

## Introduction

Experimental studies have revealed that spatial processing of stimuli can occur even when it is irrelevant to the task's goal [1]. In this experiment we used MEG recordings to examine whether cross domain (verbal-spatial) binding takes place automatically in a working memory task requiring the maintenance of either the verbal or spatial aspects of consonants appearing in distinct visual locations.

## Methods

**Participants:** Five native Spanish speakers participated in the experiment, three females and two males (ranged from 22 to 25,  $M=23.6$ ;  $SD=1.14$ )

**Task:** In the Verbal task, participants were instructed to remember the consonants only. In the Spatial task, they were asked to remember the locations. Two types of positive probes were presented, Intact probes (consonant in the same location as at encoding), and Recombined probes (consonants and locations presented at encoding, but not together).

**MEG recordings:** The MEG signal was obtained using a 148 channel whole-head neuromagnetometer housed in a shielded room. The data were obtained using a sample rate of 254 Hz and filtered with a band pass filter between 0.1 and 50 Hz. Data were submitted to an interactive noise reduction procedure.

**MEG analysis:** Digitized MEG data were imported into MATLAB, using Fieldtrip software package. The time-frequency representation of MEG data was calculated on a single trial basis using a Fourier transform approach applied to short sliding window (50 ms) of four cycles for each frequency. For each trial, the power calculated from the Fourier transform was averaged. Source image of the TF data was constructed using a minimum-norm estimation procedure (MNE). MNE was calculated in the frequency domain by submitting the real and imaginary parts of the Fourier coefficients.

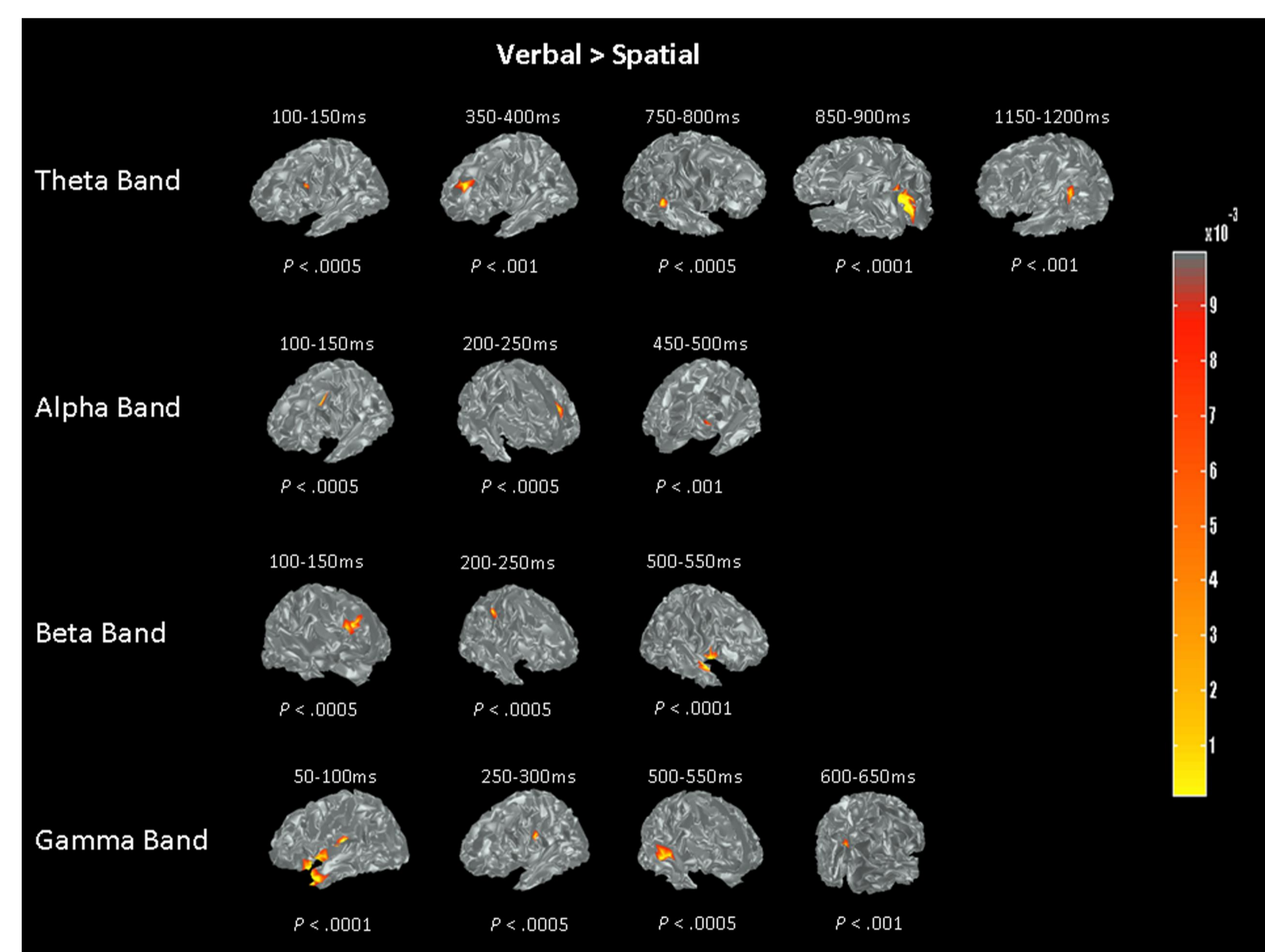
A tessellated cortical mesh template surface derived from the Montreal Neurological Institute (3004 nodes) phantom brain served as a brain model to estimate the current source distribution. The forward solution was calculated using a spherical head model. The inverse problem was solved by applying L<sub>2</sub> MNE.

## Behavioral results

Performance was assessed in terms of accuracy (% correct) and reaction time (RT) for both positive probe trials in each task.

In the verbal task, participants were more accurate for intact ( $M = 89.78\%$ ;  $SD = 8.61$ ) relative to recombined probe trials ( $M = 83.67\%$ ;  $SD = 7.17$ ) ( $p < .01$ ). RTs in the verbal task were also significantly faster on intact probe trials ( $M = 908.36$  ms;  $SD = 163.67$ ) relative to recombined probe trials ( $M = 927.27$  ms;  $SD = 158.21$ ) ( $p < .05$ ). In contrast, in the spatial task, accuracy measures for intact ( $M = 90.59\%$ ;  $SD = 8.73$ ) and recombined probe trials ( $M = 89.18\%$ ;  $SD = 8.51$ ) did not show significant differences ( $p > .20$ ), and did not differ in terms of RT measures (intact:  $M = 859.36$  ms;  $SD = 224.60$ ; recombined: ( $M = 850.54$  ms;  $SD = 224.85$ )( $p > .30$ ).

## MEG results



Cortical source clusters indicating statistically significant increase in amplitude for the verbal task relative to the spatial task

## Conclusion

Behavioural differences between Intact and Recombined probes have been considered as the critical evidence for binding [2]. Our behavioural results revealed that an implicit binding occurs when participants are asked to remember the identity aspect of the verbal-spatial stimuli array but not when they are instructed to remember the space aspect, in consonance with other studies [1].

Brain oscillations results of the Verbal task revealed greater prefrontal and parietal activation in the classical frequency bands than in the Spatial task, as it has been found in other studies comparing integrated and unintegrated presentation of verbal-spatial information [3,4,5].

Behavioural and neuroimaging results suggest an implicit binding of space in a letter identity task, supporting the notion of associative asymmetry.

## REFERENCES

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