



Reduced sensory attenuation reflects altered motor control in Tourette Syndrome

Giulia Stanco, Angela Marotta, Marika Mariano, Mauro Porta and Laura Zapparoli

Professor Mary Robertson Award for Research Contribution



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Tourette Syndrome



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Tics have been described as ***unvoluntary*** actions: **movements that are not fully intentional, but not totally outside voluntary control.**





**Altered interactions between
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action control.**



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The ability to predict the sensory consequences of our own actions.

Why can't you tickle yourself?

Sarah-Jayne Blakemore,^{CA} Daniel Wolpert and Chris Frith

(Blakemore et al., 1998, 2000; Frith et al., 2000; Wolpert & Ghahramani, 2000)

Motor prediction



When we move, the brain generates **predictions** about the sensory outcomes of that movement.

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Motor execution and sensory feedback



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Matching between predicted and actual sensory feedback



When the predicted and actual sensory outcome **match**, the brain usually down-weights, or **attenuates**, the sensory impact of our **own** actions.

Sensory attenuation phenomenon

Marker of predictive sensorimotor mechanisms

(Blakemore et al., 1998, 2000)



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This mechanism is particularly relevant for **Tourette** syndrome.

If the brain is **less able to attenuate self-generated sensory signals**, **bodily sensations** may become more **salient**.

This **could contribute** to the experience of premonitory urges and, ultimately, to tic expression.

(Rae et al., 2019)

Sensory attenuation phenomenon

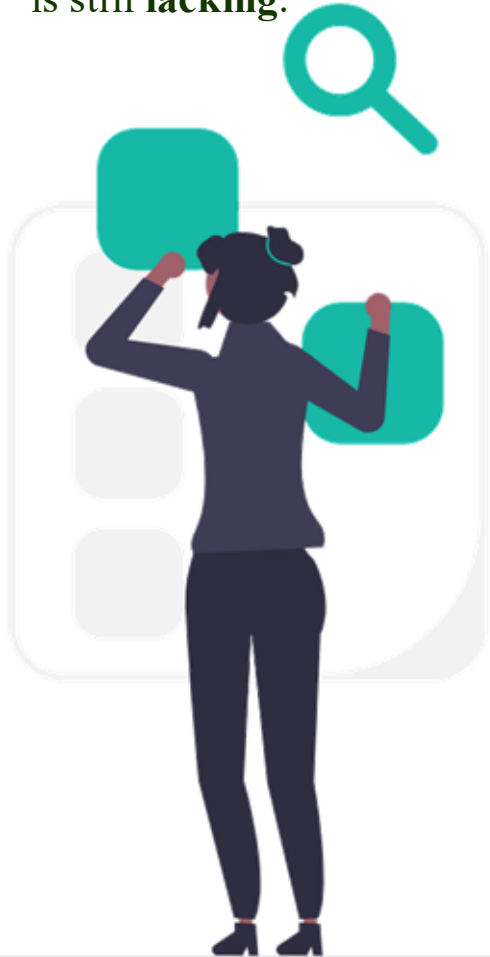
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Direct behavioural evidence of altered sensory attenuation in Tourette's syndrome is still **lacking**.



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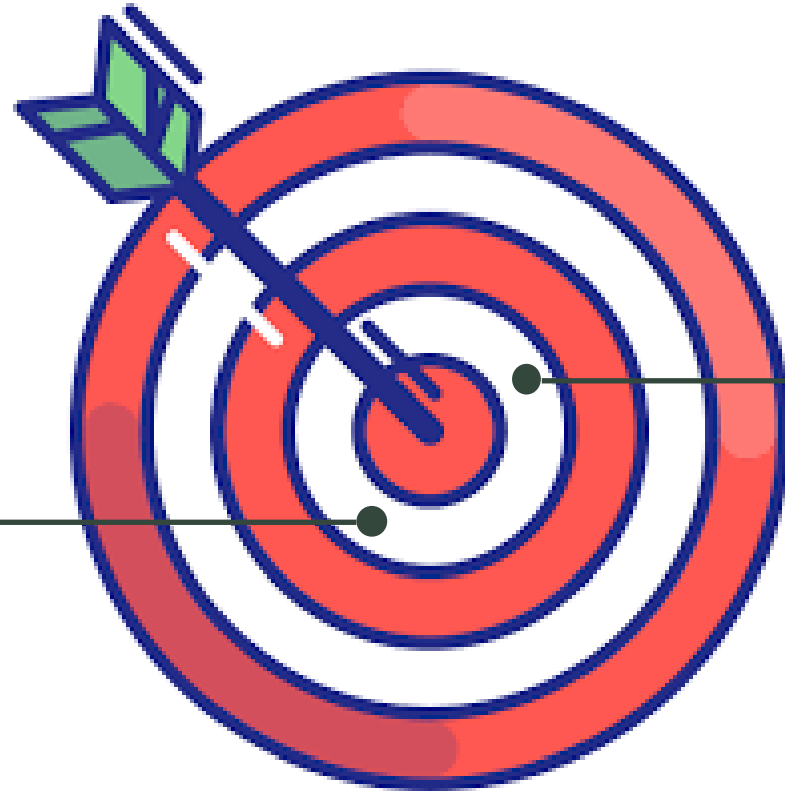
Aim of the study



Whether sensory attenuation is altered in TS, as a possible physiological marker of impaired sensorimotor filtering.



Whether the magnitude of this alteration is associated with the clinical severity of the syndrome



Participants and clinical assessment



Thirty patients with Tourette Syndrome (TS)

Age: 32.03 ± 13.41 ; F/M: 8/22

Thirty healthy controls (HC)

Age: 31.87 ± 13.19 ; F/M: 8/22



**I.R.C.C.S. Ospedale
Galeazzi - Sant'Ambrogio**

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- **Medical treatment**



- **Yale Global Tic Severity Scale (YGTSS)**
- **Premonitory Urge for Tics Scale**



- Barat Impulsivity Scale
- Yale-Brown Obsessive Compulsive Scale (Y-BOCS)
- Beck Depression Inventory
- Conners Adult ADHD Rating Scale
- STAI-X



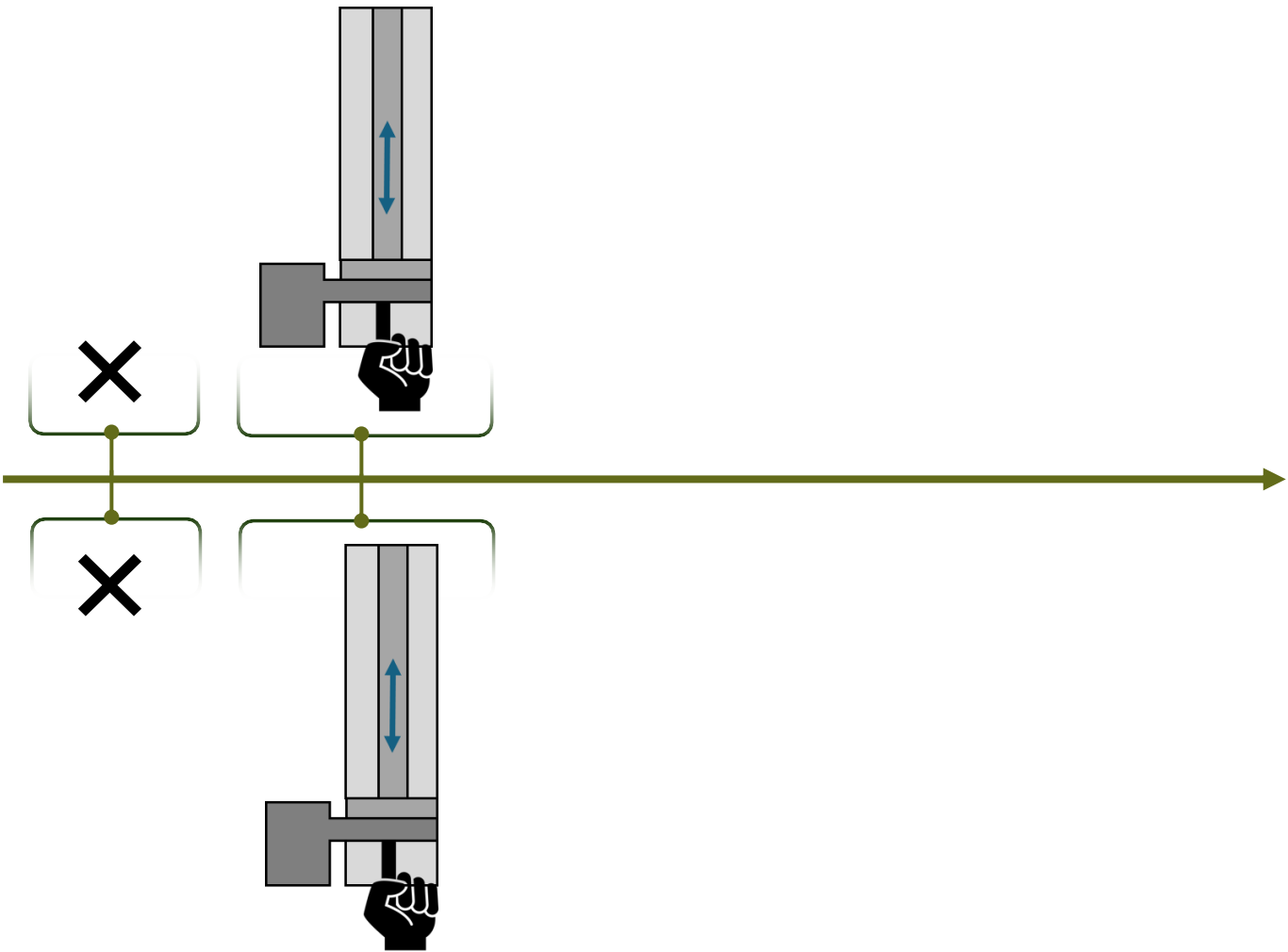
- Mini-Mental State Examination
- Frontal Assessment Battery
- Raven's Progressive Matrices



Experimental paradigm

Stimulation (1/2/3 N)

Force Matching Task



Stimulation (1/2/3 N)

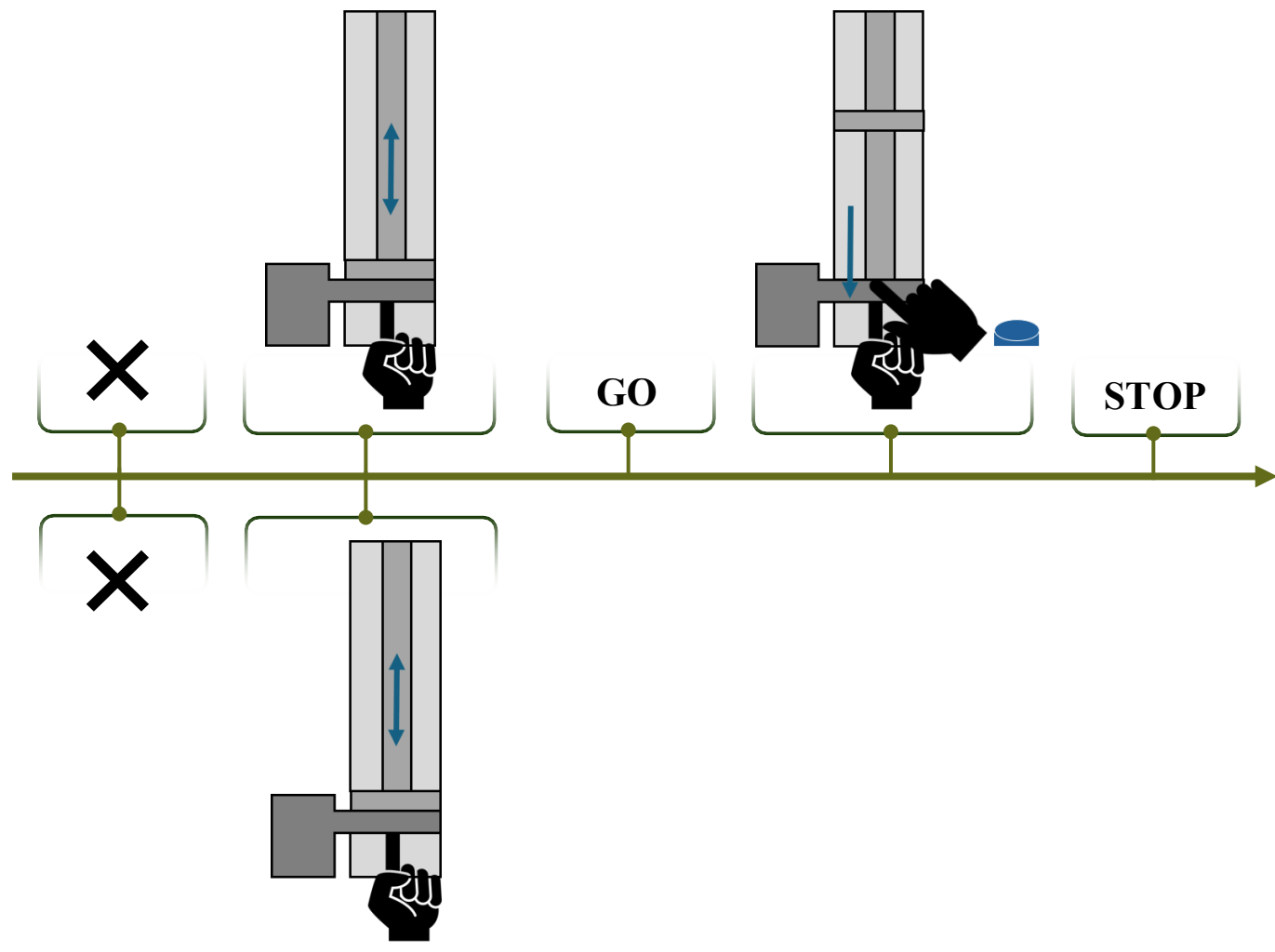


Experimental paradigm

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DIRECT reproduction

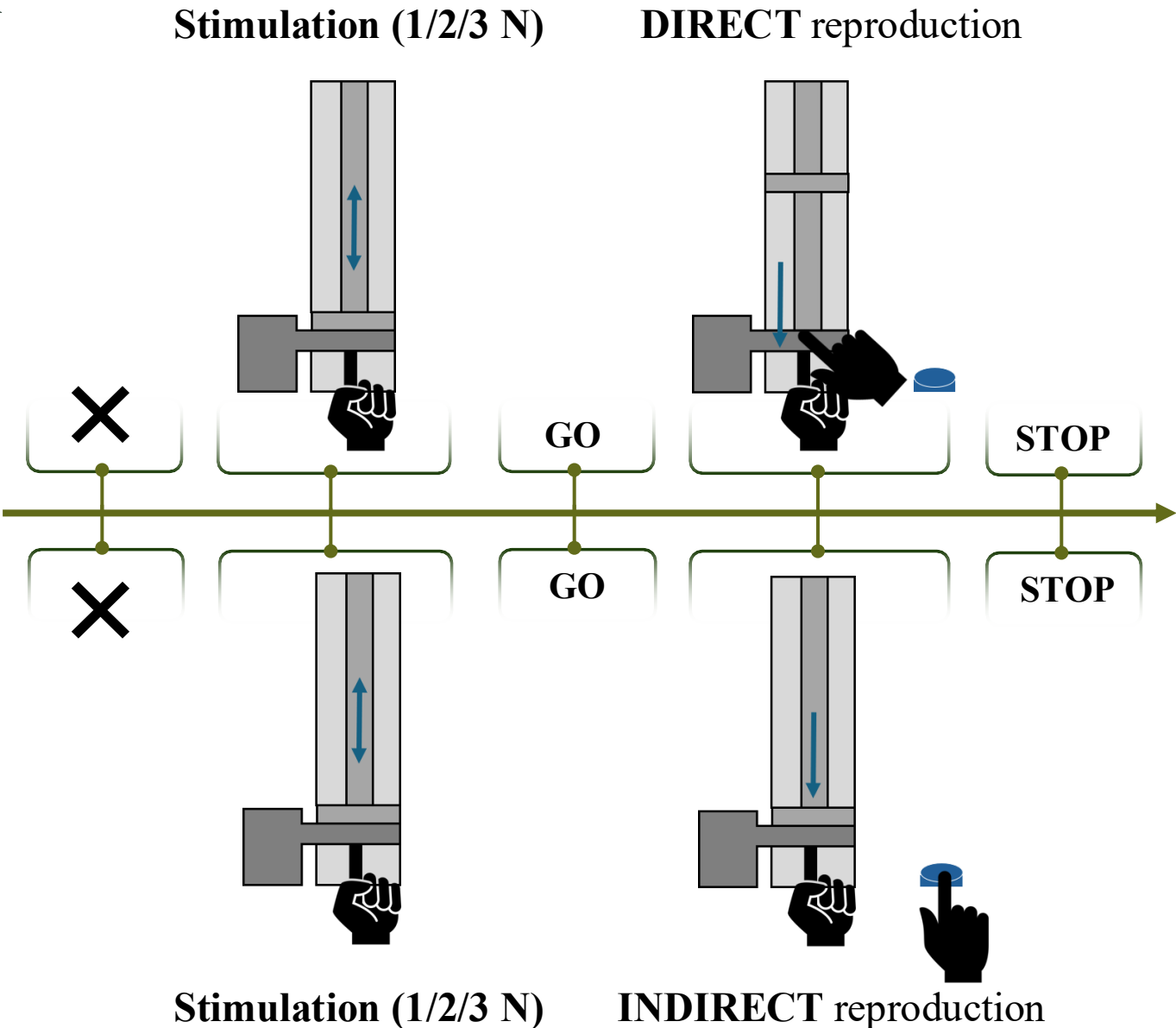


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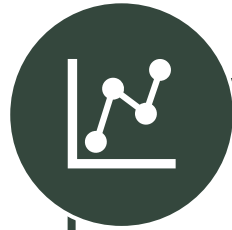
Experimental paradigm

Force Matching Task





Statistical analyses



SA index = Applied force / Target force

> **1**: force overestimation
~ **1**: accurate reproduction



SA index Direct > SA index Indirect
Greater overestimation for direct force-reproduction

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Mixed repeated-measures ANOVAs

Dependent variable:

SA index

Independent variables:

Group (TS, HC)
Condition (Direct, Indirect)
Force (1N, 2N, 3N)

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Other analyses



Explored the **correlation**
between the **SA Index**
and the **clinical profile**.

Hierarchical regression
to assess if SA explained
tic severity beyond other
clinical factors.

Main Sensory Attenuation analyses

Exploratory force-level analyses

Correlations analyses

Exploratory hierarchical regression analysis

Results availability

The results are not reported in this version of the presentation, as the manuscript is currently under review.

For any questions or further information, please contact:

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Prof. Laura Zapparoli – laura.zapparoli@unimib.it



First empirical evidence of **altered Sensory Attenuation** in Tourette's syndrome.

Alteration specific to the **self-generated actions**, suggesting an **alteration in predictive sensorimotor processes**.



First empirical evidence of altered **Sensory Attenuation** in Tourette's syndrome compared to the HC group.

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Tourette Syndrome may involve an **imbalance** between **sensory evidence** and **motor predictions**: sensory signals may have a stronger influence than expected predictions.

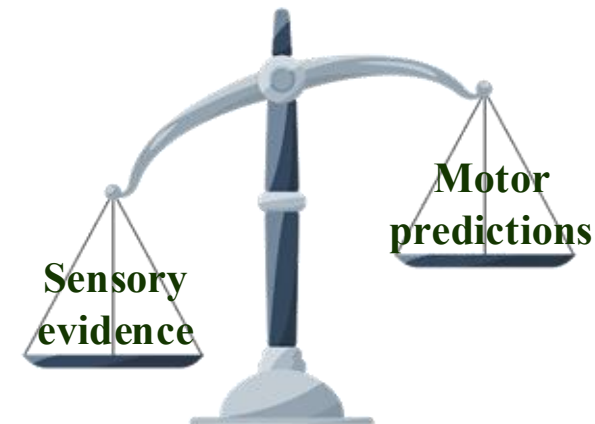
This could explain why patients showed less attenuation and reproduced self-generated forces more **accurately, especially when sensory input became more salient**.



A Bayesian Account of the Sensory-Motor Interactions Underlying Symptoms of Tourette Syndrome

Charlotte L. Rae^{1,2*}, Hugo D. Critchley^{1,2,3} and Anil K. Seth^{1,4}

(Rae et al., 2019)





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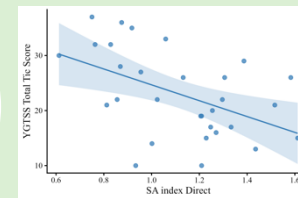


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Altered attenuation scales with tic severity, capturing a **distinct dimension** beyond established clinical measures.



This mechanism may be **clinically relevant** and closely linked to the clinical expression of the disorder.



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Altered attenuation scales with tic severity, capturing a **distinct dimension** beyond established clinical measures.

Association specific to tic severity and **did not extend to premonitory urge severity**, suggesting that altered sensory attenuation is more closely related to the behavioural expression of tics.

Future directions?



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Tourette Syndrome may involve an **imbalance** between **sensory evidence** and **motor predictions**.



Altered attenuation scales with the **clinical expression** of the disorder.



Altered sensory attenuation may represent a clinically meaningful marker of abnormal sensorimotor prediction in Tourette syndrome, closely linked to the tic severity.



Thanks for your attention!
And thanks to



Angela Marotta



Marika Mariano



Mauro Porta



Laura Zapparoli

Let's stay in touch!



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