Investigating brain oscillations in intermodal selective attention

Murray, A.[1-3], Soulières, I.[1,3], Saint-Amour, D.[1,2]
[1] Psychology Department, Université du Québec à Montréal, Montréal, Canada [2] Sainte-Justine University Hospital Research Center, Montréal, Canada
[3] Nord-de-l'île-de-Montréal Integrated University Health and Social Services Centre, Montréal, Canada

BACKGROUND

- Alpha band oscillations activity (~8-14 Hz) in parieto-occipital regions is linked with the inhibition of distracting visual information when the auditory modality is cued to be relevant[1-2].
- It has been recently proposed that theta power modulation (~4-7 Hz) in frontal regions represents a key mechanism of endogenous attention[3].
- However, no clear electrophysiological pattern of intermodal selective attention has yet been identified.
- Clarifying the role of alpha and theta oscillations in neurotypical mechanisms could bolster our understanding of altered attentional patterns present in many neurodevelopmental conditions[4].

OBJECTIVE

To investigate theta and alpha bands oscillatory activity patterns during an intermodal selective attention task.

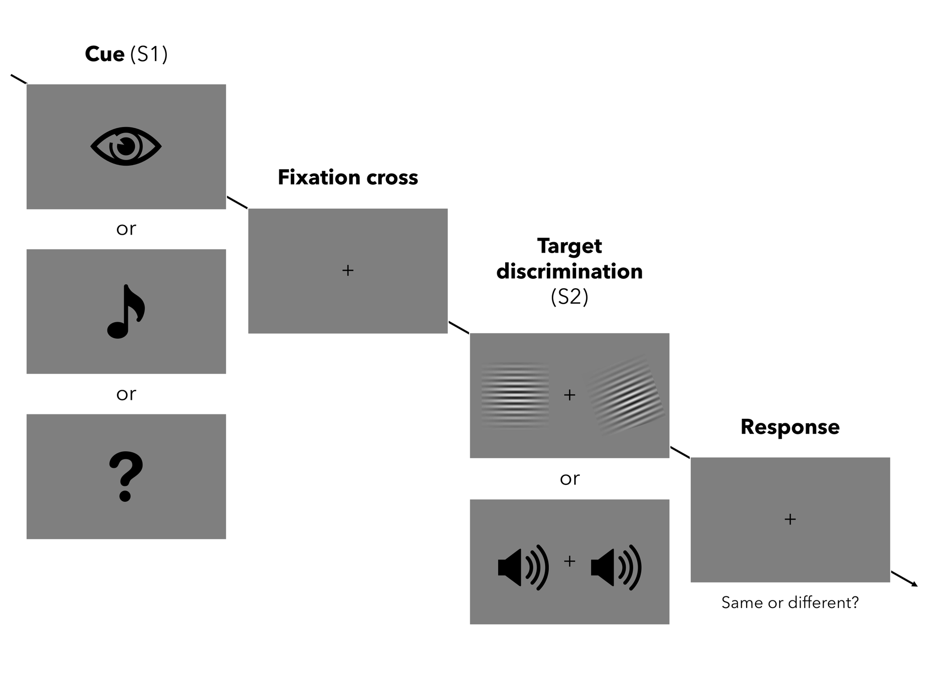
METHOD

Participants

	Age (years)		Auditory threshold (Hertz)		Visual threshold (polar angle)	
	M	*SD*	*M*	*SD*	*M*	*SD*
n = 20 (10 women)	26.74	3.25	9.21	4.08	3.04	1.57

Experimental task

- 520 trials: **cue condition** (congruent or incongruent with targets, or no cue) X **targets' sensory modality** (auditory or visual).
- Auditory targets: 2 frequency tones, 2 000 Hz tone reference.
- Visual targets: 2 Gabor patches, horizontal lines orientation reference.
- Targets were psychophysically titrated for each participant using a 2AFC staircase procedure.



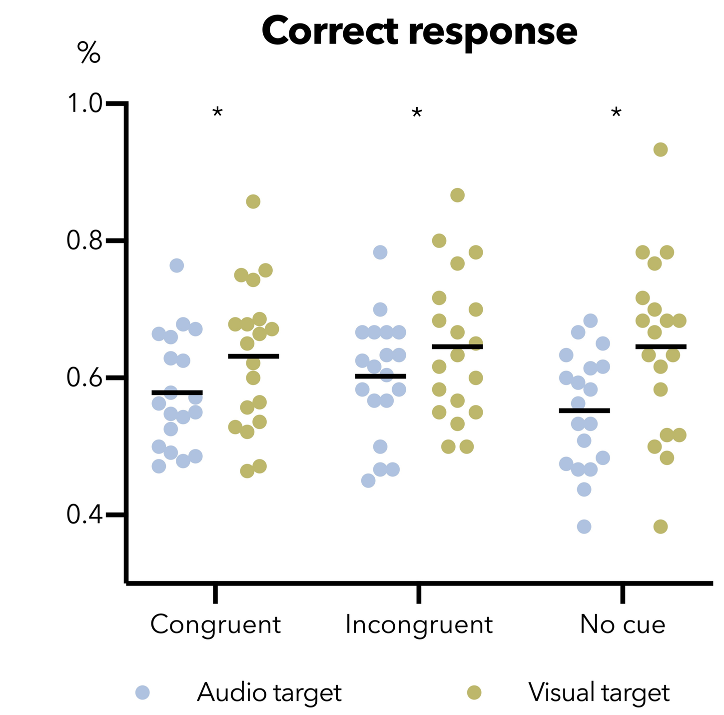
A cue indicated on a trial-by-trial basis the sensory modality of a subsequent auditory or visual targets discrimination.

EEG

- Fast Fourier Transforms (FFT), power density spectrum (μV^2/Hz).
- Theta activity: data epoched 500ms after cue stimulus onset.
- Alpha band activity: data epoched 500ms before target stimuli onset, 10-12 Hz frequency range selected based on participants' peak activity.

RESULTS

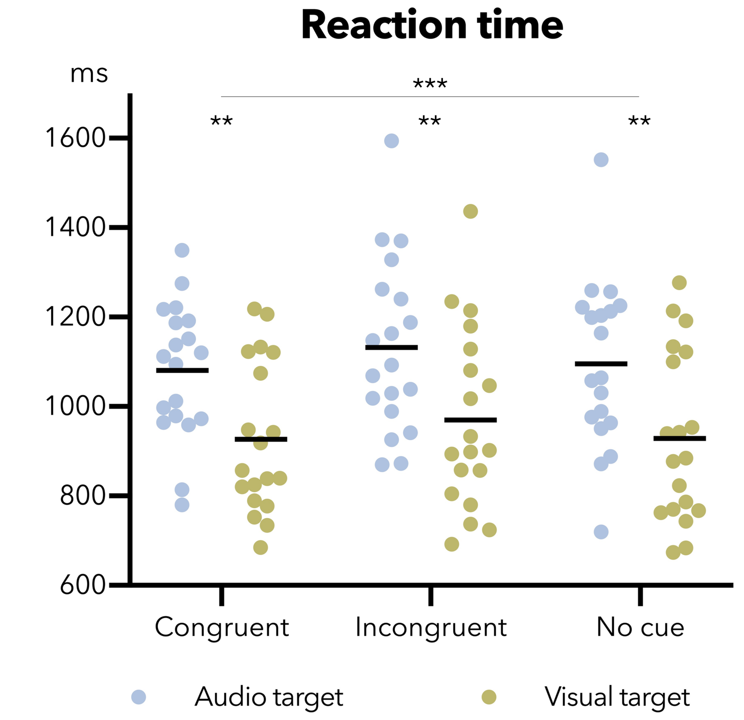
Behavioral results



Cue condition
F(2, 36) = 2.907, p = .068, η_p^2 = .139

Target modality
F(1,18) = 5.804, p = .027, η_p^2 = .244

Cue condition X Target modality
F(2,36) = 2.985, p = .063, η_p^2 = .142

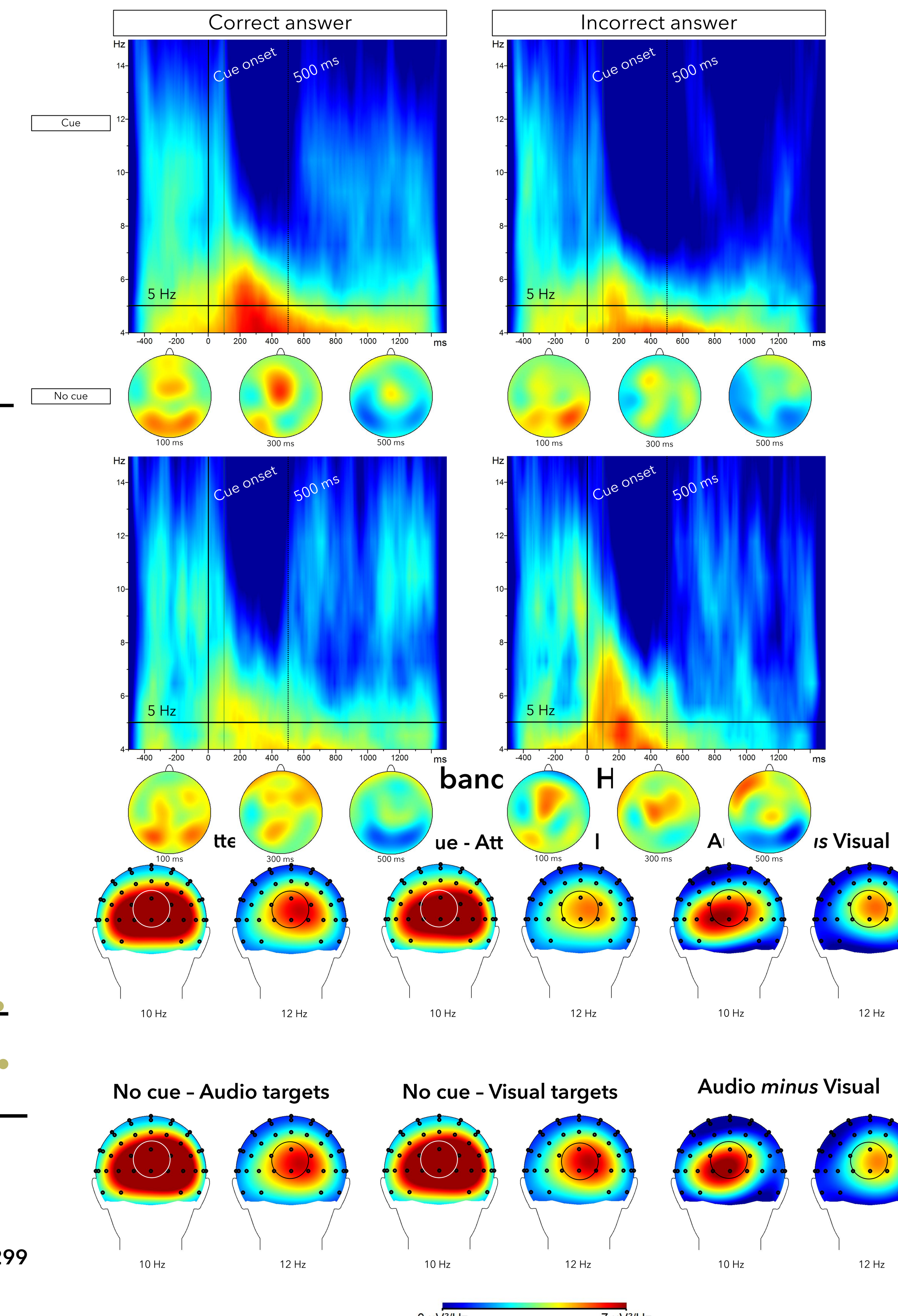


Cue condition
F(1.498, 26.970) = 7.691, p = .005, η_p^2 = .299

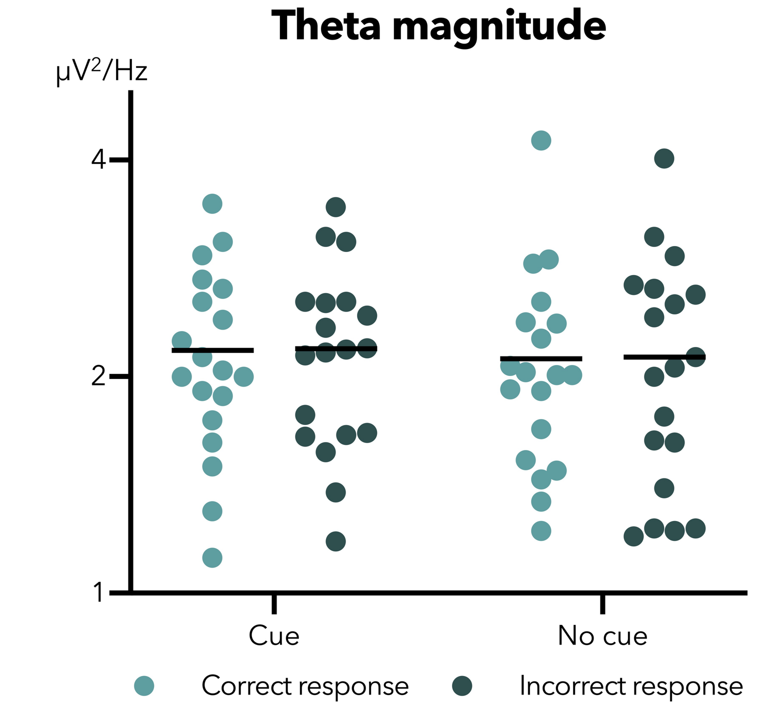
Target modality
F(1,18) = 14.339, p = .001, η_p^2 = .443

Cue condition X Target modality
F(2,36) = .122, p = .885, η_p^2 = .007

EEG results



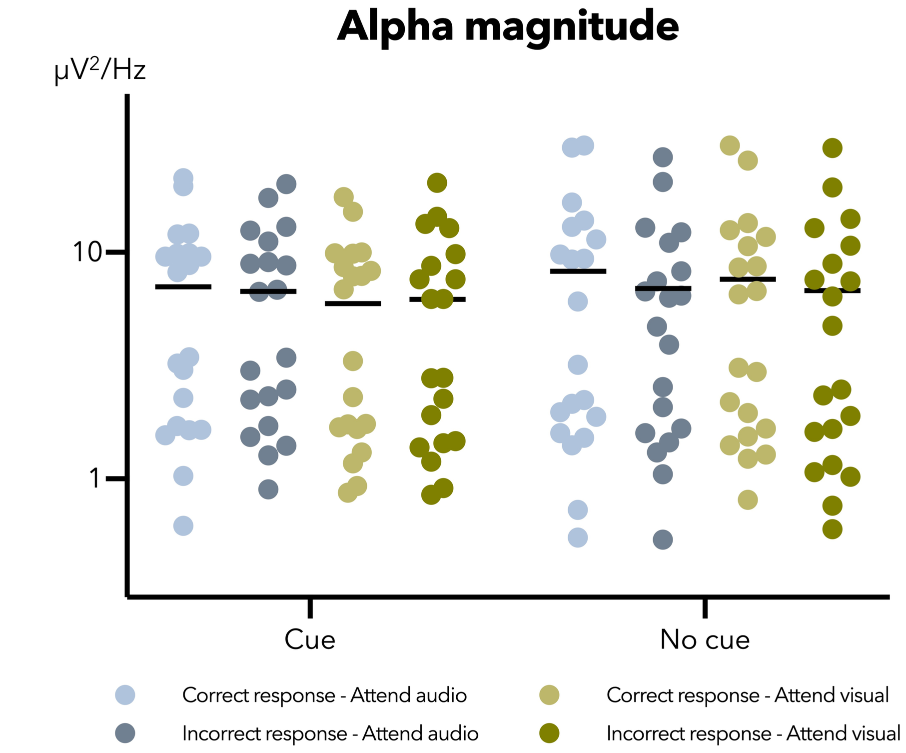
Parieto-occipital regions of interest (Oz, POz) are circled on topographies.



Cue condition
F(1, 18) = .690, p = .417, η_p^2 = .037

Correct response
F(1,18) = .078, p = .783, η_p^2 = .004

Cue condition X Correct response
F(2,36) = .001, p = .977, η_p^2 = .000



Cue condition
F(1,18) = 1.768, p = .200, η_p^2 = .089

Cue modality
F(1,18) = 3.127, p = .094, η_p^2 = .148

Correct response
F(1,18) = 1.117, p = .304, η_p^2 = .058

DISCUSSION

- Participants performed better and were faster at discriminating visual versus auditory targets.
- As expected, reaction time was slower when cues were incongruent compared to congruent with target stimuli, or the absence of cue. These behavioral results suggest that the task could successfully measure intermodal selective attention.
- EEG results did not show a greater power of theta oscillations in frontal regions in cued relative to non-cued trials. The involvement of lower frequency bands (e.g., 3 Hz)[5] or other mechanisms such as phase-amplitude coupling are more likely to occur.
- Although alpha power in parieto-occipital regions seemed to be greater in auditory compared to visual modalities, there was no significant difference between cued and non-cued trials. This study failed to replicate previous findings on the role of alpha band in intermodal selective attention.

1. Foxe, J. J., & Snyder, A. C. (2011). The role of alpha-band brain oscillations as a sensory suppression mechanism during selective attention. *Frontiers in psychology, 2*, 154. http://dx.doi.org/https://doi.org/10.3389/fpsyg.2011.00154
2. Fu, K.-M. G., Foxe, J. J., Murray, M. M., Higgins, B. A., Javitt, D. C., & Schroeder, C. E. (2001). Attention-dependent suppression of distracter visual input can be cross-modally cued as indexed by anticipatory parieto-occipital alpha-band oscillations. *Cognitive brain research, 12*(1), 145-152. http://dx.doi.org/https://doi.org/10.1016/S0926-6410(01)00034-9
3. Keller, A. S., Payne, L., & Sekuler, R. (2017). Characterizing the roles of alpha and theta oscillations in multisensory attention. *Neuropsychologia, 99*, 48-63. http://dx.doi.org/https://doi.org/10.1016/j.neuropsychologia.2017.02.021
4. Simon, D. M., & Wallace, M. T. (2016). Dysfunction of sensory oscillations in autism spectrum disorder. *Neuroscience & Biobehavioral Reviews, 68*, 848-861. http://dx.doi.org/https://doi.org/10.1016/j.neubiorev.2016.07.016
5. Schroeder, C. E., & Lakatos, P. (2009). Low-frequency neuronal oscillations as instruments of sensory selection. *Trends in neurosciences, 32*(1), 9-18. http://dx.doi.org/https://doi.org/10.1016/j.tins.2008.09.012

Audrey Murray
murray.audrey.4@courrier.uqam.ca