

THE RELATIONSHIP BETWEEN SIGN LANGUAGE FLUENCY AND MENTAL ROTATION: AN EEG STUDY

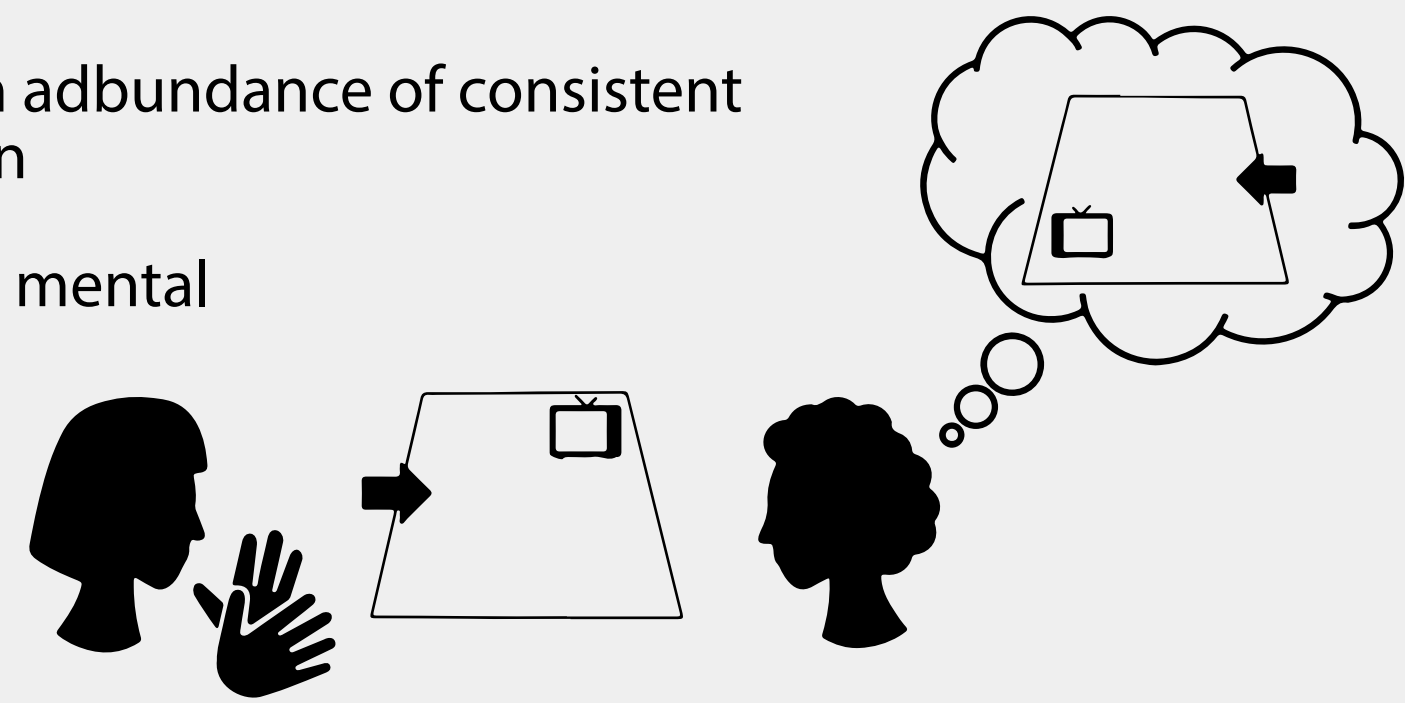
Emily Kubicek, Lorna Quandt, & David Thornton



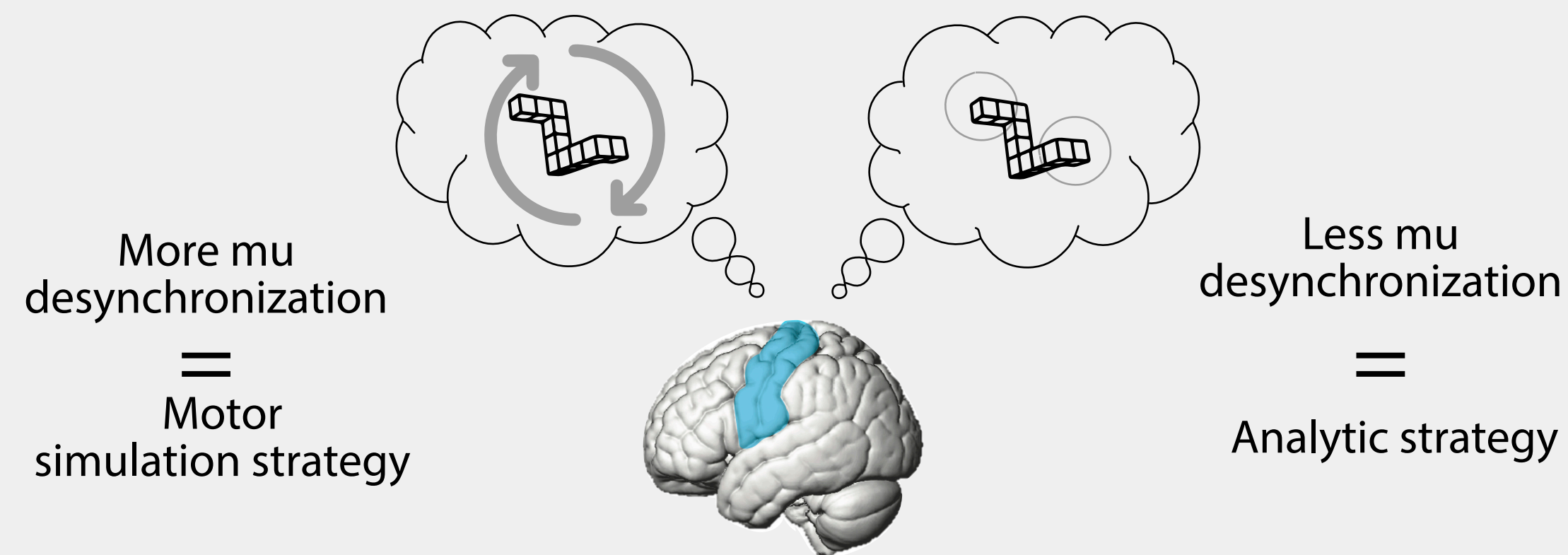
INTRO

Sign language users have an abundance of consistent practice with mental rotation

FLUENT signers are better at mental rotation than non-signers



Is **FLUENCY** needed to achieve this mental rotation benefit?



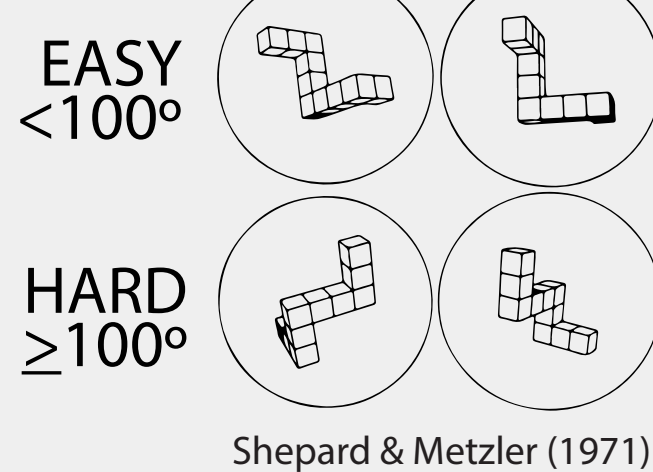
Does sign language **FLUENCY** affect which strategy is used during mental rotation tasks?

METHODS

PARTICIPANTS

- "Fluent"
 - Deaf Fluent (n = 18)
 - Hearing Fluent (n = 16)
- "Non-Skilled"
 - Hearing Non-Fluent (n = 17)
 - Hearing Non-Signers (n = 15)

STIMULI

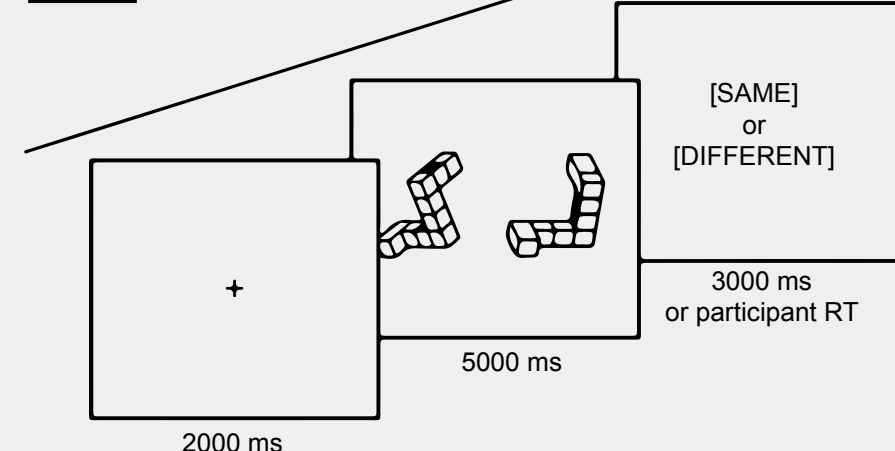


Shepard & Metzler (1971)

BEHAVIORAL

- ASL-CT
- Spatial Experience Survey
- Basic Background
- V-K Mental Rotation Test

EEG



HIGHLIGHTS

Fluent sign language users perform better on mental rotation tasks than non-signers

No studies prior to this have tried to see if the relationship between sign language knowledge and mental rotation is discrete or continuous (i.e. must one be fluent to gain mental rotation skill benefits)

Past studies have shown a unique activation signature during mental rotation tasks but none have investigated if this applies to sign language using populations

MAIN FINDINGS

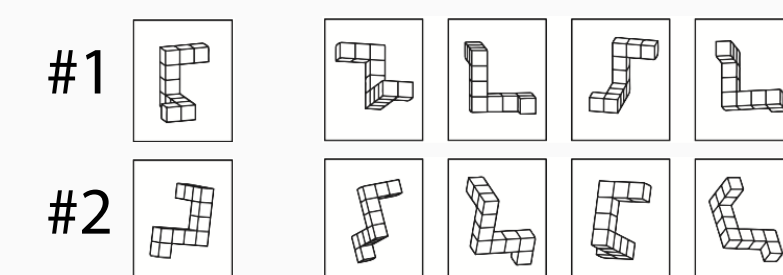
- Positive correlation between sign language knowledge and mental rotation ability
- When spatial experience is held constant, fluent signers still perform better than the non-skilled group
 - + Suggests sign language should be added to measures of spatial experience, as it may impact MRT scores/abilities
- No evidence to support any statistically significant differences between fluent and non-skilled groups' sensorimotor cortex engagement
 - + Suggests both groups are using similar motor simulation/analytic strategies to arrive at solutions

RESULTS

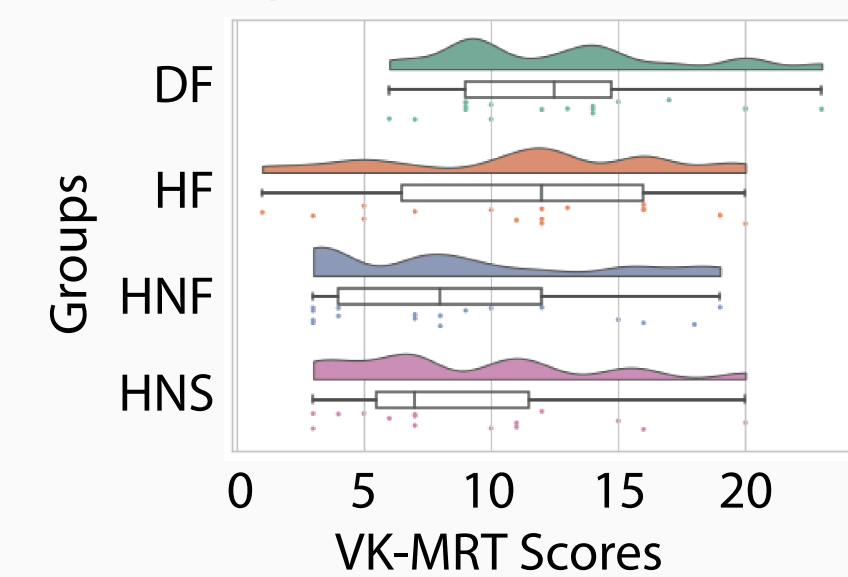
BEHAVIORAL

Mental Rotation Scores

Example problems from V-K MRT



All Groups' VK-MRT scores (out of 24)



FLUENT > NON-SKILLED
 $t(64) = 2.42, p = .02, d = .60$

DEAF FLUENT = HEARING FLUENT
 $t(32) = .95, p = .35, d = .33$

Fluent (Deaf-Fluent + Hearing-Fluent) signers had significantly higher mental rotation scores than the non-skilled (Hearing Non-Fluent, Hearing Non-Signers) group. Deaf fluent signers and hearing fluent signers had similar mental rotation scores.

Spatial Experience Scores

FLUENT = NON-SKILLED
 $t(64) = .90, p = .34, d = .22$

DEAF FLUENT > HEARING FLUENT
 $t(25) = 3.01, p = .006, d = 1.02$

Fluent (Deaf-Fluent + Hearing-Fluent) signers and the non-skilled (Hearing Non-Fluent, Hearing Non-Signers) group had similar spatial experience scores. Deaf fluent signers had significantly higher spatial experience scores than hearing fluent signers.

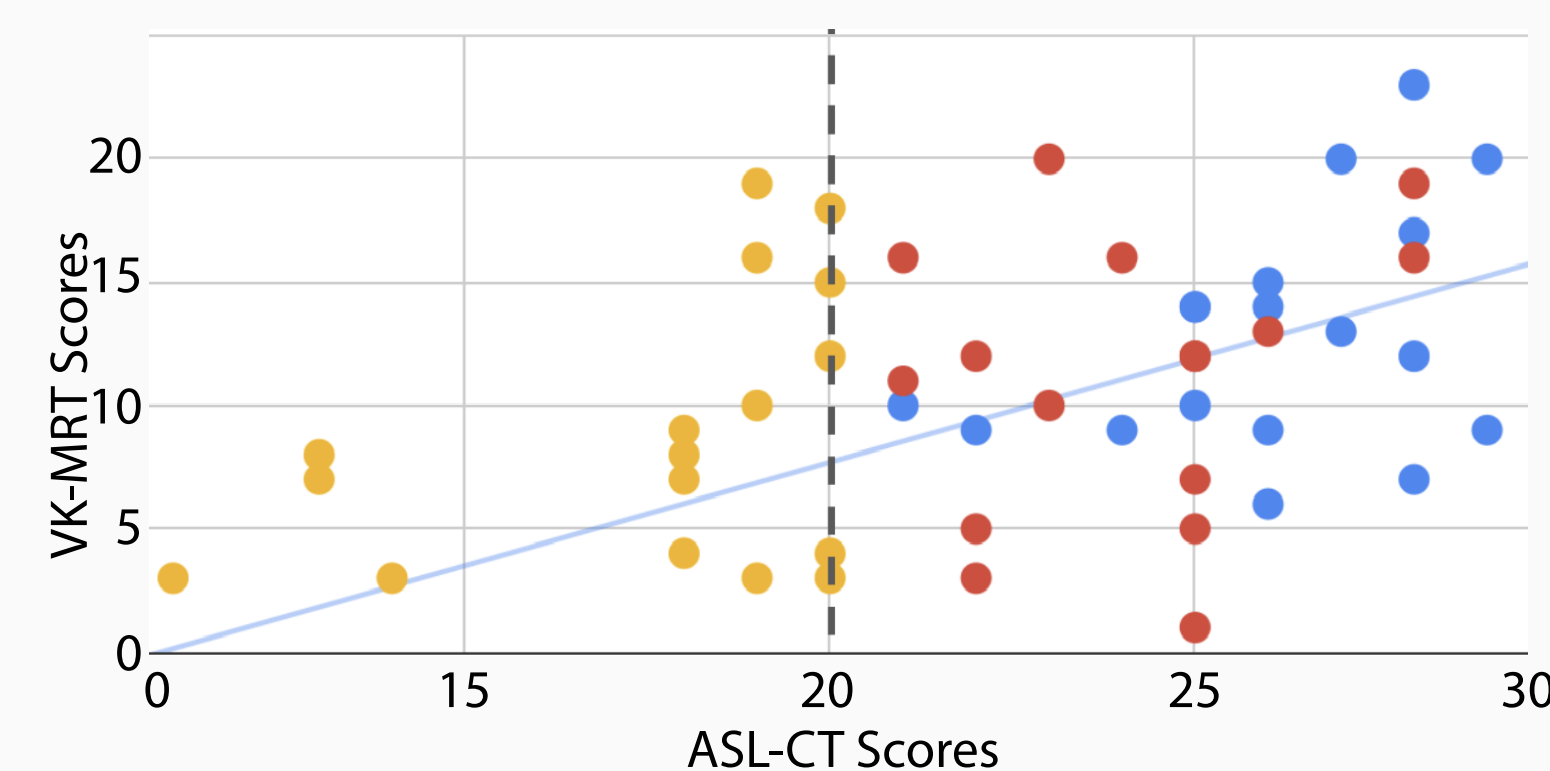
Example activities from Spatial Experience Survey

- GYMNASTICS: Never participated, Once a year, Once a month, Once a week, More than once a week
- PUZZLES: Never participated, Once a year, Once a month, Once a week, More than once a week

MRT, ASL Comprehension Partial Correlation

$r(50) = .47, p = .001$

● Deaf Fluent ● Hearing Fluent ● Hearing Non-Fluent



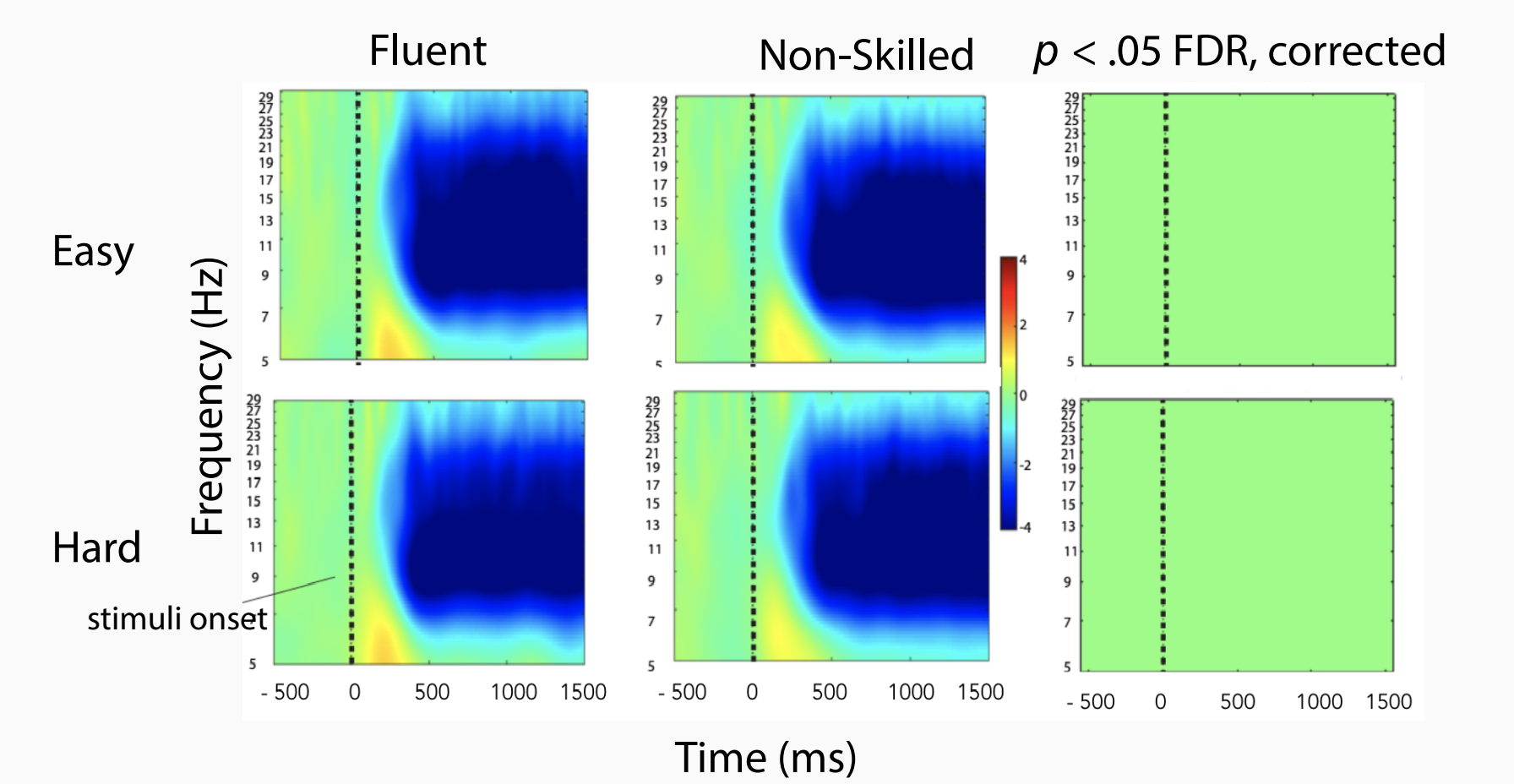
Scatterplot shows a positive trend of higher VK-MRT scores paired with higher ASL-CT scores ($r(50) = .47, p = .001$). Dotted line indicates score cut-off where participants are no longer considered 'Fluent'.

SCAN ME



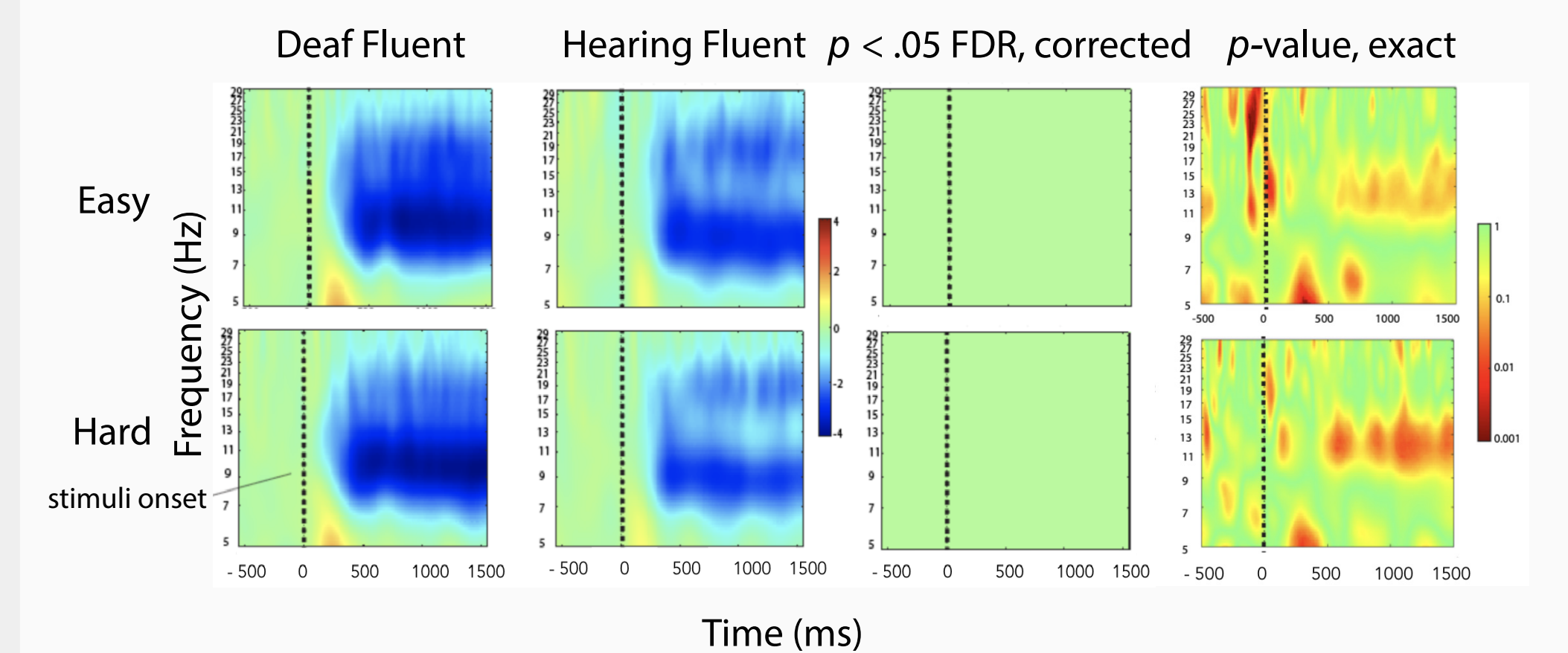
EEG

Fluent v. Non-Skilled



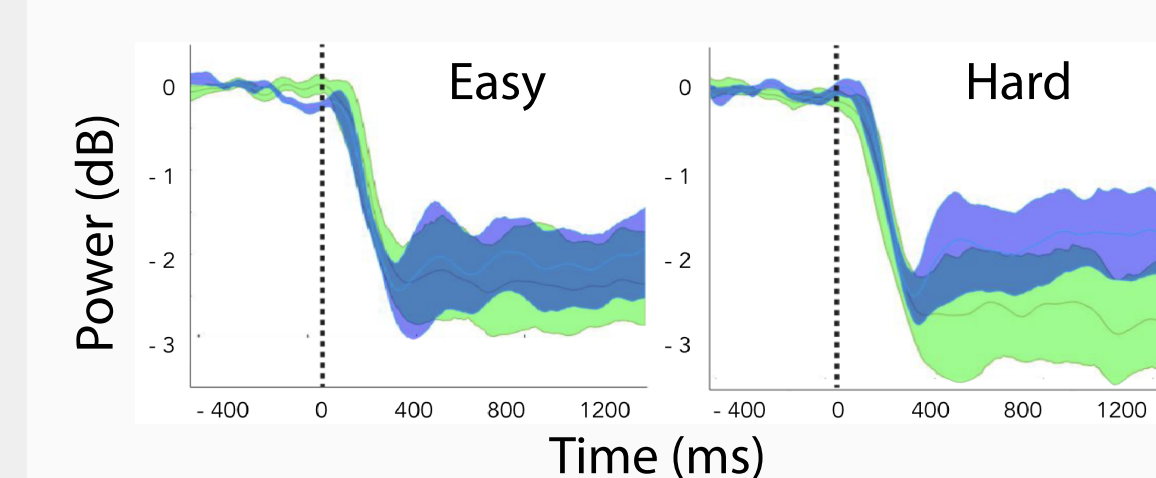
Time-frequency plots of electrode CPz during mental rotation. Cool colors indicate a decrease in power, warm colors indicate an increase in power. The third column shows that there are no significant differences ($p < .05$) between the two groups in either condition, with the false discovery rate (FDR) applied. Electrode CPz is reflective of results found for all other electrodes within the region of interest.

Deaf Fluent v. Hearing Fluent



Time-frequency plots of electrode CP3 during mental rotation. The third column shows that there are no significant differences ($p < .05$) between the two groups in either condition, with the false discovery rate (FDR) applied. The fourth column shows exact p -values when comparing the two groups. Warmer colors indicate smaller p -values. Electrode CP3 is reflective of similar results found for 16 of 21 electrodes within our region of interest.

- Deaf Fluent
- Hearing Fluent



Alpha desynchronization over time (x-axis) by decibel (dB; y-axis) change for Deaf-Fluent and Hearing-Fluent groups. Left shows alpha desynchronization during Easy tasks, right shows alpha desynchronization during hard tasks. Green = Deaf-Fluent, Purple = Hearing-Fluent.