

# Resting - State EEG Indicates Unstable Microstates in Visual Snow Syndrome

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## Visual Snow Syndrome (VSS)

- broad spectrum of positive visual symptoms
- main symptom is the perception of tiny flickering dots throughout the visual field
- More than 2% of the population is affected<sup>1</sup>
- Cause and pathophysiology of VSS are still largely unknown
- It's most likely a neural network disorder<sup>1</sup>

## Findings

- MS explained 78.4% of data and did not differ between groups
- The life span and amplitude (mean global field power; GFP) of MS were significant lower in VSS patients compared to controls
- MA class A demonstrated an aberrant transition probability and switched more often to class B ( $p = .001$ ) and less likely to MS class C ( $p = .011$ ) in VSS patients

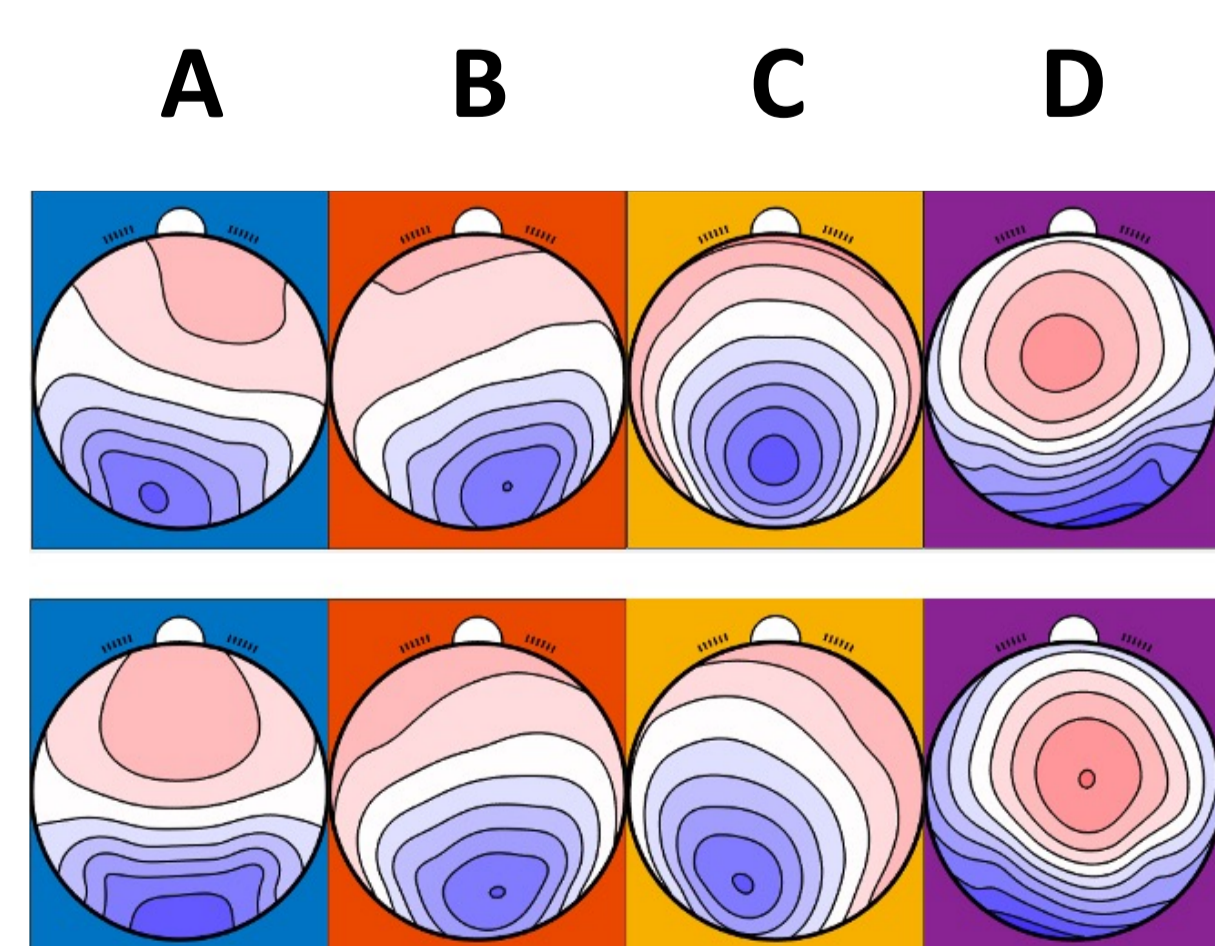
## Microstates (MS)

- account for a significant amount of the variance in resting - state EEG activity
- considered the basic building blocks of human neurological processes
- Changes in topographies & dynamics reflect shifts & alterations in underlying neural processes
- Divergent dynamics in migraine, schizophrenia and other disorders<sup>2,3</sup>
- 4 well replicated canonical microstate classes correlate with specific neural mechanisms:<sup>2,3</sup>

A (auditory & visual processing, arousal)  
B (visual processing)  
C (self-reflection, salience network)  
D (dorsal attention network)

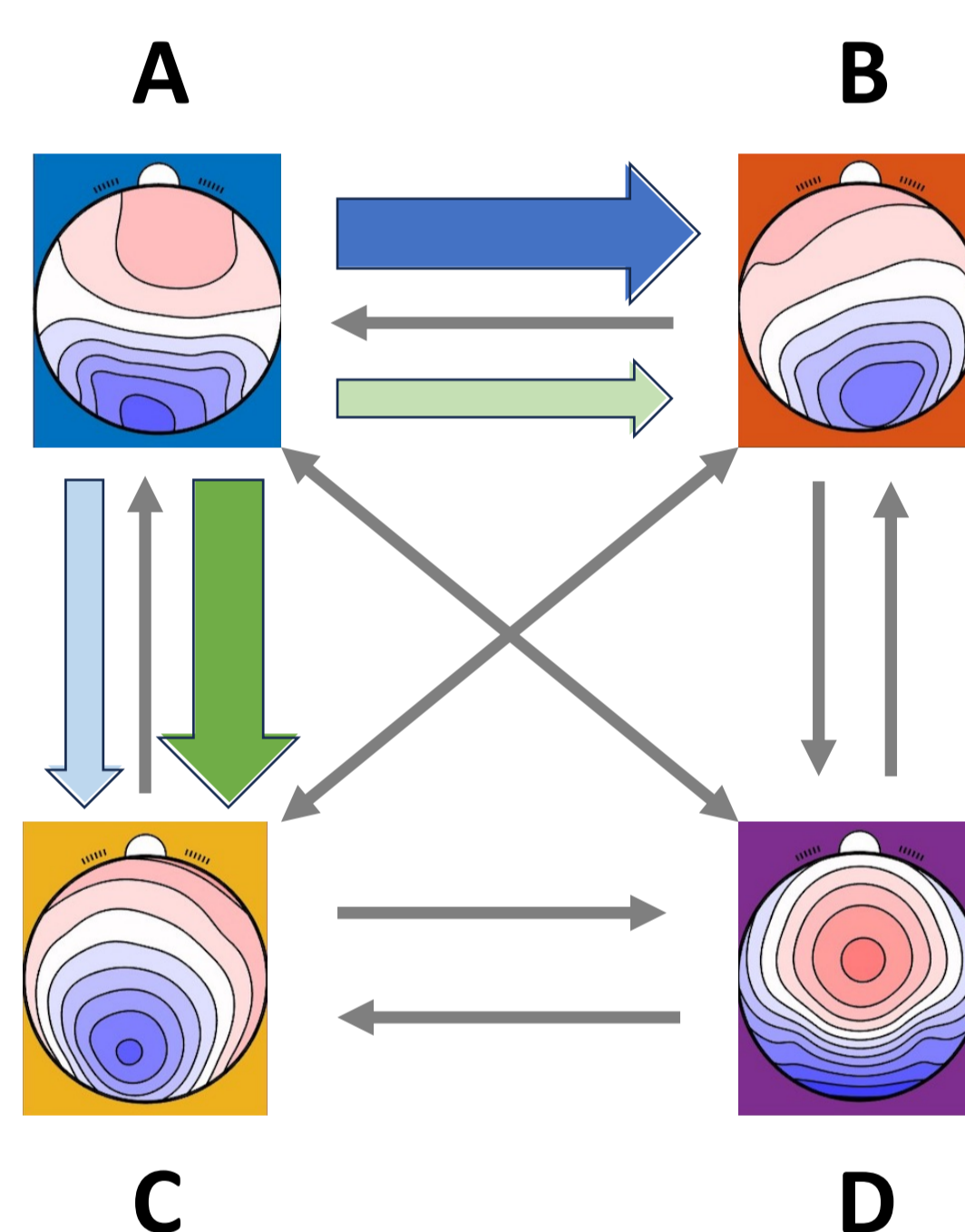
## Methods

- Comparison of resting - state EEG microstate dynamics, eyes closed
- cohort of 21 subjects with VSS (8 females,  $33 \pm 9.56$  years) & 21 matched control patients (8 females,  $33 \pm 11.1$  years)
- Matching on diagnosed VSS, sex, age, & migraine status
- Two-thirds had migraine; tinnitus not surveyed.

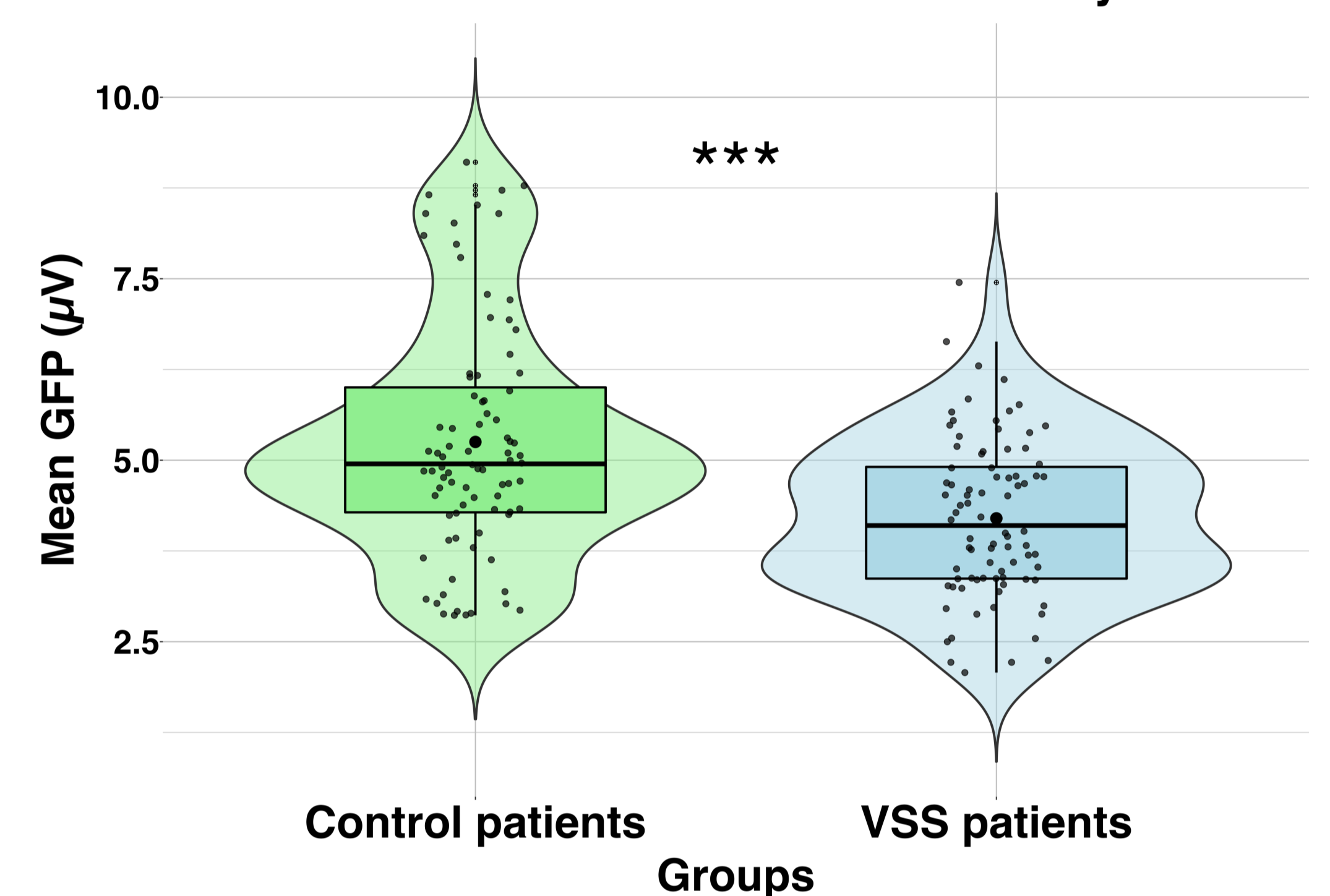


Four computed MS classes A – D  
Top row: mean microstates of control group  
Bottom row: mean microstates of VSS group

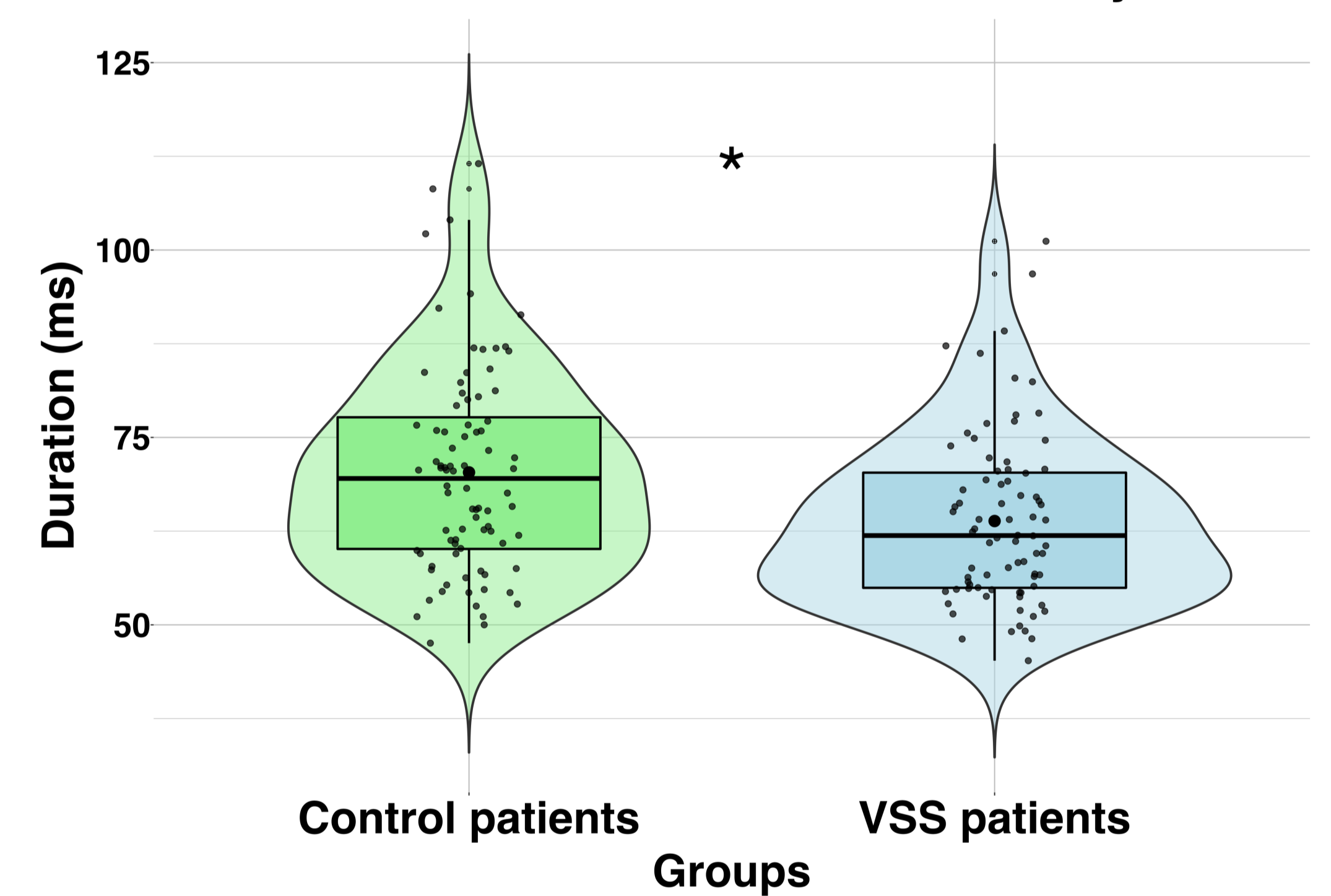
### Transition differences between groups



### Microstates are weaker in visual snow syndrome



### Microstates are shorter in visual snow syndrome



— median, • mean, \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

## Conclusion

We demonstrated that the general manifestation of microstates and specific dynamics differed from those of control subjects. Subjects with VSS had a shorter duration and lower strength of microstates, indicating unstable and weaker neural network activity in this cohort. MS class A showed abnormalities in transition behavior, suggesting an imbalance in auditory and visual neural processing. Further analyses of microstates within homogeneous cohorts could lead to differentiated results that can be used as potential biomarkers for VSS. The present study supports the existing consensus that seeing tiny flickering dots is not an illusion but rather due to disturbed large scale networks processes.

1) Klein, A., & Schankin, C. J. (2021a). Visual Snow Syndrome as a Network Disorder: A Systematic Review. *Frontiers in Neurology*, 12, 724072. <https://doi.org/10.3389/fneur.2021.724072>

2) Michel, C. M., & Koenig, T. (2018). EEG microstates as a tool for studying the temporal dynamics of whole-brain neuronal networks: A review. *NeuroImage*, 180, 577–593. <https://doi.org/10.1016/j.neuroimage.2017.11.062>

3) Tarailis, P., Koenig, T., Michel, C. M., & Griškova-Bulanova, I. (2023). The Functional Aspects of Resting EEG Microstates: A Systematic Review. *Brain Topography*. <https://doi.org/10.1007/s10548-023-00958-9>