

# Sense of agency and sense of body ownership in Functional Movement Disorders: new evidence from the moving Rubber Hand Illusion paradigm

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## Introduction

Functional movement disorders (FMD) are characterized by motor symptoms that, although physiologically similar to voluntary movements, are experienced as out of control by patients. This gap might be related to abnormalities in two fundamental components of self-consciousness: the sense of agency (SoA) and the sense of body ownership (SoBo). The SoA is the feeling of control over own actions, while the SoBo is the experience of the body as part of the self. **Aim.** This study was aimed at investigating whether SoA, SoBo and the relationship between them are altered in FMD.

## The moving Rubber Hand Illusion (mRHI)

### Active synchronous



Ownership  
Agency

### Active asynchronous



### Active incongruent



Agency

### Passive congruent



Ownership

Explicit measures of **Agency** and **Ownership**:  
the mRHI questionnaire

### Ownership-statements

1. I felt as if I was looking at my own hand
2. I felt as if the rubber hand was part of my body
3. It seemed as if I were sensing the movement of my finger in the location where the rubber finger moved
4. I felt as if the rubber hand were my hand

### Ownership-control

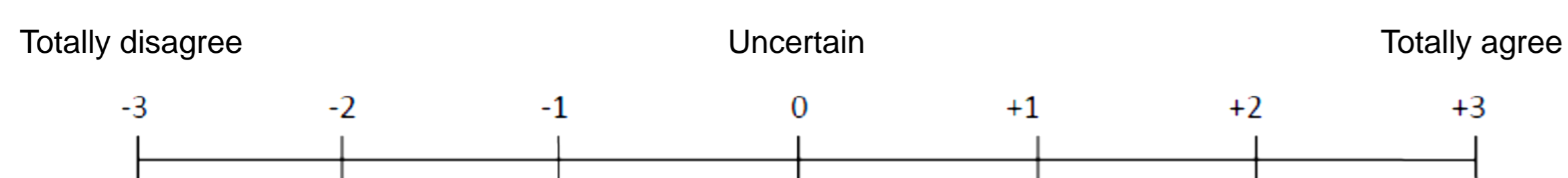
5. I felt as if my real hand were turning rubbery
6. It seems as if I had more than one right hand
7. It appeared as if the rubber hand were drifting towards my real hand
8. It felt as if I had no longer a right hand, as if my right hand had disappeared

### Agency-statements

9. The rubber hand moved just like I wanted it to, as if it was obeying at my will
10. I felt as if I was causing the movements of the rubber hand
11. I felt as if I was causing the movement I saw
12. Whenever I moved my index finger I expected the rubber finger to move in the same way

### Agency-control

13. It felt as if the rubber hand was controlling my will
14. It felt as if the rubber hand was controlling my movements
15. I could sense the movement from somewhere between my real hand and the rubber hand
16. It seemed as if the rubber hand had a will of its own



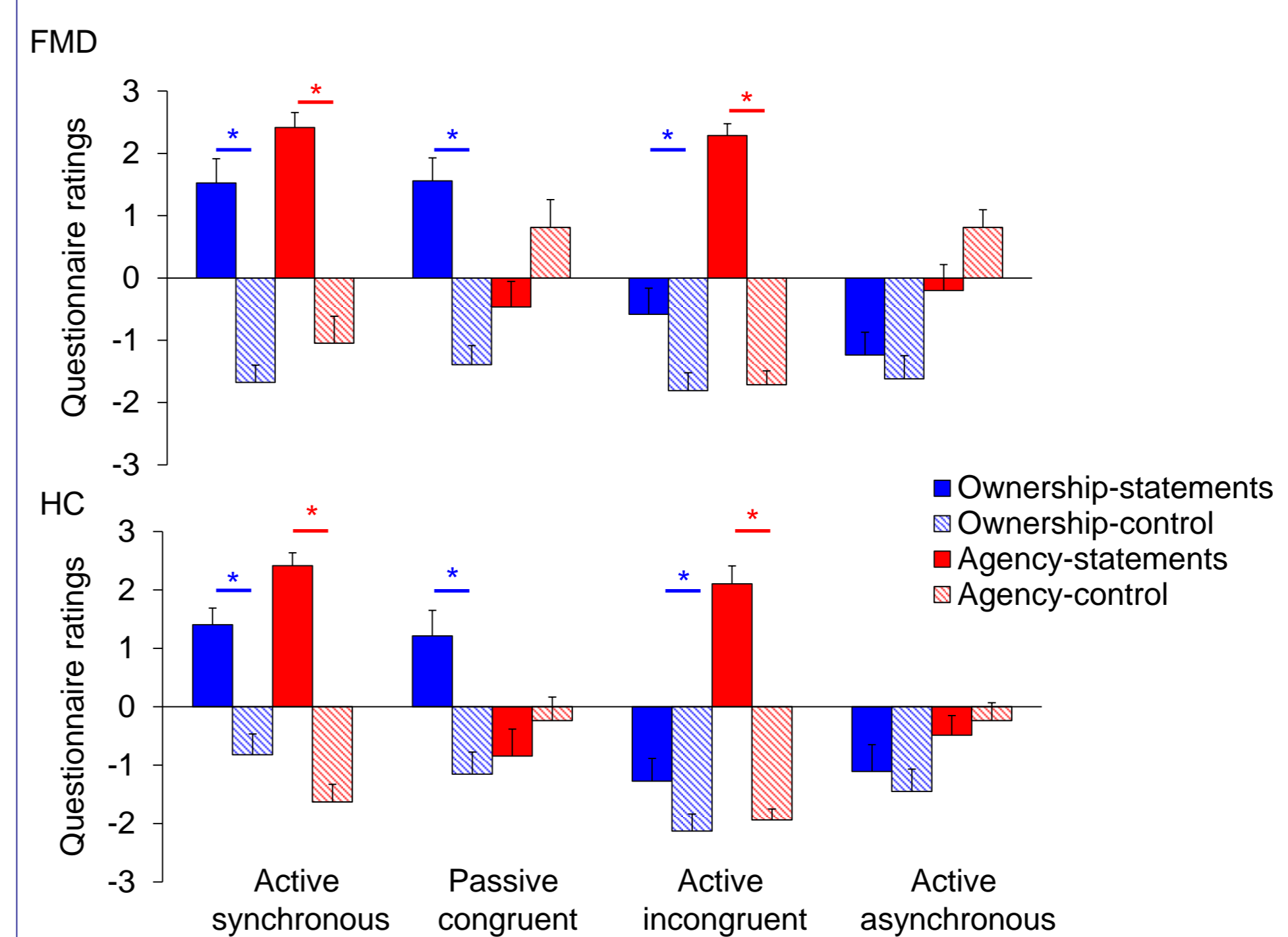
## Participants

Patient/ Gender	Age	Disease duration (months)	Type of FMD
1/F	36	1	Gait disorder
2/F	44	84	Gait disorder
3/F	66	84	Gait disorder
4/F	44	10	Gait disorder
5/F	37	8	Gait disorder, cervical dystonia
6/F	40	18	Gait disorder, legs dystonia
7/F	44	24	Gait disorder
8/F	34	-	Gait disorder
9/F	36	6	Gait disorder, tremor
10/F	26	40	Gait disorder
11/F	32	32	Gait disorder
12/M	52	3	Gait disorder, tremor
13/F	38	36	Gait disorder
14/F	29	36	Gait disorder, tremor
15/F	53	48	Gait disorder, tremor
16/F	23	3	Gait disorder, cervical dystonia, tremor
17/F	30	6	Upper limb and voice tremor
18/M	30	2	Upper limb tremor
19/F	22	10	Gait disorder, left hand tremor
20/F	70	12	Upper limb tremor
21/F	51	36	Left hand tremor

**FMD group**  
21 patients with clinically defined diagnosis of functional movement disorder (FMD)

**HC group**  
21 age and gender matched healthy volunteer

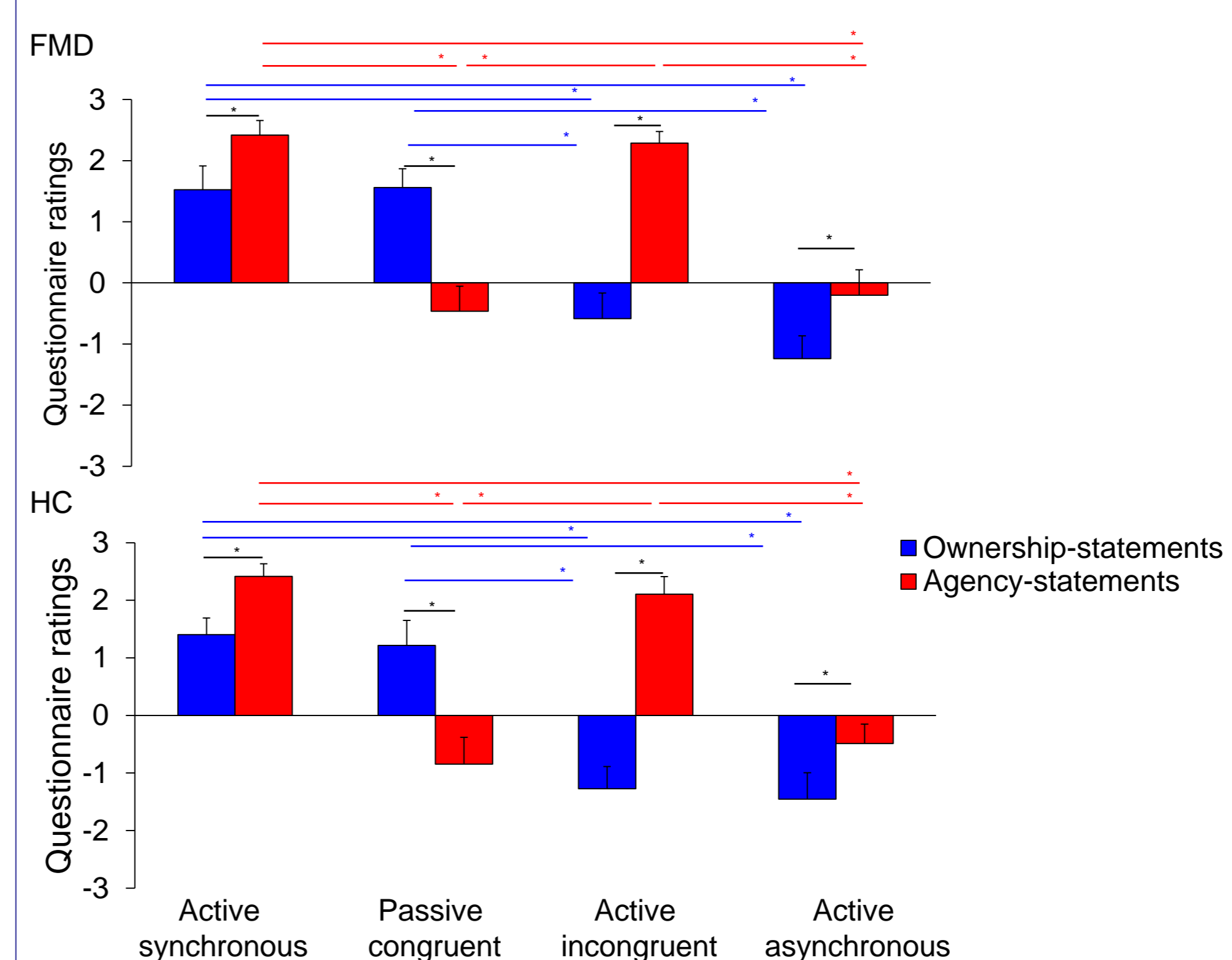
## Results



### Reliability of mRHI

Experimental vs. control statements in each condition and in both groups

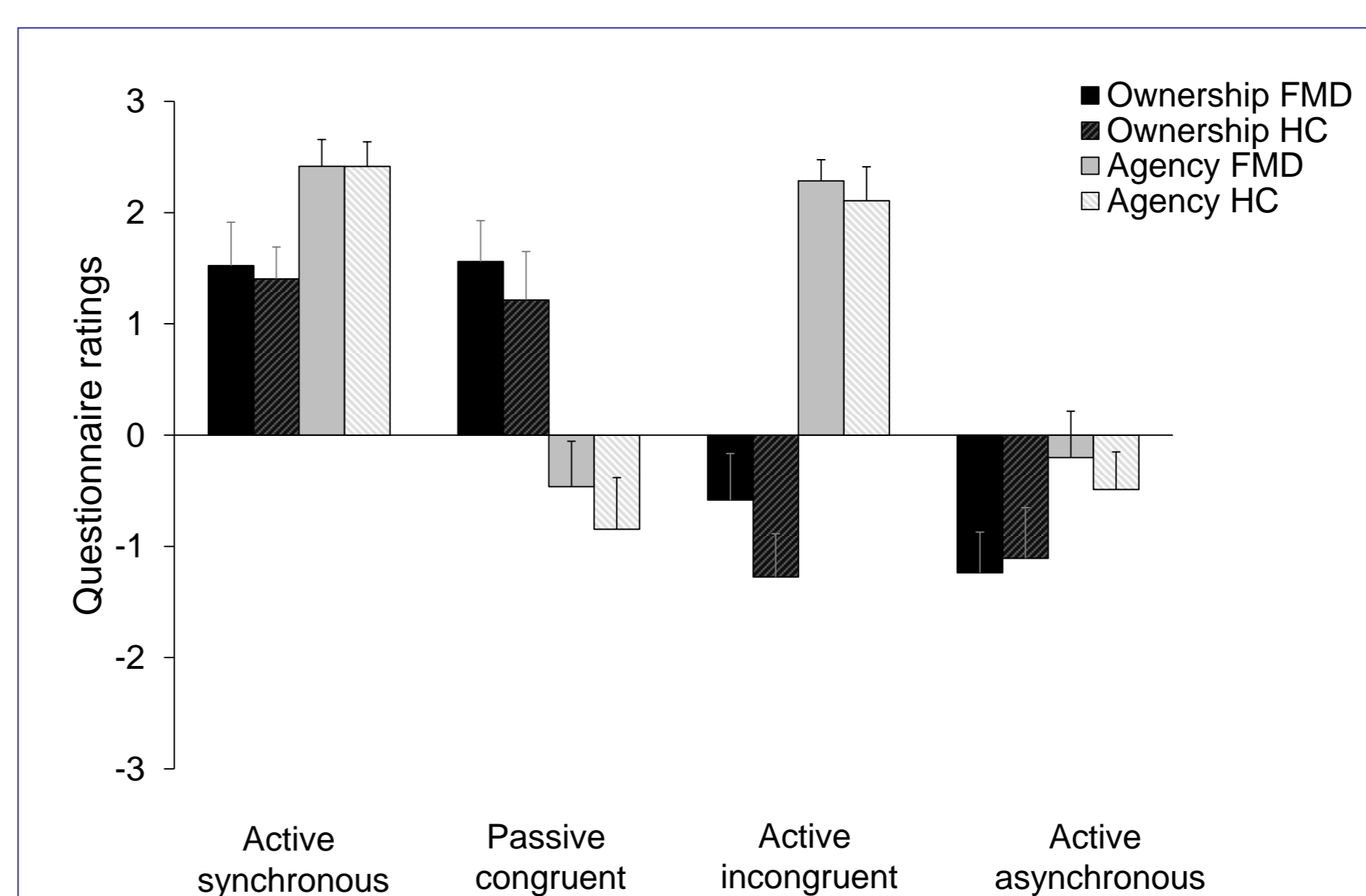
The mRHI is a **reliable tool** to investigate the SoA and the SoBo.



### Sensitivity of mRHI to SoA and SoBo

Ownership and agency ratings across condition in both groups.

The mRHI has ad hoc conditions for **selectively** and **simultaneously** inducing the SoA and SoBo.



### Explicit SoA and SoBo in FMD

Ownership and agency ratings between groups in all the conditions.

FMD patients have unaltered **explicit** SoA and SoBo.

## Discussion

Previous studies found altered implicit measure of agency (e.g., action-effect binding) for normal voluntary movements (e.g., button press) in FMD. Conversely, we found unaltered explicit feeling of agency in FMD. These contrasting evidences could hint at a dissociation between explicit and implicit SoA for normal voluntary movements in FMD, with the former being preserved and the latter impaired. Regarding the SoBo, our results are in line with a previous RHI study finding spared SoBo in FMD.

### References

Edwards MJ et al., 2011; Kalckert and Ehrsson, 2012; Kranick et al., 2013; Demartini et al., 2016.