

Temporal characteristics of hemodynamic responses during active and passive hand movements in schizophrenia spectrum disorder

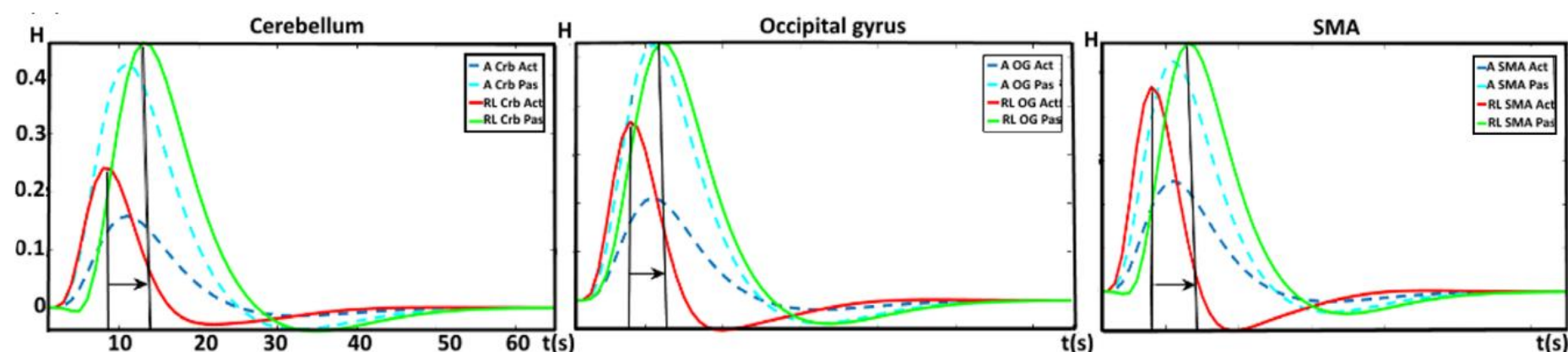
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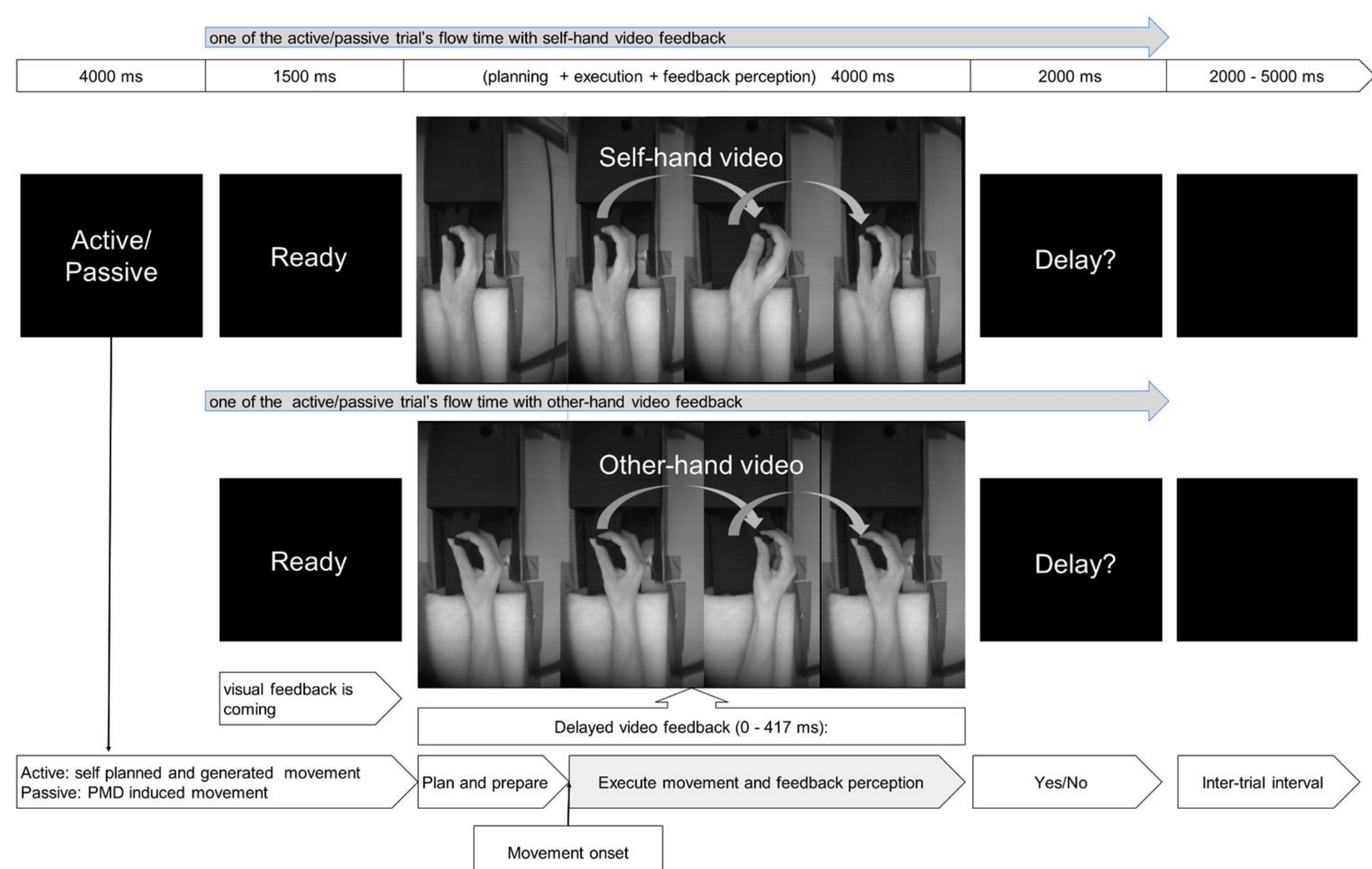
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Introduction

- Hallucinations and passivity symptoms are core symptoms of schizophrenia spectrum disorder (SSD), which at least partly rely on sensory-motor predictive mechanisms and are impaired in SSD patients. SSDs are characterized by having temporal deficits.
- Previous research demonstrated earlier and shorter processing of neural activity in active compared to passive hand movement (Kavroulakis et al. 2022).
- Timing and duration of BOLD responses can be quantified by derivatives of the hemodynamic response function using Taylor approximation.
- However, if impairments in predictive mechanisms related to active compared to passive hand movements in SSD are reflected in temporal aspects of the BOLD response is unknown.
- Hypothesis: Deficit in temporal processing, action-consequence prediction, and action-feedback monitoring deficit might reflect in the altered self-generated hand movement-induced temporal dynamics of BOLD responses in SSD patients.



Experiment process



- In an fMRI study, SSD patients (n = 20) and healthy controls (n = 20) are asked to detect temporal delays between active and passive hand movements and the displayed video feedback (Uhlmann et al., 2021).
- The video feedback was either from their own or from someone else's hand, moving following their hand movement (Uhlmann et al., 2020).
- Here, we focused on fMRI contrasts of complete hand movement processing (4000 ms); Fig. 1) of active vs passive movements.
- Canonically analysed results of this complete movement period had been published by Uhlmann et al., 2021 (see the following Figure 2).

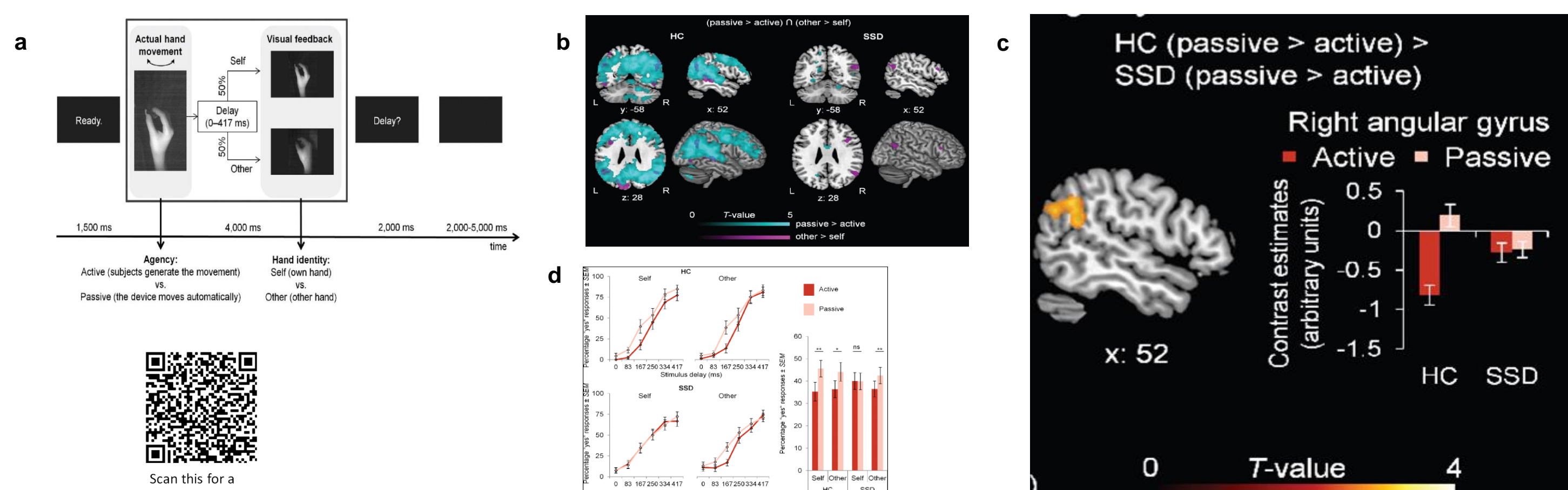
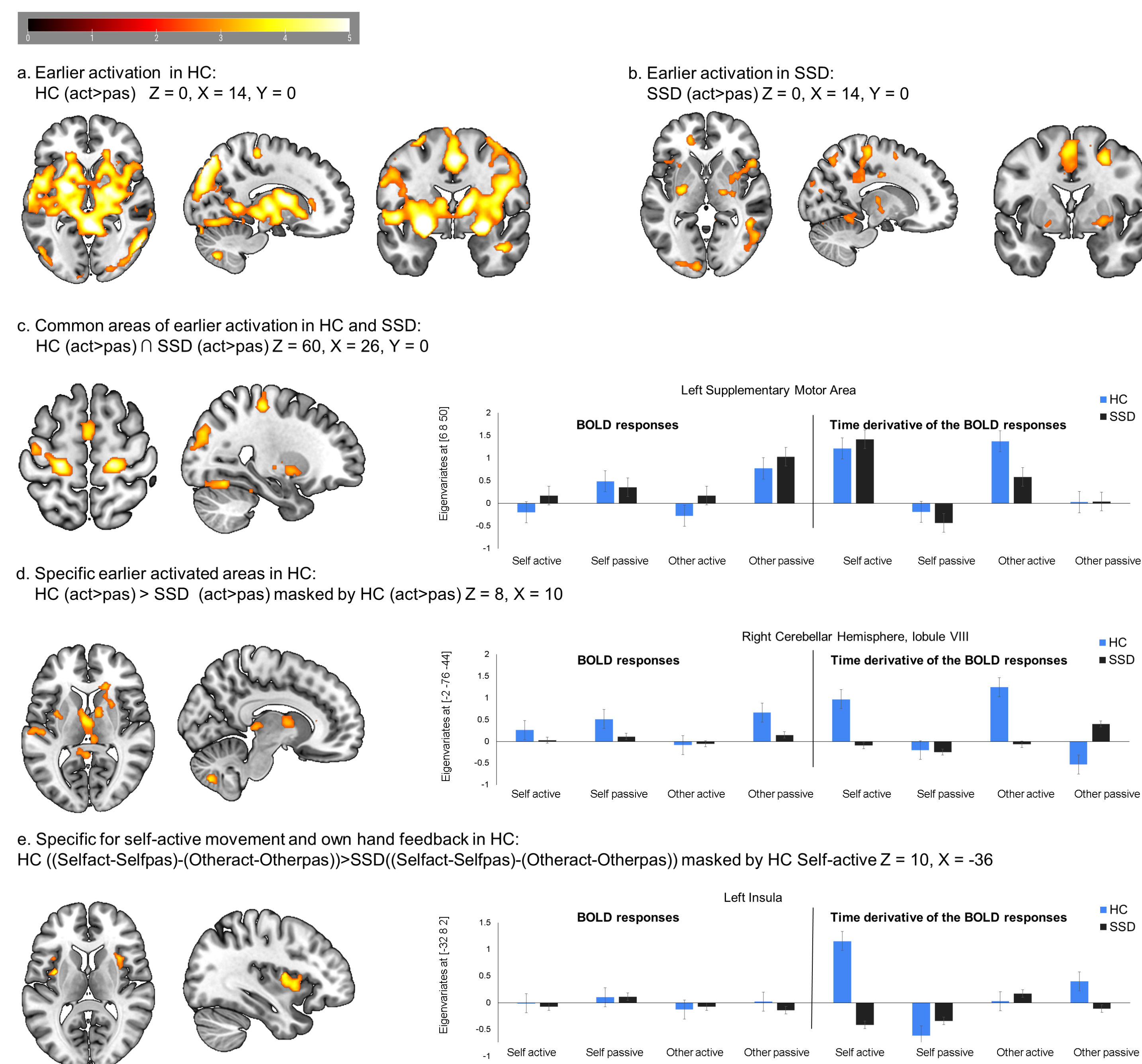


Figure 2: a) experimental setup, b) overlapping effects of agency and hand ID, c) Group effects of agency, and d) delay detection task result (Uhlmann et al., 2021)

fMRI results



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Discussion

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- Here, we focused on the temporal dynamics of BOLD responses during the self-generated (active) vs externally triggered (passive) hand movement. We found a large number of areas with similar processing timing (see figure c)
- Compared to HC, SSD patients revealed delayed BOLD activation patterns in the right caudate nucleus, lobule VIII of the right cerebellar hemisphere, left superior temporal gyrus, left postcentral gyrus, left thalamus, and left putamen for self-induced compared to externally triggered hand movement (see figure d).
- Interestingly, HC shows specific earlier activation in the bilateral putamen and insula, particularly for the active movement with own hand feedback compared to SSD patients (see figure e)
- Another study reported reduced activation in the left insula and putamen, specifically during the preparation of active hand movement with own-hand video feedback (Rashid et al. 2025)

Conclusion

- Our results suggest that deficits in active action-outcome prediction and monitoring in schizophrenia are reflected in later neural processing specifically in active conditions with feedback of the own hand.
- Diminished differentiability and attributability of active and passive movements could underline the impaired sense of agency and ego disturbances in schizophrenia.
- Rashid et al. 2025 Preprint published in the BioRxiv

References

- [1] Kavroulakis et al., 2022 Human Brain Mapping
- [2] Uhlmann et al., 2020, Human Brain Mapping
- [3] Uhlmann et al., 2021, Schizophrenia Bulletin
- [4] Rashid et al. 2025, Brain Communication
- [5] Rashid et al. 2025, Preprint published in the BioRxiv

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