Delta vs. Gamma synchronization in Schizophrenia

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Schizophrenia

- Mental disorder
- Affects 1% of general population
- Heterogeneous symptoms
  - Abnormal perceptions, thoughts
  - Poor executive function
  - Reduced verbal working memory
  - Speech disorganization
  - Hallucinations
    - Auditory and visual

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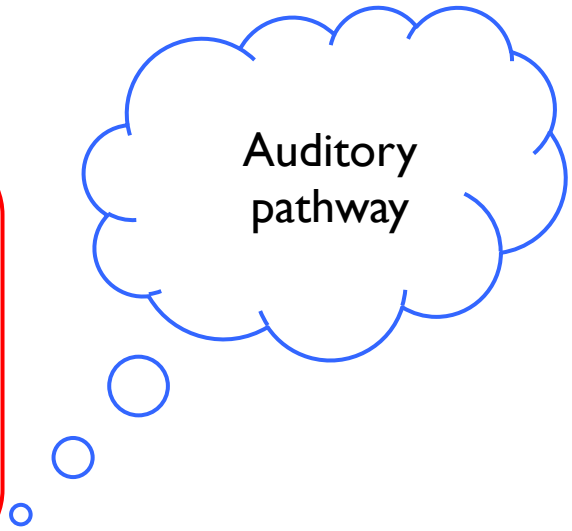

Schizophrenia

- Electrophysiological abnormalities (EEG)
  - Mismatch negativity, steady state responses etc.
- Auditory Steady State Responses (ASSRs)
  - Response to a periodic stimulus
    - Clicks, AM, etc.
  - Typically studied at 40 Hz (gamma band)
    - Strongest response (in humans)
    - Association of gamma band synchrony with cognition

Example of ASSR at 40 Hz

Kwon et al. 1999

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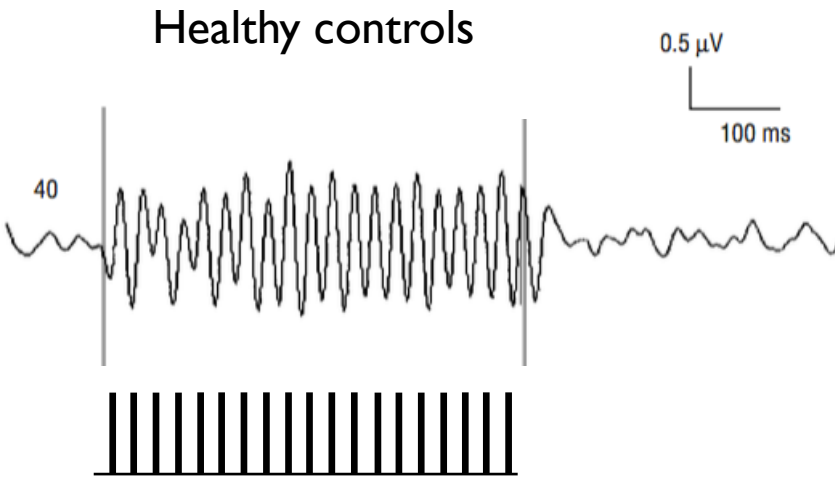

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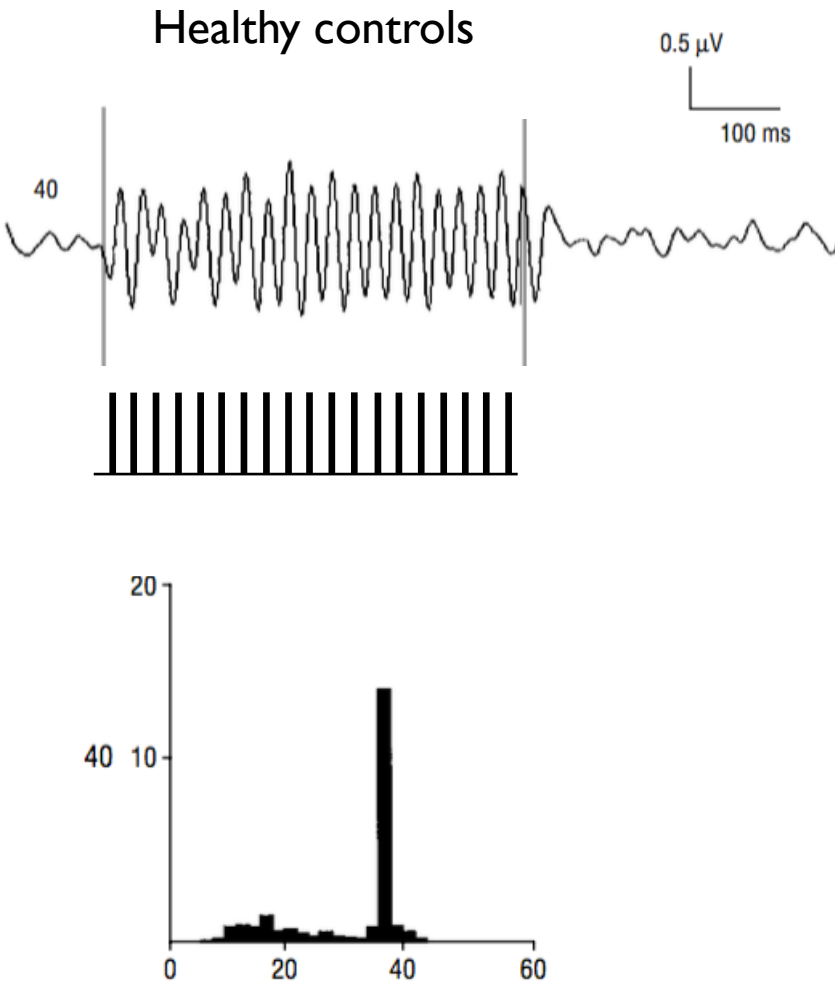

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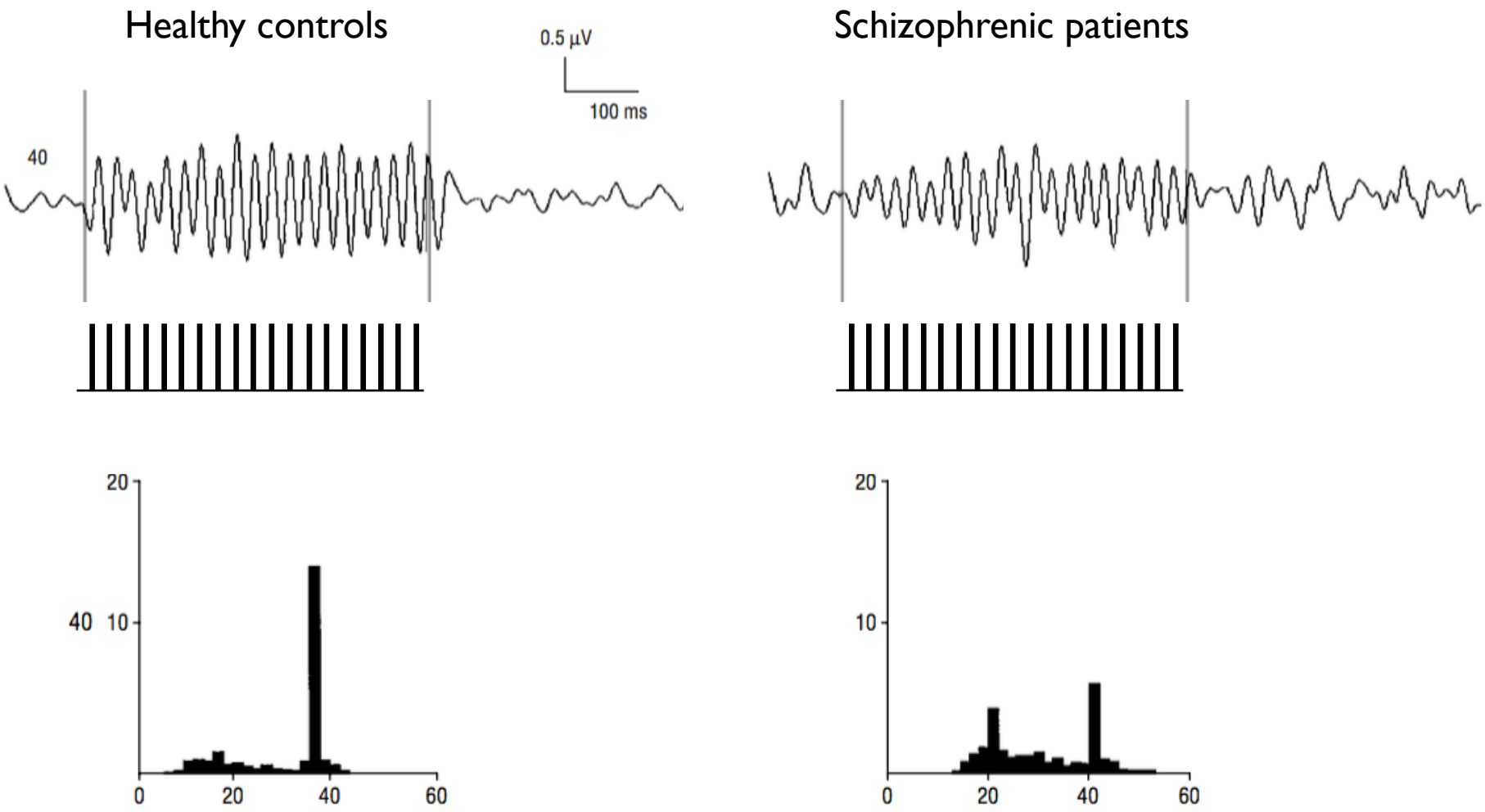

Kwon et al. 1999

Hypothesis

- Auditory hallucinations, a hallmark symptom
- Slow temporal modulations (delta 1-4 Hz , theta 4-8 Hz) are important for perception of speech and natural sounds.
- Delta & theta band abnormalities may be a better indicator !

Methods

- Click train at 2.5, 5, 10, 20, 40, 80 Hz rates
- Responses recorded using EEG

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- 108 Healthy controls
- 128 Schizophrenic patients
- 55 First degree relatives

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- ASSR measure: Power at stimulus frequency, normalized by baseline power.

Whole head EEG auditory response

Normalized ASSR power

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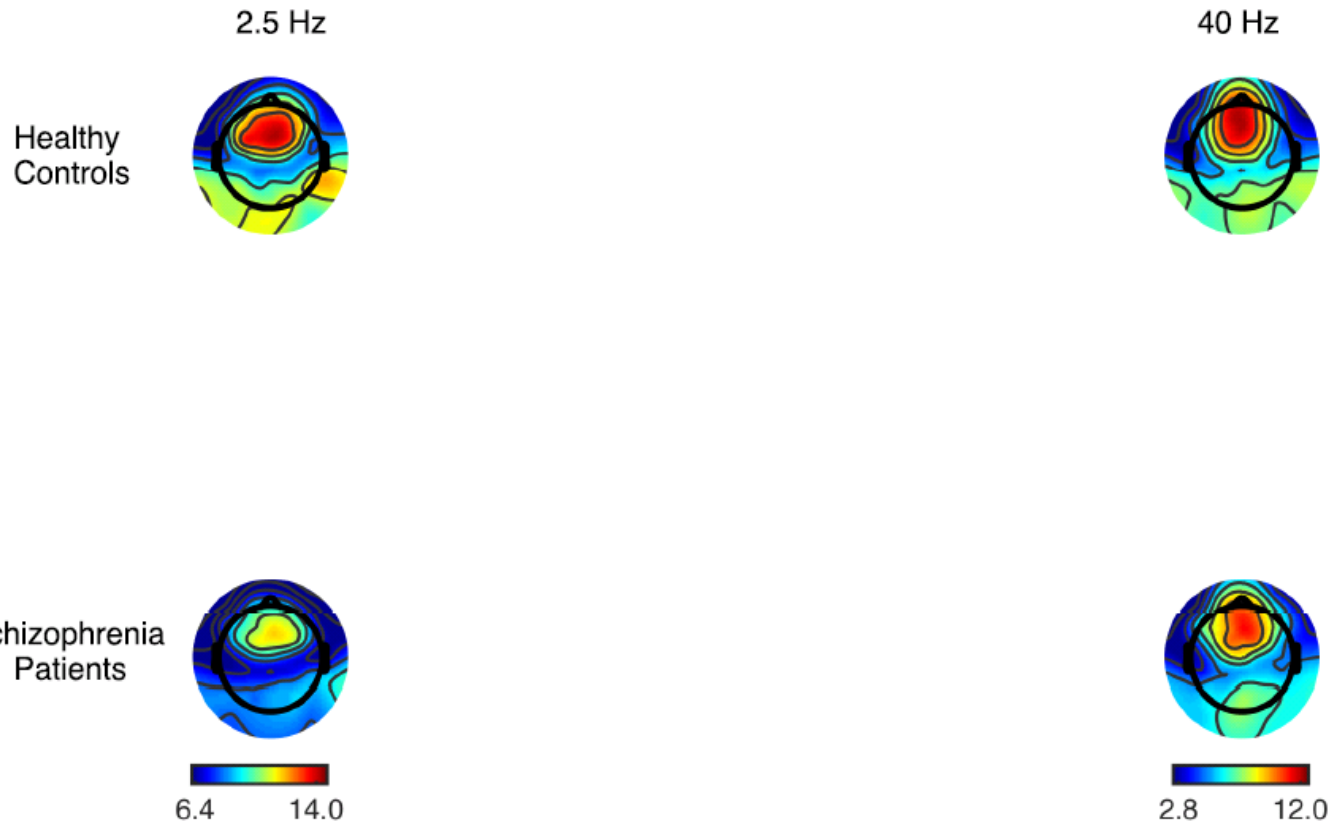
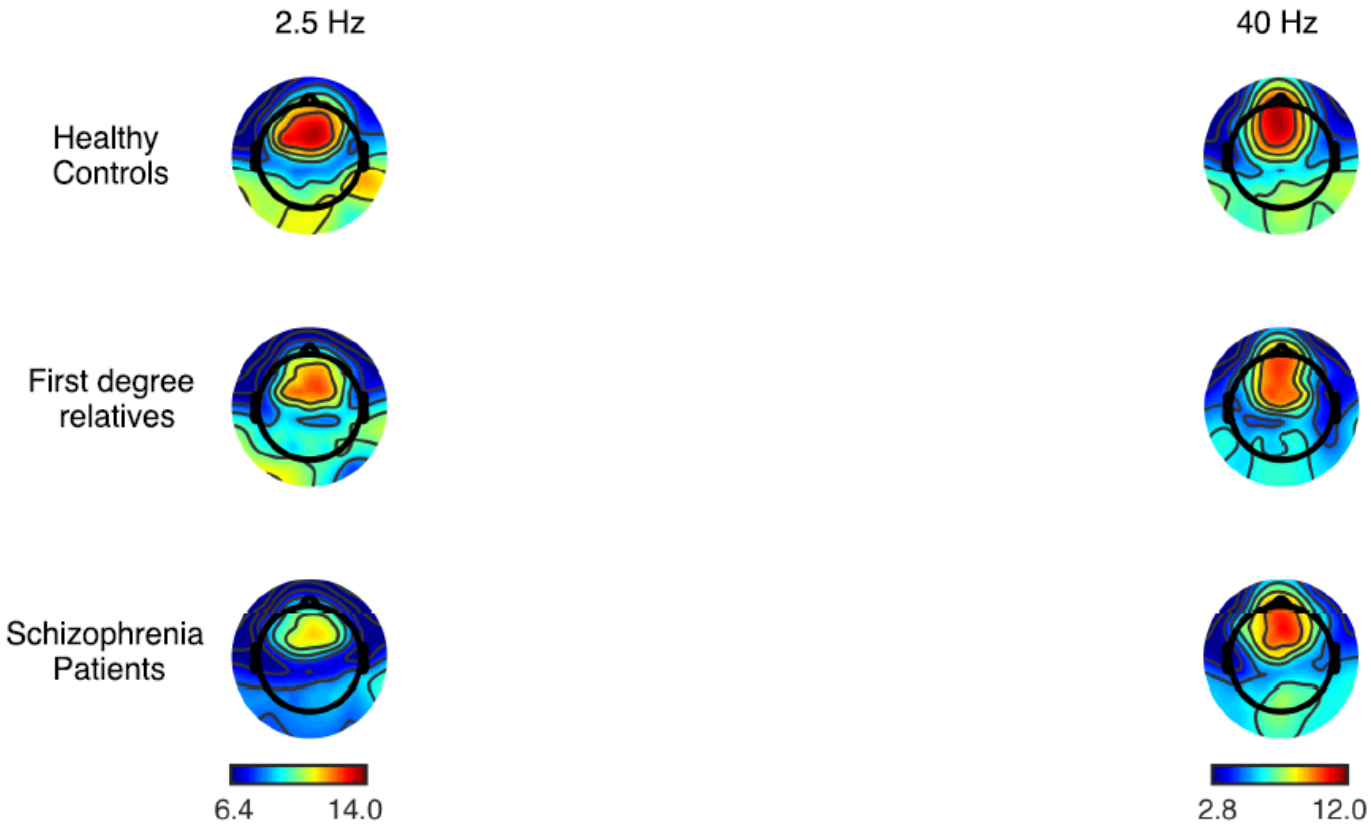


Whole head EEG auditory response

Normalized ASSR power



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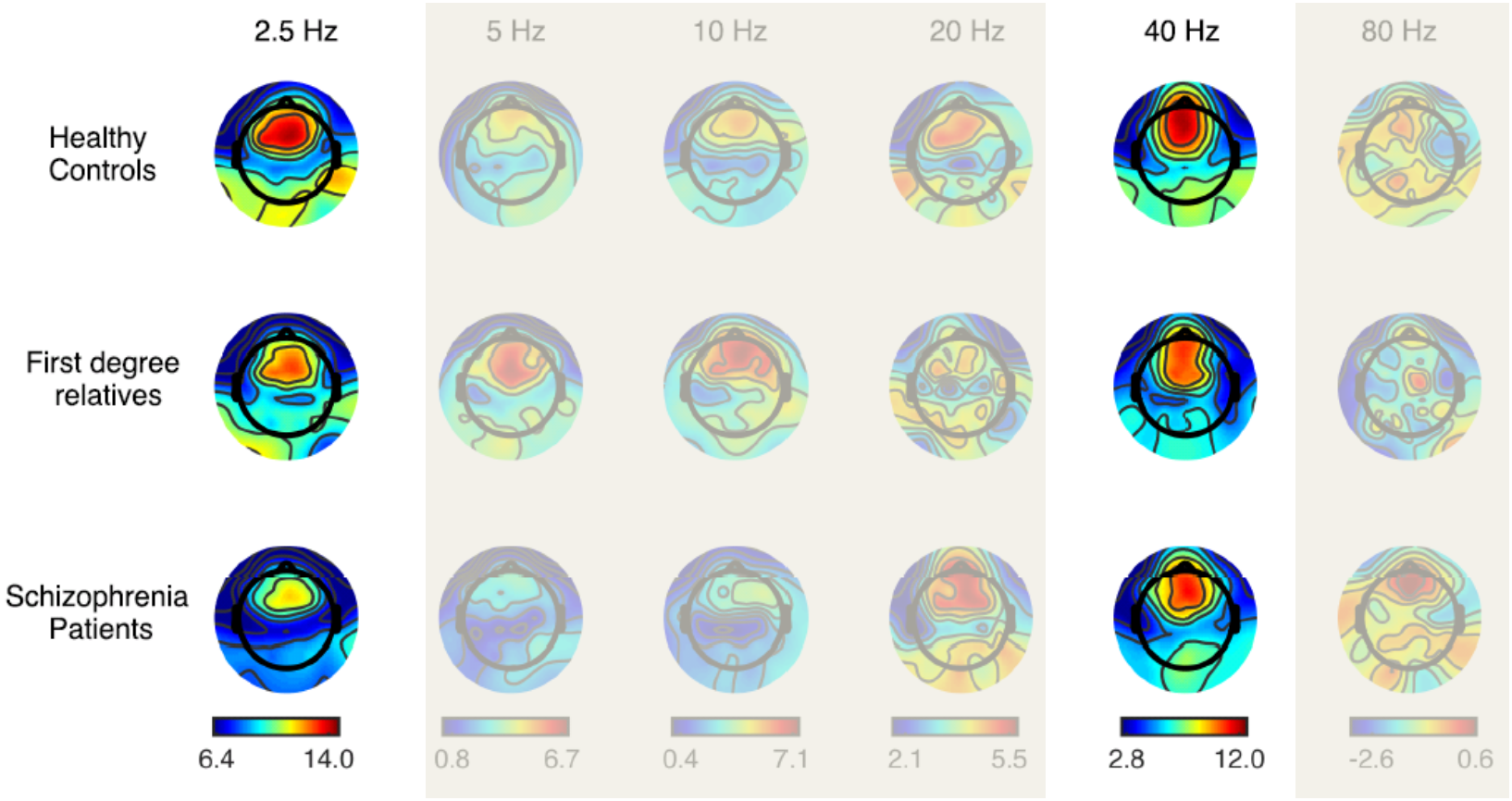
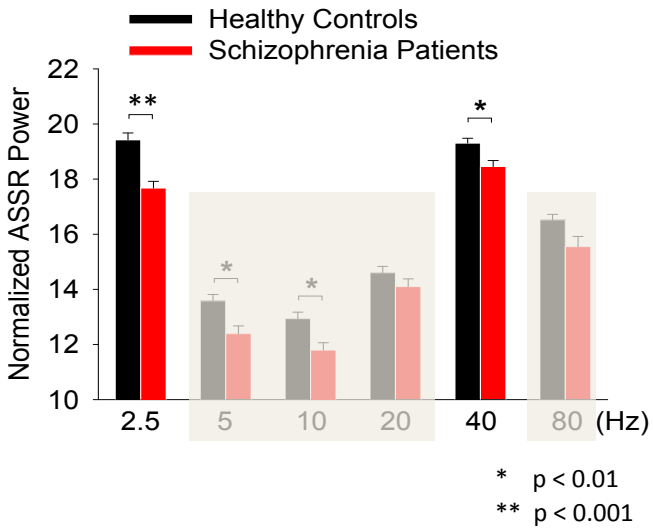


ASSR differences by rates



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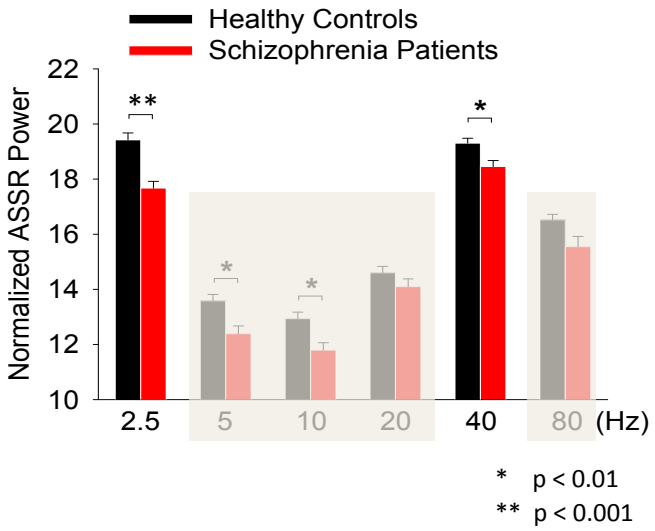

- Significant difference between Healthy Controls (↑) and Schizophrenic Patients (↓) at 2.5 Hz, 5 Hz, 10 Hz and 40 Hz

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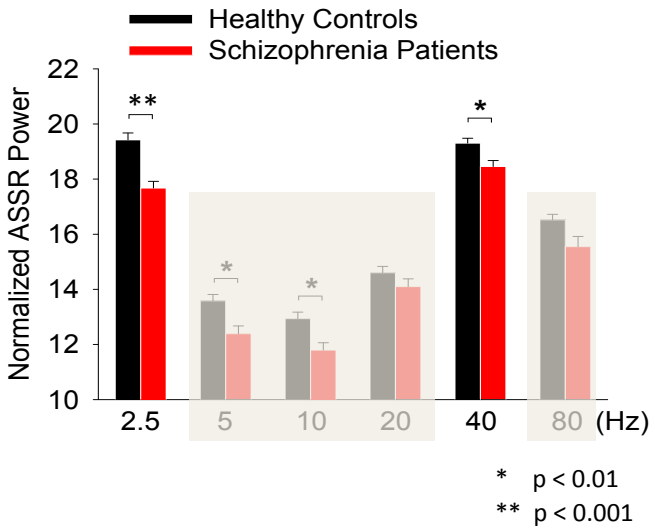

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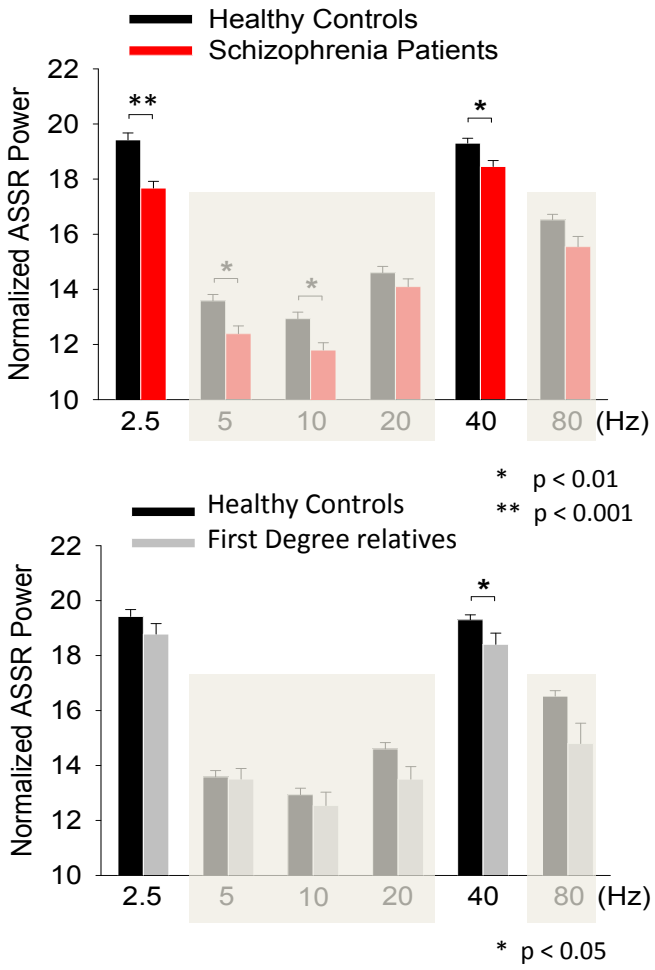

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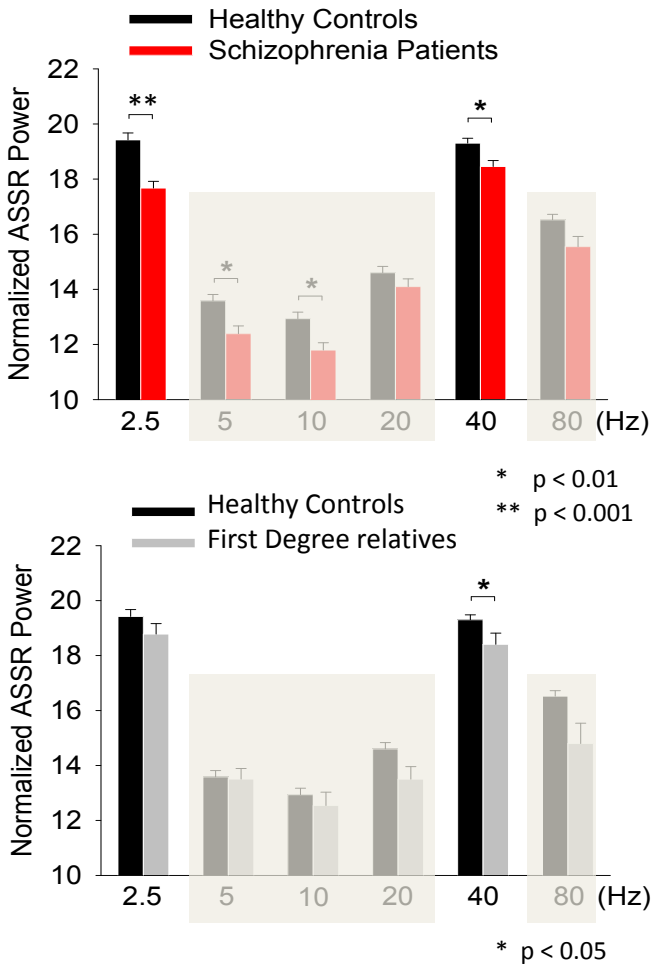

- Significant difference between Healthy Controls (↑) and Schizophrenic Patients (↓) at 2.5 Hz, 5 Hz, 10 Hz and 40 Hz
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- 40 Hz difference between Healthy controls and non-schizophrenic First degree relatives

Cognitive measure

- Verbal working memory task

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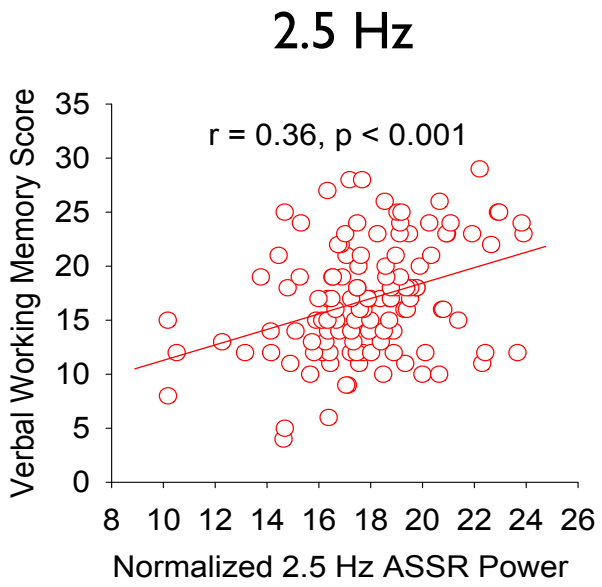
Schizophrenia Patients



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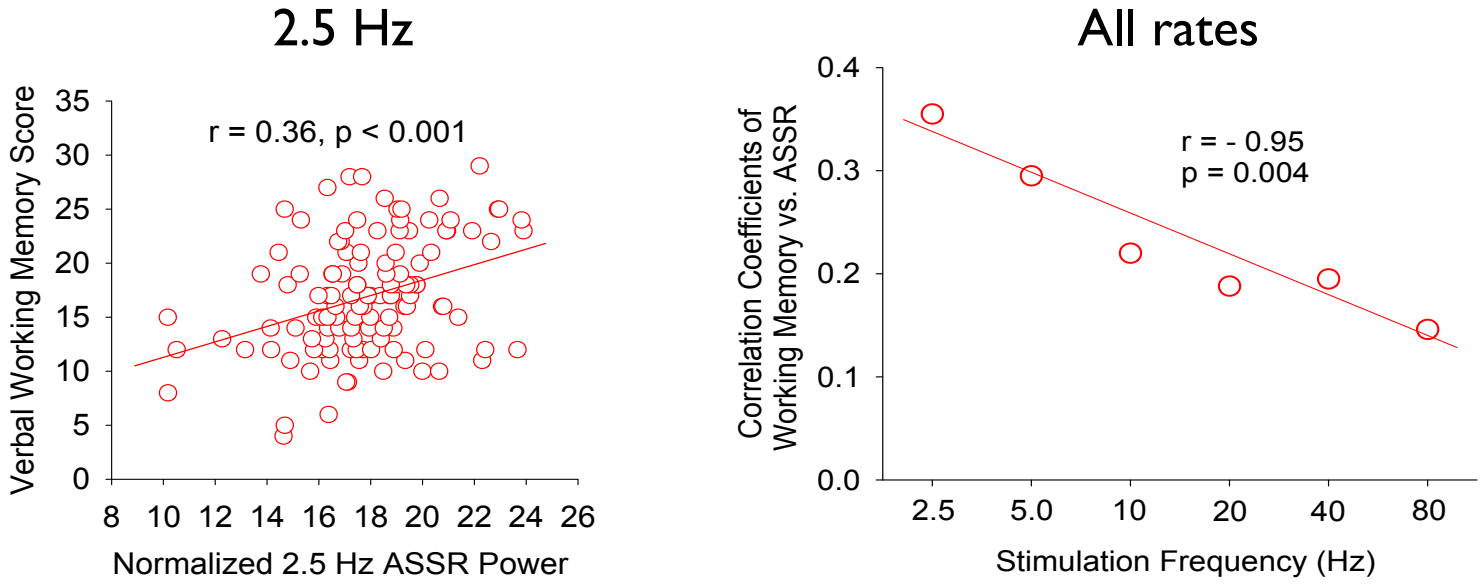

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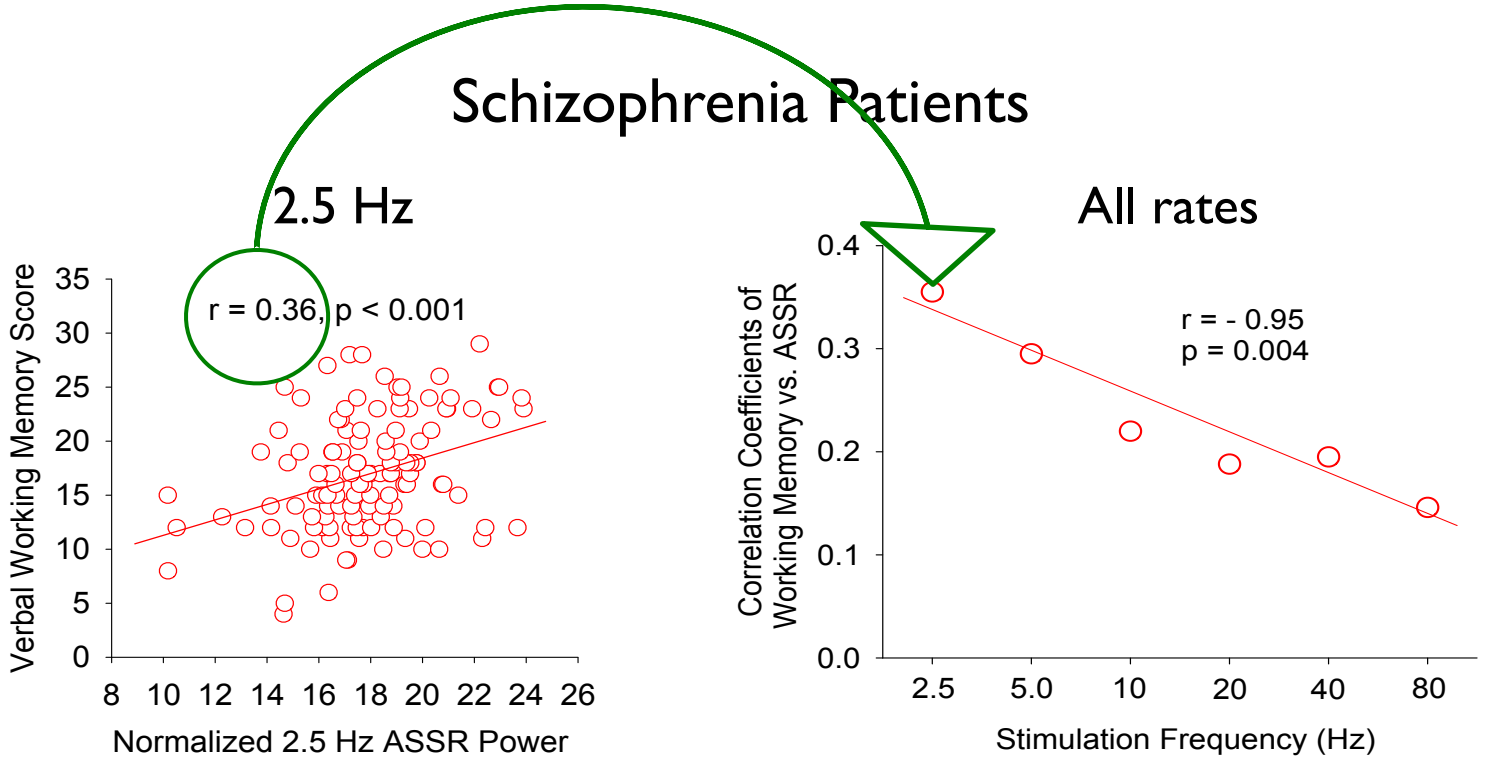

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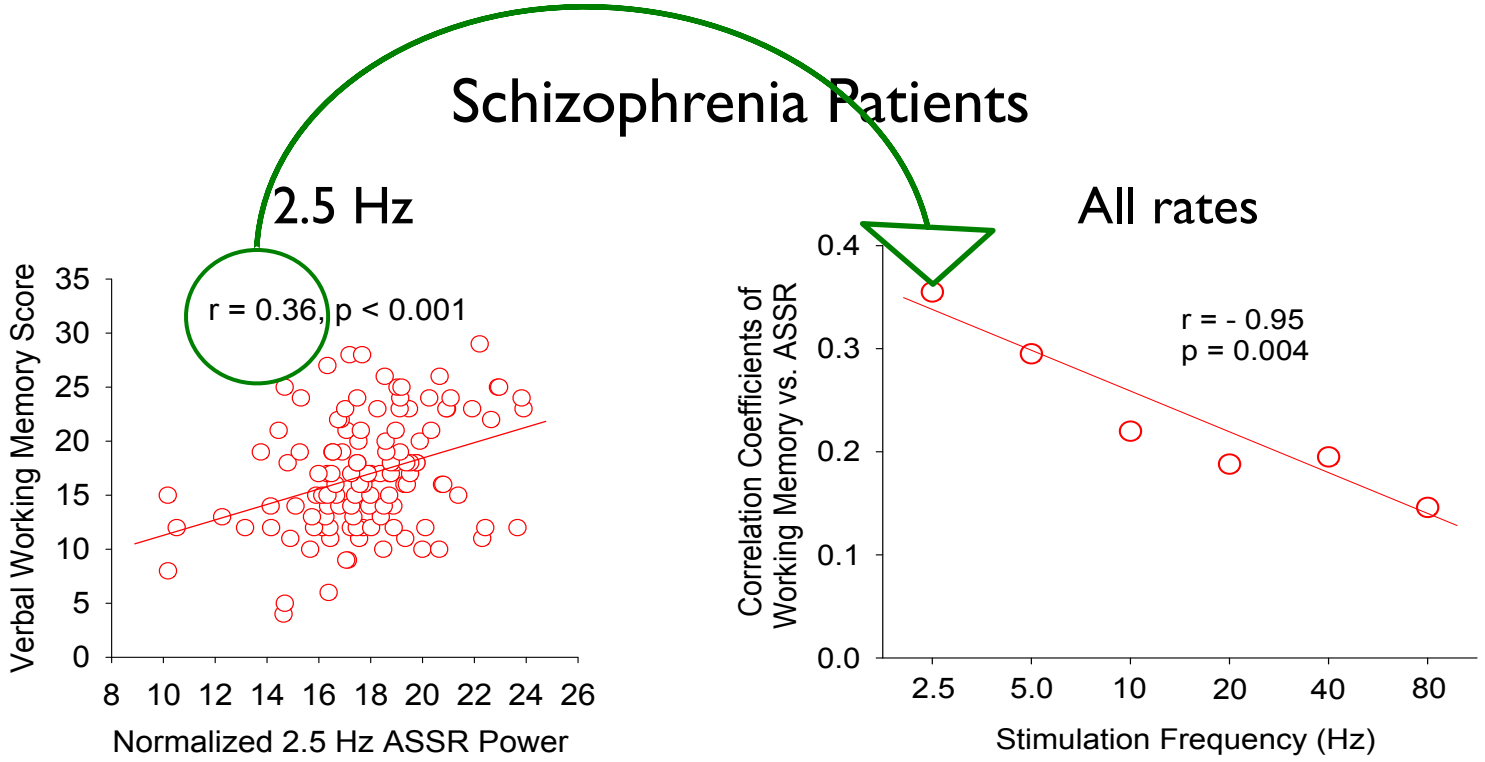
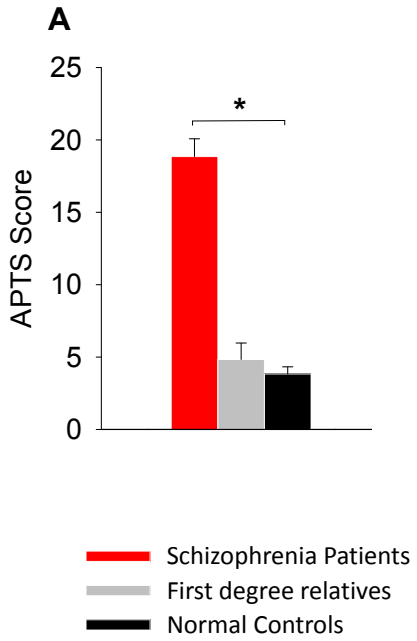


- Weaker auditory response ⇔ verbal working memory problems
- Holds only for slower frequencies

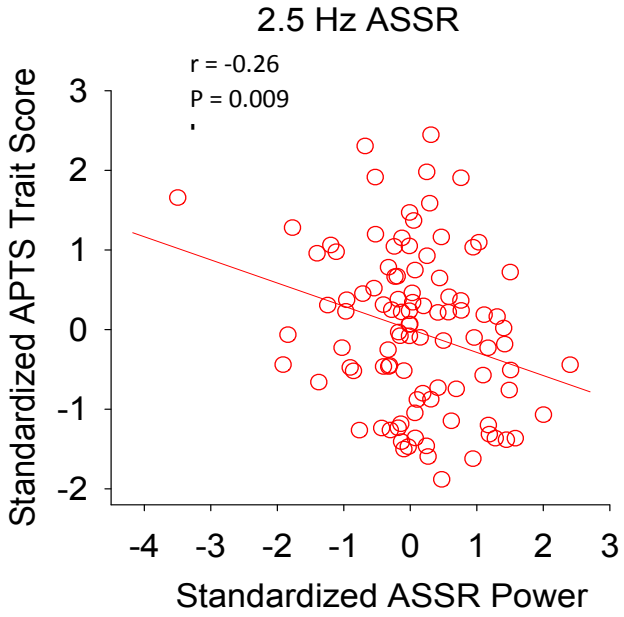
Behavioral measure

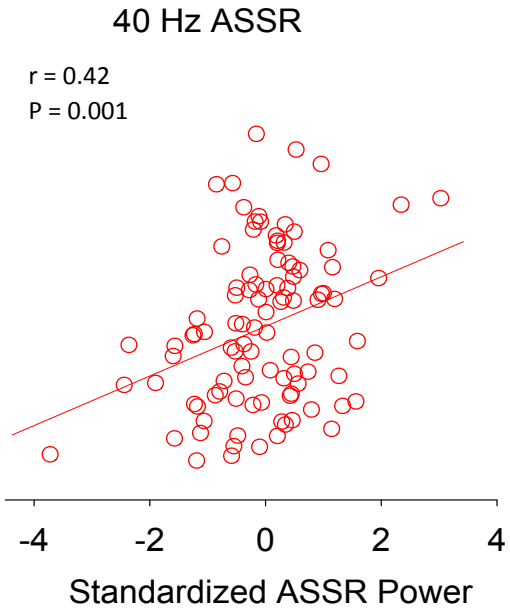
- Auditory Perceptual Trait and State scale (APTS)
  - Self reported questionnaire
  - "hallucination index"
    - 'hearing my name called but realizing that it must have been my imagination'
    - 'I have experiences that I cannot suppress or ignore the voices or sounds in my head'



Correlation with APTS

Schizophrenia Patients





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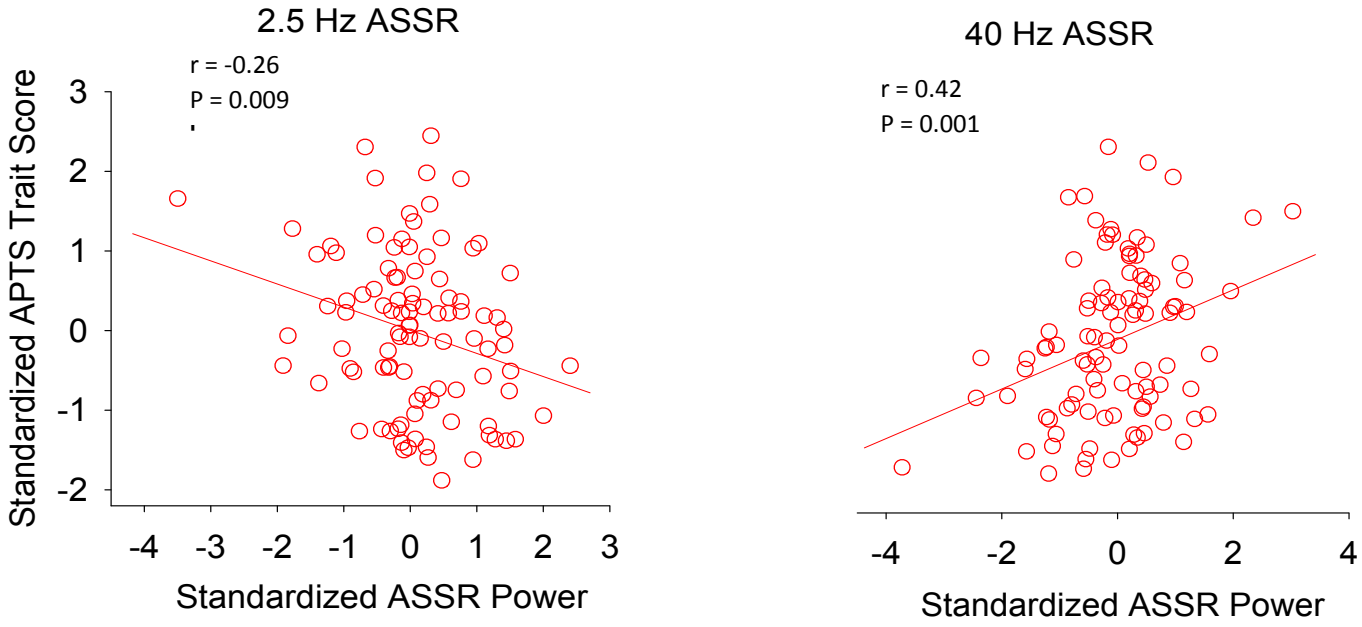

In delta band, weaker auditory response is associated with more severe hallucinations.

Summary

- Delta ASSR
  - shows better separability between healthy controls and schizophrenia patients than gamma
  - shows stronger association with working memory deficits

- Delta ASSR linked to behavioral auditory symptoms of schizophrenia
  - Gamma ASSR linked to susceptibility, not symptoms

Thank you