Enhanced excitability to visual stimulation in area V1 and LGN in patients with migraine with aura

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Purpose

In migraine, abnormal visual cortical excitability between headaches could predispose to cortical spreading depression and visual aura followed by headache.

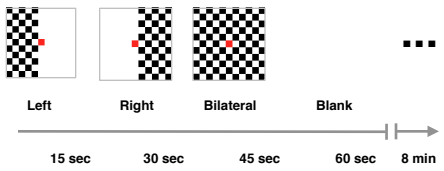
While prior interictal studies (imaging and TMS) comparing migraineurs with aura (MWA) to controls have shown consistent differences in extra-striate cortex, reports of altered V1 responses to light have been conflicting.

Methods

Subject Demographics	MWA	MWoA	Controls
Number (n)	25	25	25
Age (yrs ± SD)	32 ± 6	32 ± 6	32 ± 6
Gender	4 m/21 f	4 m/21 f	4 m/21 f

Task: Subjects underwent BOLD EPI at 3 T scanner (160 TRs, 3mm voxels, TR=3 sec) while viewing a 5 Hz flickering checkerboard in a random sequence as shown in Figure 1. Subjects performed an attention task at the fixation dot.

Fig 1

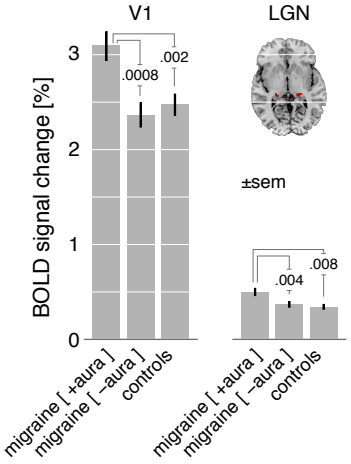


Data Processing: For each subject, V1 was defined anatomically on FreeSurfer surface (Hinds 2008).
A V1 sub-region of interest corresponding to central 10 degrees was created from retinotopic data (Benson 2011), and a volumetric mask derived.
The lateral geniculate nucleus was defined using the SPM anatomy toolbox in MNI space (Eickhoff 2005) and warped back to subject specific space.

Results

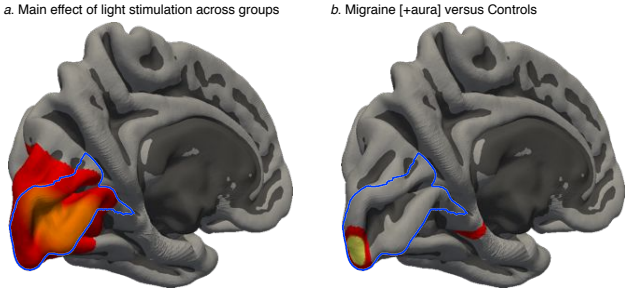
ROI Analyses: The average amplitude of BOLD response was obtained for each subject within the V1-subregion of interest and within an LGN region of interest. Two-tailed t-tests compared the responses between the populations.

Fig 2



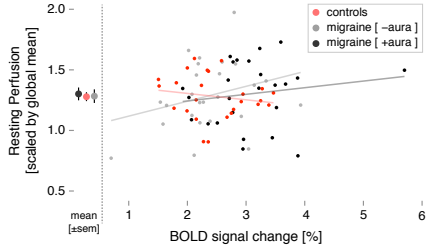
Whole Brain Analysis: BOLD response amplitude was mapped onto each subject's inflated surface. The data from LH and RH were registered to a common LH "pseudohemisphere" (Greve OHBM 2011) and smoothed with a 2-D, 15 mm FWHM kernel. Whole brain random-effects models tested for group differences in BOLD response at each vertex. Additional covariates modeled the effects of age and gender. FDRs were used to determine map-wise thresholds.

Fig 3



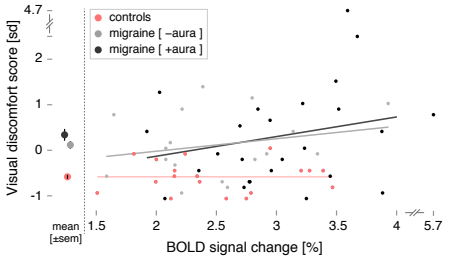
Relation to perfusion: Could activation differences in V1 simply be the result of greater or lesser resting blood flow to V1 in MWA as opposed to a difference in neural reactivity?

Fig 4



Relation to perfusion: Do the activation differences in V1 correlate with differences in a behavioral metric of photophobia ie a Visual Discomfort Score (VDS) (Conlon 1999)?

Fig 5



Conclusions

- A significantly larger BOLD response to light was seen in patients with aura compared both to controls and MWoA within area V1.
- This is likely a neural effect, as no difference in resting blood flow was seen between the groups in the primary visual cortex.
- Altered excitability to light is present precortically in the LGN of thalamus.
- VDS scores are significantly higher for MWA and MWoA patients than Controls. However, no correlation could be found between VDS and BOLD activations.

References

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