Hearing through your eyes:
Modulation of visually-evoked auditory response by transcranial electrical stimulation

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Background

- Some people 'hear' visual events as sounds[1]
- They also show better discrimination of visual 'Morse-code' sequences, relative to auditory[1].
- We measured sequence discrimination while applying Transcranial Alternating Current Stimulation (TACS) over auditory vs visual cortex.
- *Does TACS effect depend on individual differences in ability to hear flashes, and visual:auditory discrimination?*

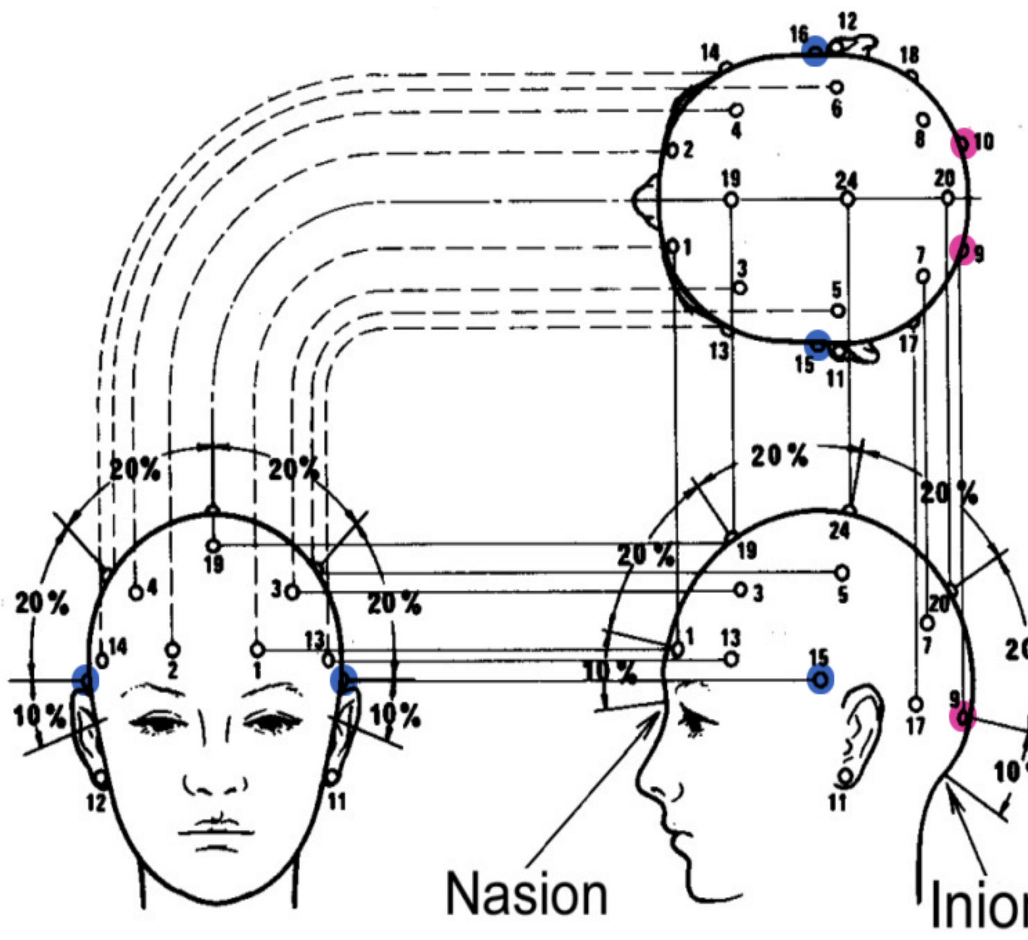
Methods

26 Participants:

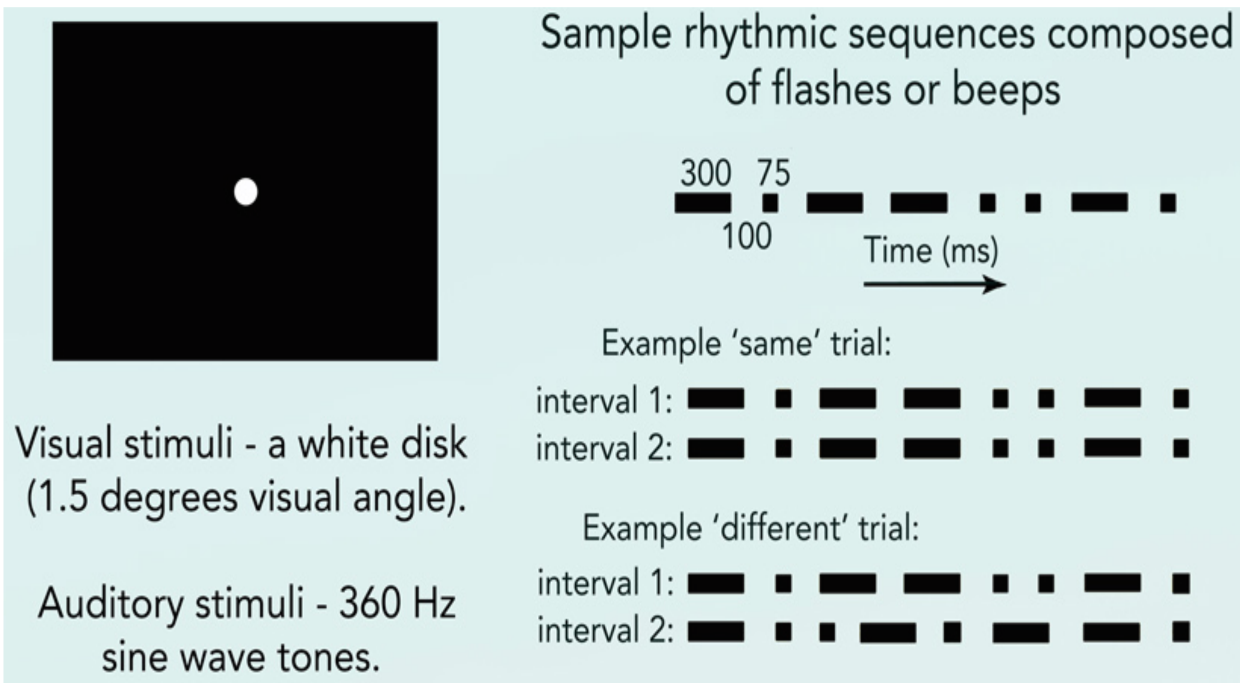
- 18 to 55 years (M24, SD 8.69)
- including six self-reporting synaesthetes (e.g. grapheme-colour, music-colour) and 14 musicians (musical training for 5 to 46 years (M15.3, SD 9.9)
- 23 were asked: *'did you hear faint sounds accompanying flashes?'*

10Hz TACS:

- 1000μA bilateral for 15 minutes during task
- Stimulation vs Sham double-blinded; counterbalanced within-session
- Sites: occipital pole (O1, O2) vs temporal (T3, T4); counterbalanced between session



Task

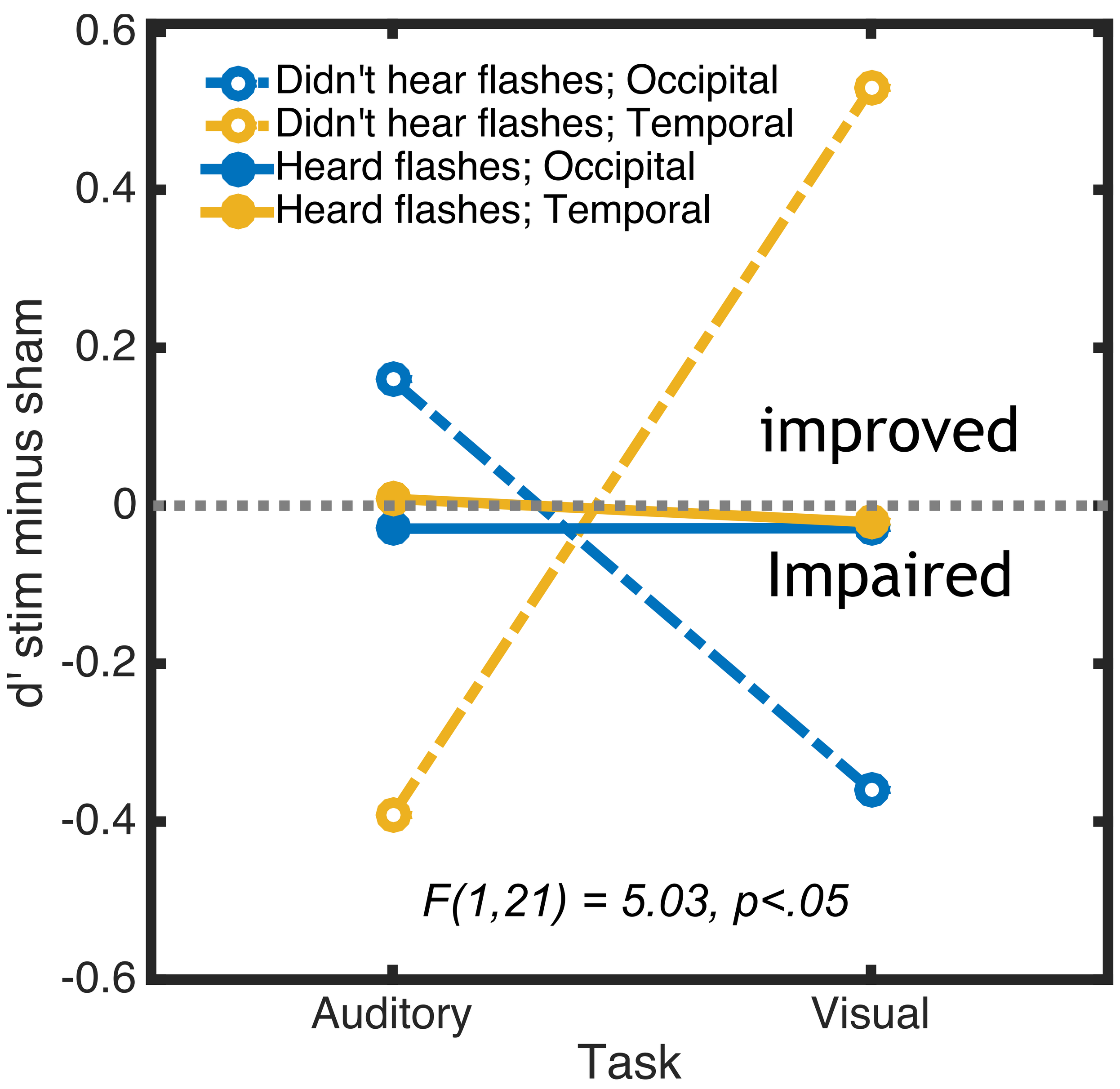


'Morse code' sequences:

- Same/Different discrimination
- Unimodal Auditory and Visual
- Modality randomised each trial
- 8 Long and short events
- Events 3 to 7 shuffled in 'Different' trials

Results

a) TACS effect depends on 'hearing flashes'

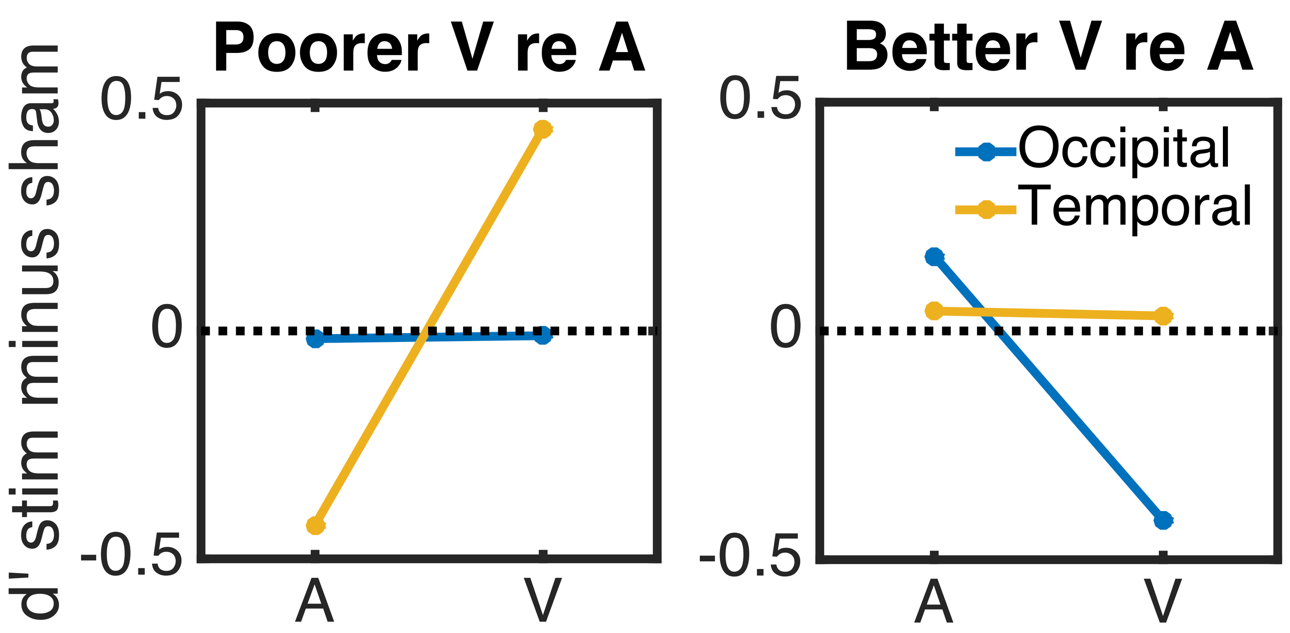


b) Hearing flashes is more prevalent in synaesthetes

χ^2 = 4.41, p = 0.04		*Synaesthesia*		
		No	*Yes*	*Σ*
Hear flashes?	*No*	*12*	*2*	*14*
	Yes	*4*	*5*	*9*
	Σ	*16*	*7*	*23*

- But synaesthesia per se does not predict TACS effect

c) Visual:Auditory bias modulates TACS effects



F(1,26) = 6.13, p<.02

Interpretation

a) **Cortices inhibit each other[2]**

- Inhibition carried by alpha oscillations[3]
- Alpha TACS biases competition between cortices
- *Hearing-flashes people have less inhibition? → weaker TACS effect*

b) **Supports *'unmasking'* theory of synaesthesia[4]**

c) **Individuals also differ in balance between cortices**

- Indexed by V:A performance
- TACS to dominant cortex disrupts inhibition of sub-dominant cortex
- Less effect of TACS on sub-dominant cortex as it is already inhibited. Further support for TACS biasing competition

Conclusions

- People who hear flashes use both vision and audition together to solve the sequencing task
- This may involve cooperative representations across visual and auditory cortices which resist disruptive effects of TACS.

References

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4. Grossenbacher, P. & Lovelace, C. (2001) *Trends in Cognitive Sciences*, 5(1), 36-41; Cohen Kadosh, R., Walsh, V. (2006) *Current Biology*, 16(22), R962-3.