# The utility of Magnetoencephalography in Multiple Sclerosis - a Systematic Review

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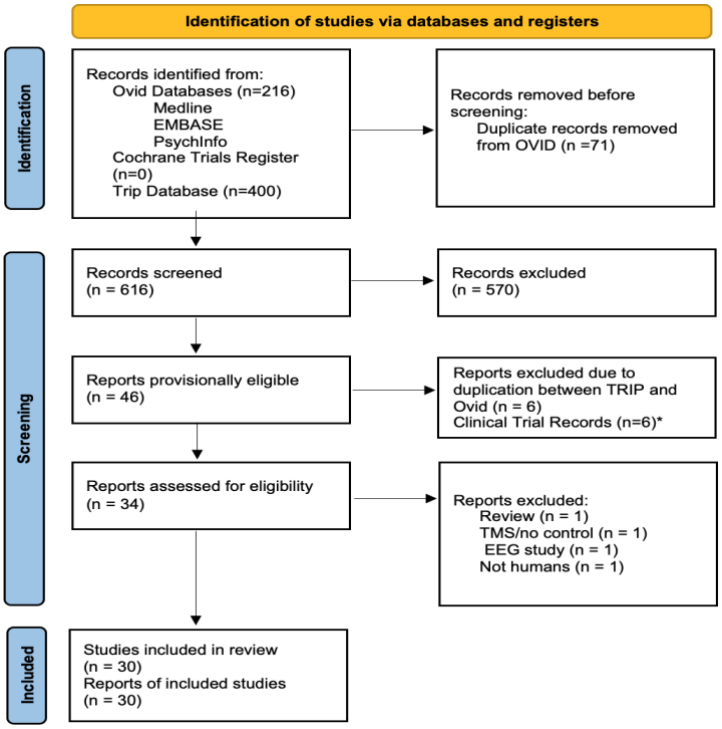
## OVERVIEW

- We conducted a Systematic Review of studies, looking at 30 studies from 13 centres
- MS patients had reduced power in some induced responses (motor beta, visual gamma)
- Increased latency and reduced connectivity were seen for somatosensory evoked fields
- There was an association between upper alpha connectivity and cognitive function
- MEG shows promise, although work is too preliminary to recommend current clinical use

## METHODS

We identified MEG studies carried out in MS using databases illustrated below (PRISMA 2020 Flow diagram for systematic reviews). We included original research articles with a cohort of minimum of five multiple sclerosis patients and quantifying of at least one MEG parameter. We used a modified version of the JBI (mJBI) for case-control studies to assess for risk of bias.




## CONCLUSION

- Good evidence that MEG shows evidence of altered neural activity, perturbed connectivity, and association with clinical impairment in MS
- Event-related designs are of particular value and show replicability between centres
- Areas of interest are beta changes in the motor cortex, changes in visual gamma in the visual cortex and alterations in somatosensory processing in Somatosensory Evoked Fields
- Evidence that diminished alpha connectivity is seen in patients and this is associated with altered cognitive functioning
- Currently no clear whether these changes are specific to MS or can be observed in other disease state
- Further studies should look to explore cognitive control in more depth using in-task designs and undertake longitudinal studies to determine whether these changes have prognostic value.

**References:** Waldman, A. T. *et al.* (2020) 'Structural correlates of atypical visual and motor cortical oscillations in pediatric-onset multiple sclerosis', *Human Brain Mapping*, 41(15), pp. 4299–4313. doi: 10.1002/hbm.25126.
Costers, L. *et al.* (2021) 'The role of hippocampal theta oscillations in working memory impairment in multiple sclerosis', *Human Brain Mapping*, 42(5), pp. 1376–1390. doi: 10.1002/hbm.25299.
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*This paper has been accepted and is in press with Neuroimage Clinical (Khan et al, 2021)*

## RESULTS

- 30 studies from 13 centers
- 433 MS patients and 347 controls

*1.Is MS associated with altered MEG activity compared to healthy controls*

- Most studies suggest increased latencies of evoked fields in MS
- Evidence of impaired gating suggesting impairment of the usual refractory period
- Evidence of abnormal neuronal activity appears to be best demonstrated in simple paradigms (button press, visual stimulus and nerve stimulation)

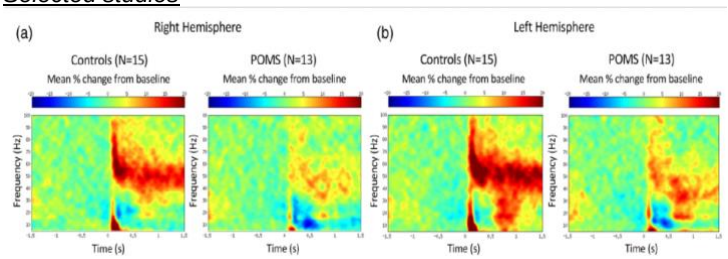
*2. Is MS associated with perturbed connectivity compared to healthy controls*

- There is good evidence for perturbed connectivity in relation to somatosensory evoked fields
- Resting state studies also show some degree of altered connectivity and topology in patients versus controls

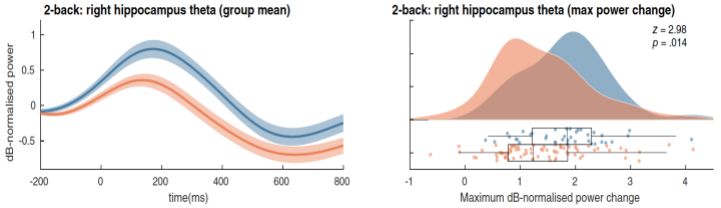
*Assessment of bias*

The lowest mJBI score was the 3 and the highest was 8, with the mean mJBI score being 6.7 indicating moderate quality of studies

*Selected studies*




Waldman et al, 2020 undertook a visuomotor task in patients with Paediatric Onset Multiple Sclerosis (POMS) vs controls: Visual Time Frequency Response and Visual amplitude plots are shown. a and b show group-averaged time-frequency for controls and paediatric onset multiple sclerosis (POMS) with reduction in visual gamma band in both hemispheres; c and d show the visual gamma power (30-80Hz) compared between POMS (red) and controls (black) in right (c) and left (d) hemispheres (Adapted from (Waldman *et al.*, 2020))




Costers and colleagues (2020) examined adult patients with MS versus controls using a n-back task. Showing time-frequency max power change in right hippocampus. Left panel shows shaded error (using standard error) of group mean power changes in the right hippocampus. Right panel shows a raincloud plot of maximum power changes in hippocampus (Adapted from (Costers *et al.*, 2021))