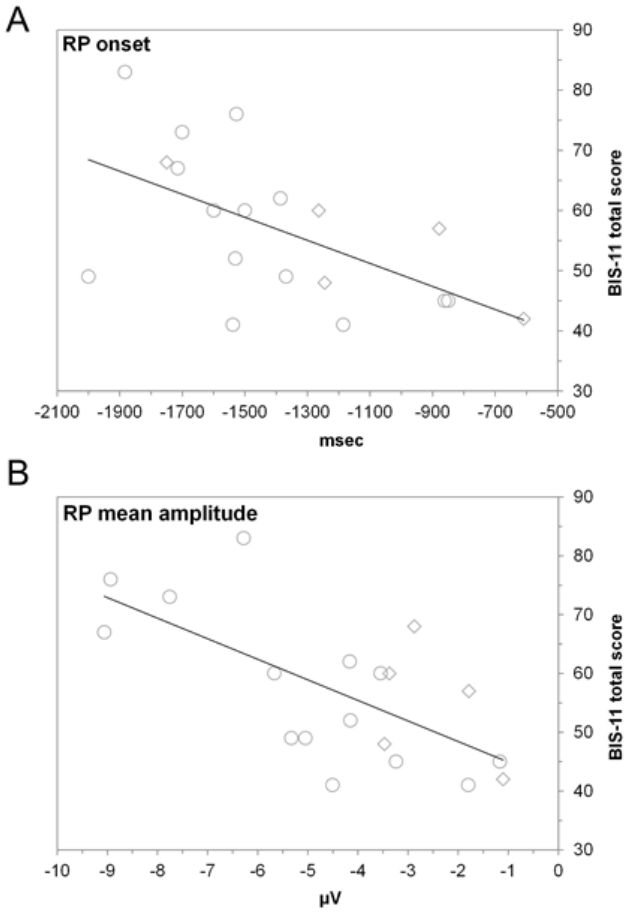
Impulsivity traits and awareness of motor intention PD





** P< 0.05; Mixed design ANOVA and Bonferoni-corrected post hoc test*

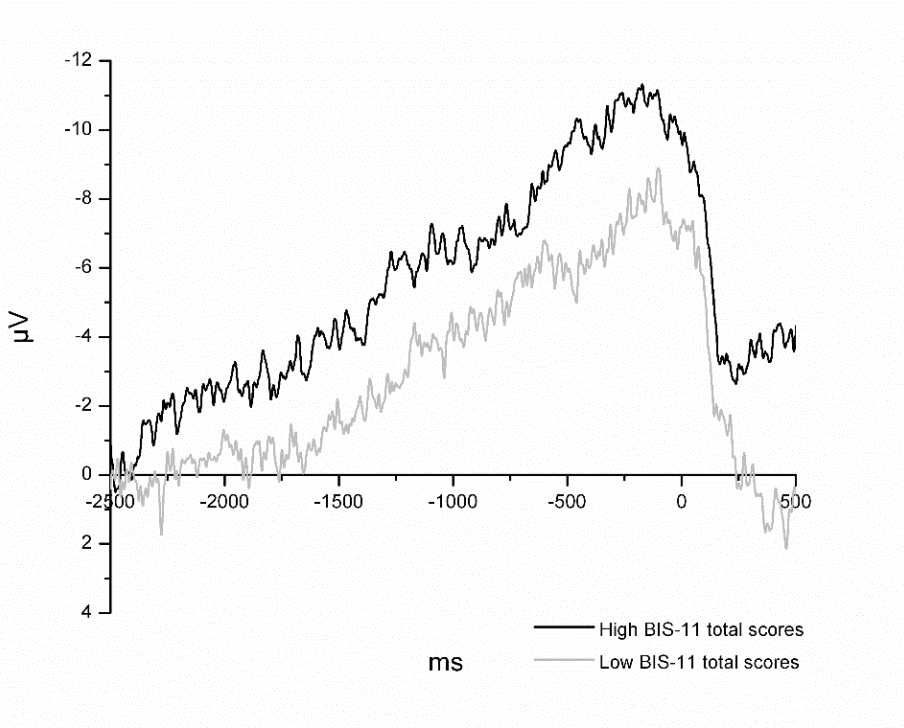
Impulsivity trait & motor preparation



NEUROSCIENCE
RESEARCH ARTICLE
A. Rossi et al. / Neuroscience 372 (2018) 266–272

Electrophysiological Activity Prior to Self-initiated Movements is Related to Impulsive Personality Traits

A. Rossi,[a] F. Giovannelli,[a] G. Gavazzi,[a] S. Righi,[a] M. Cincotta[b] and M. P. Viggiano[a*]
[a] Department of Neuroscience, Psychology, Drug Research, Child Health, University of Florence, Florence, Italy
[b] SC di Neurologia di Firenze, AUSL Toscana Centro, Florence, Italy



Proactive and reactive inhibition

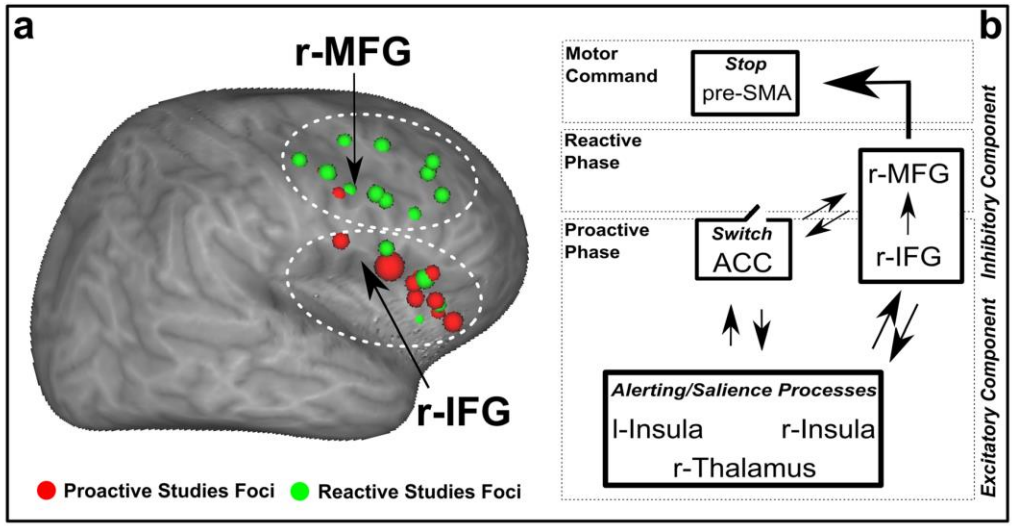
Brain Imaging and Behavior
https://doi.org/10.1007/s11682-020-00369-5

REVIEW ARTICLE

Check for updates

Contiguity of proactive and reactive inhibitory brain areas: a cognitive model based on ALE meta-analyses

Gioele Gavazzi [1] · Fabio Giovannelli [2] · Tommaso Currò [2] · Mario Mascalchi [3] · Maria Pia Viggiano [2]



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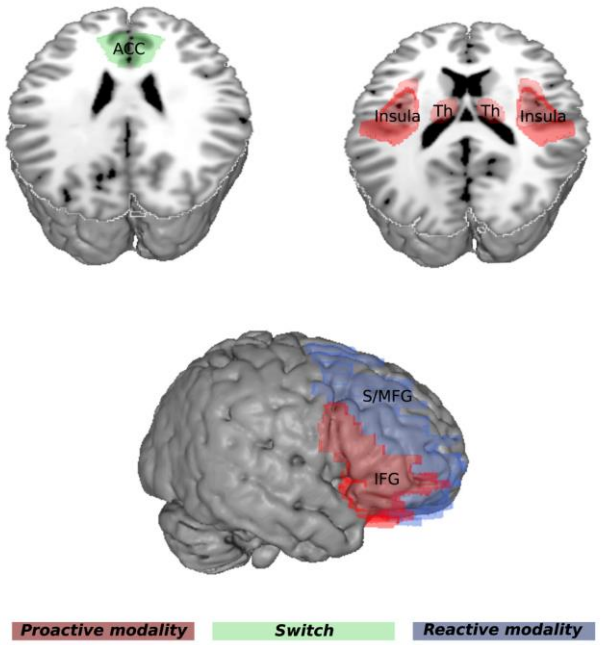
Review article

Subregional prefrontal cortex recruitment as a function of inhibitory demand: an fMRI metanalysis

Gioele Gavazzi [a], Fabio Giovannelli [a], Chiara Noferini [a], Massimo Cincotta [b], Carlo Cavaliere [c], Marco Salvatore [c], Mario Mascalchi [d,e,1], Maria Pia Viggiano [a,*,1]



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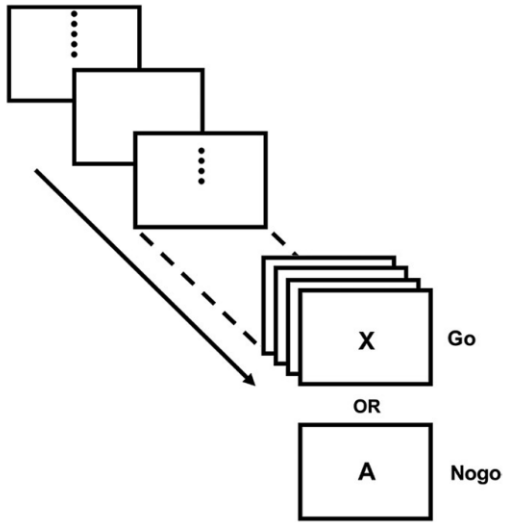
SHORT COMMUNICATION

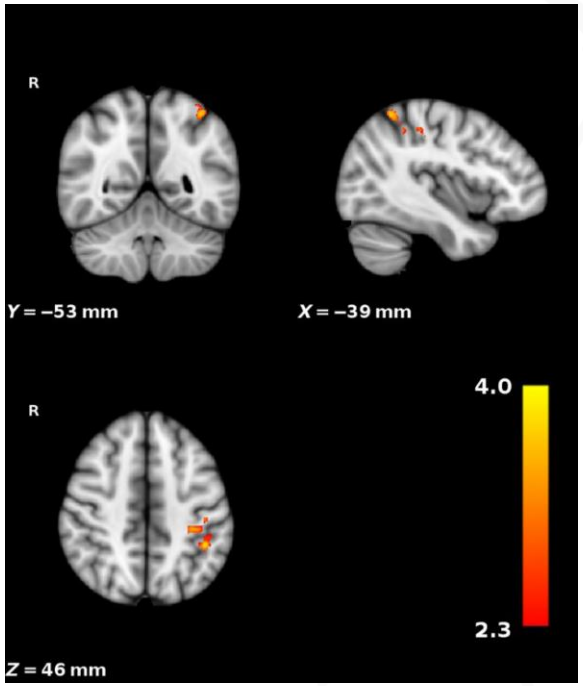
WILEY EJN European Journal of Neuroscience FENS

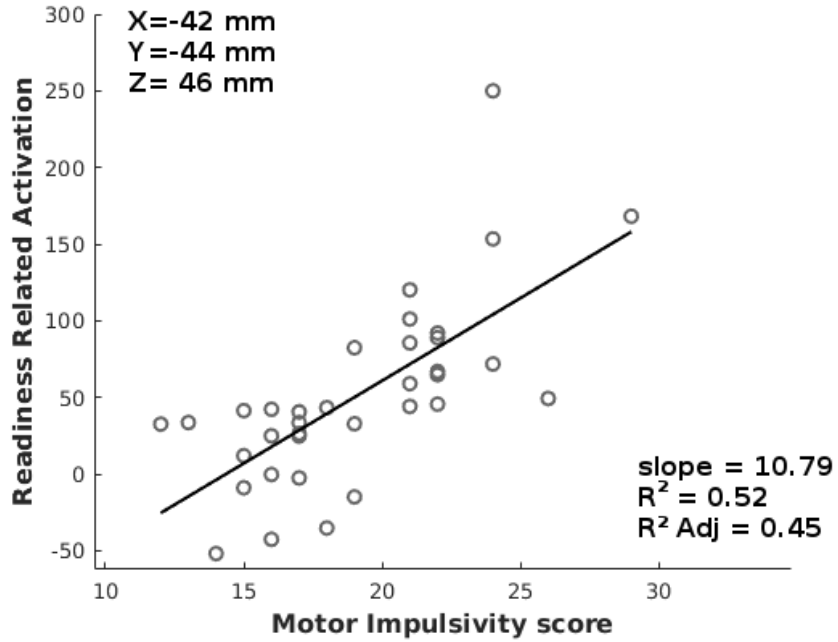
Impulsivity trait and proactive cognitive control: An fMRI study

Gioele Gavazzi[1] | Arianna Rossi[2*] | Stefano Orsolini[3*] | Stefano Diciotti[3] | Fabio Giovannelli[2] | Emilia Salvadori[4] | Leonardo Pantoni[5] | Mario Mascalchi[6†] | Maria Pia Viggiano[2†]

Positive significant correlation between **motor BIS-11 scores** and the activation of **left sensorimotor** cortices (*diminished reactivity threshold*), **left inferior and superior parietal** (*proactive control*)







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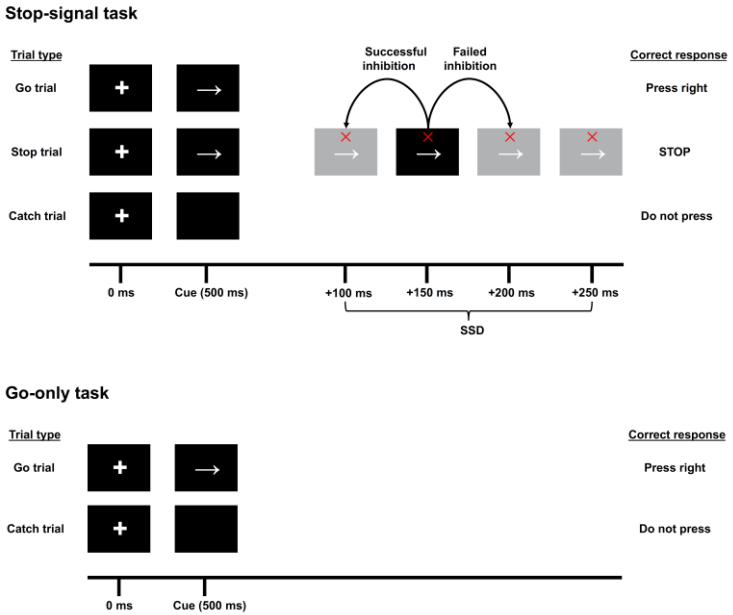
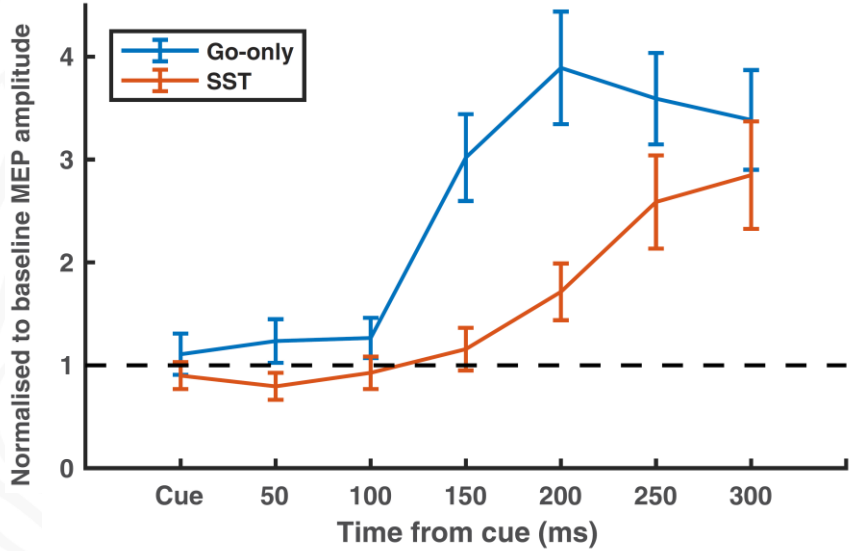
frontiers in Psychology

REVIEW
published: 21 February 2019
doi: 10.3389/fpsyg.2019.00340

Motor Preparation for Action Inhibition: A Review of Single Pulse TMS Studies Using the Go/NoGo Paradigm

Stefania C. Ficarella[1,2,3] and Lorella Battelli[2,4]*





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RESEARCH ARTICLE

Control of Movement

Proactive inhibition is marked by differences in the pattern of motor cortex activity during movement preparation and execution

Vishal Rawji,[1] Sachin Modi,[1] Lorenzo Rocchi,[1,2] Marjan Jahanshahi,[1] and John C. Rothwell[1]
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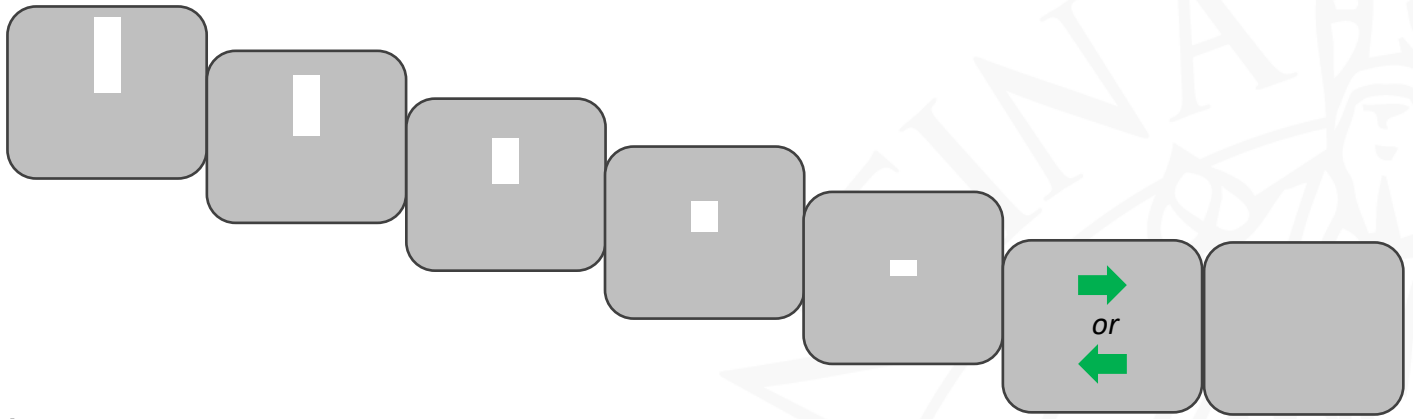
Choice reaction time (CRT)
Go-only

Proactive phase
movement preparation

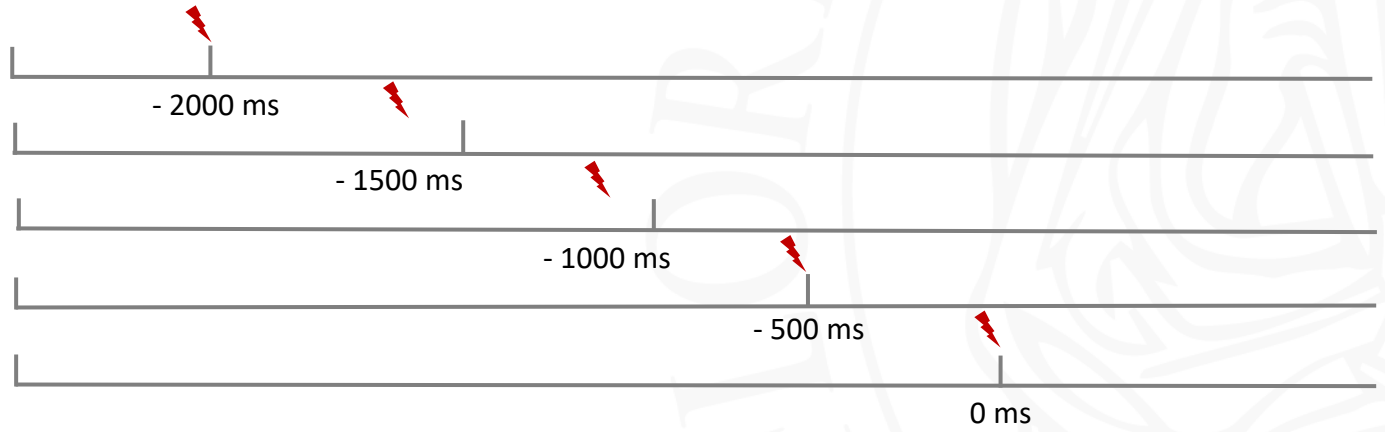
Go stimulus

Response



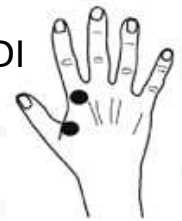
CRT

TMS



TMS
left M1

EMG
right FDI



12 MEPs for each time point.

Total: 60 trials

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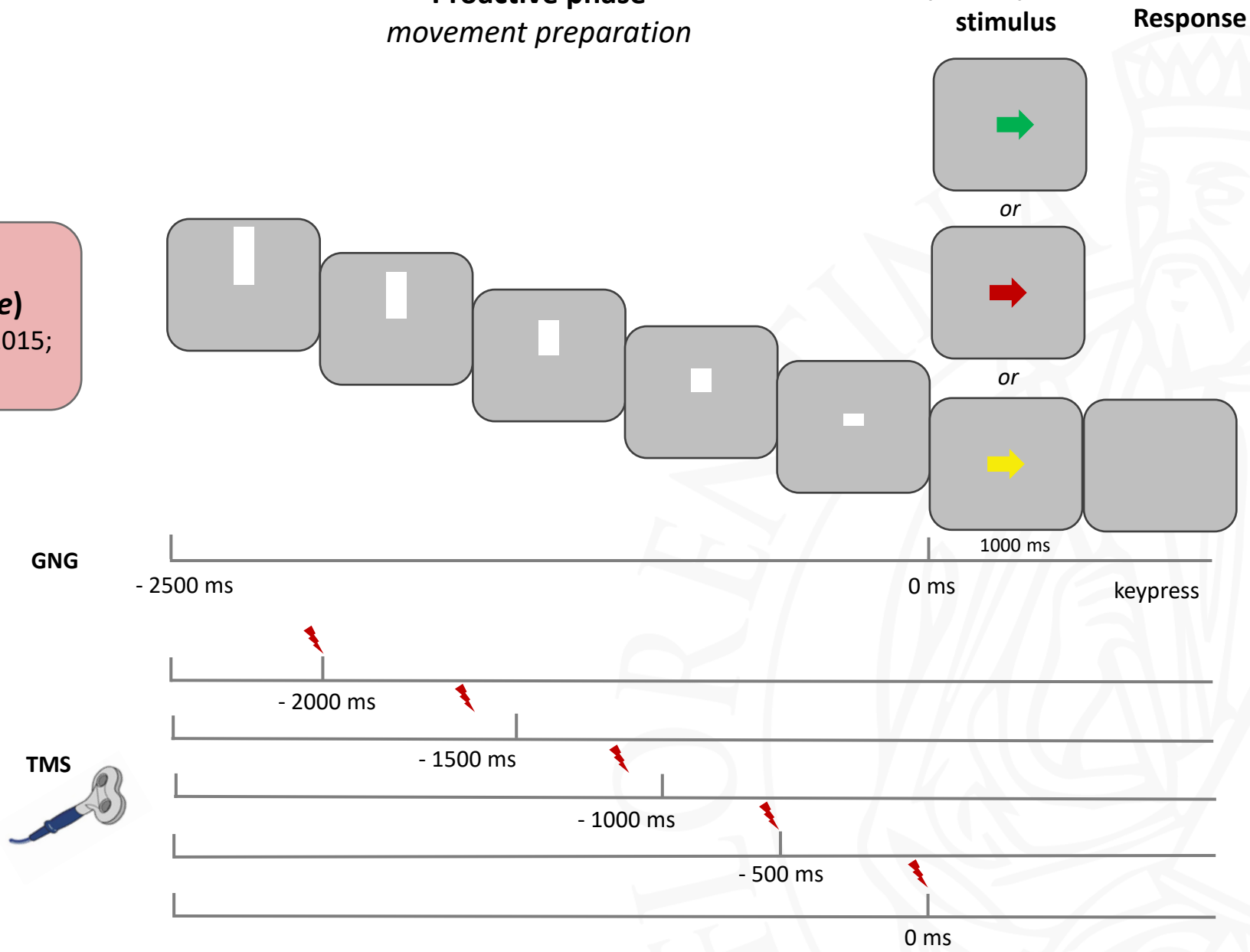
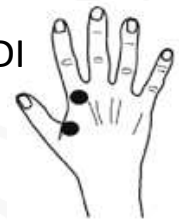
GNG task
(*Go/No-Go/Choose*)
[Parkinson & Haggard, 2015; Rae et al., 2020]

Proactive phase
movement preparation



TMS
left M1

EMG
right FDI



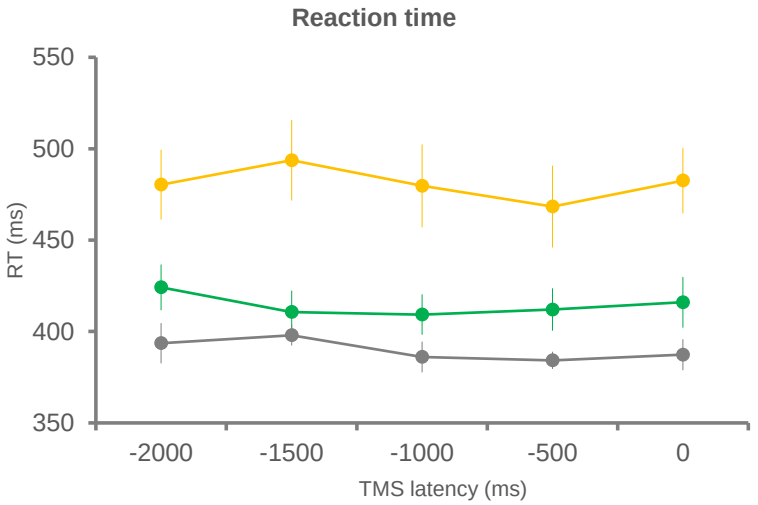
- **Go (50%)**
→ 180 trials, 36 MEPs for each time point.

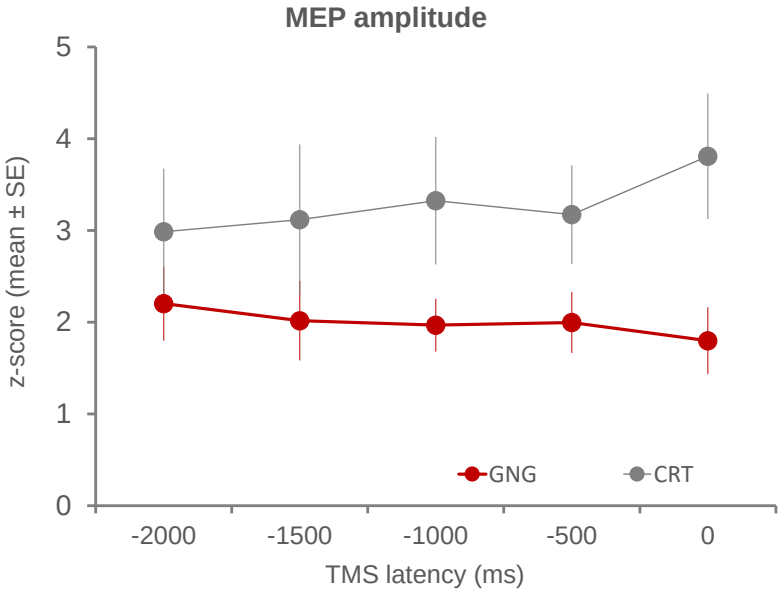
- **No-go (16.67%)**
→ 60 trials, 12 MEPs for each time point.

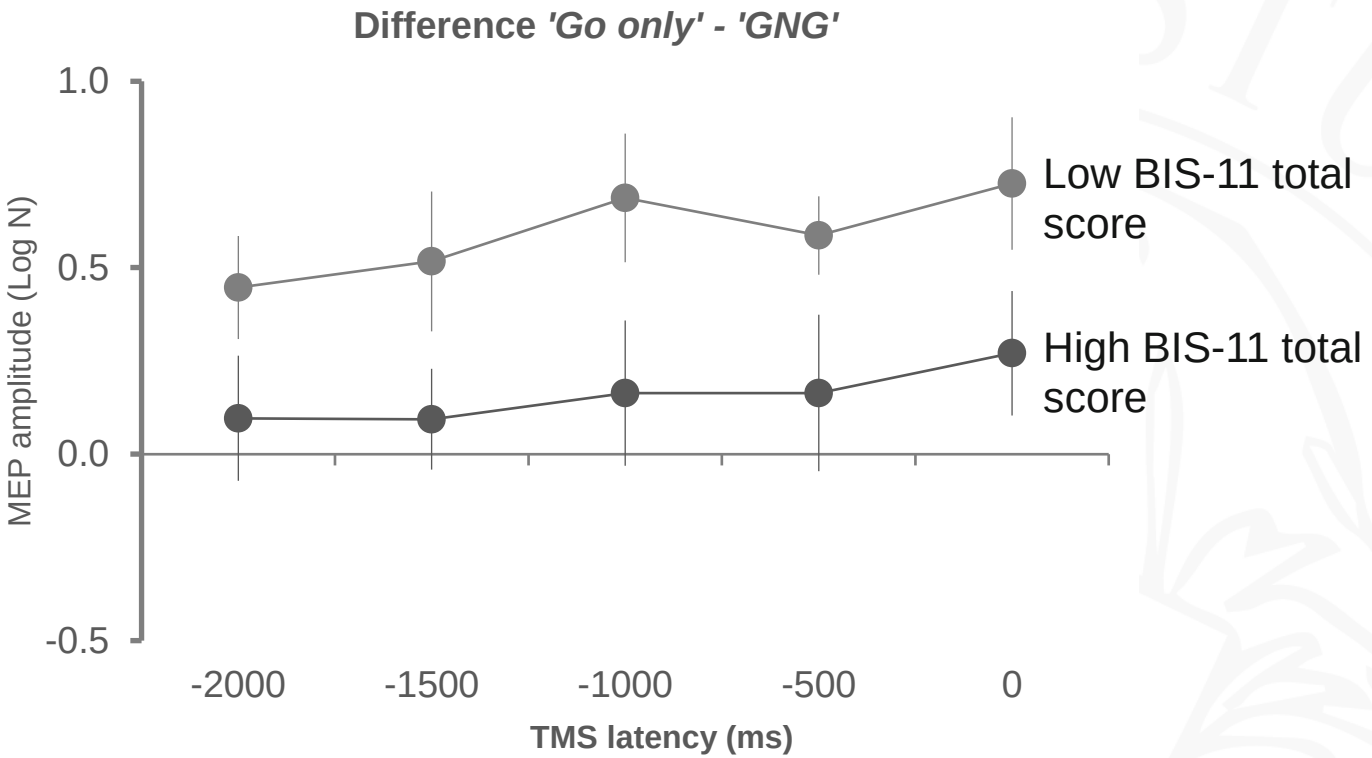
- **Choose (33,3%)**
→ 120 trials, 24 MEPs for each time point.

Total: 360 trials

Preliminary results







Conclusions

- The impulsive personality trait is related to a ‘delayed’ awareness of the intention to act (i.e. a shorter interval to allow a conscious ‘veto’ of the impending action) in healthy individuals and in patients with Parkinson’s disease (PD).

- In PD patients, the characterization of the temporal profile associated with awareness of motor intention could prove useful in identifying patients at risk of developing impulse control disorders (ICDs) during dopaminergic treatment.

“We have seen for example that patients with reduced sense of volition, or impulsive persons, have a reduced W-M interval. Such information might be a helpful biomarker for cognitive processes in such persons” (Triggiani et al 2023).

- Preliminary data suggest the corticospinal excitability during the proactive phase in a GNG/Choose task is modulated as a function of the impulsive personality traits.

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