Hexadirectional modulation of high-frequency electrophysiological activity in the human anterior medial temporal lobe maps visual space

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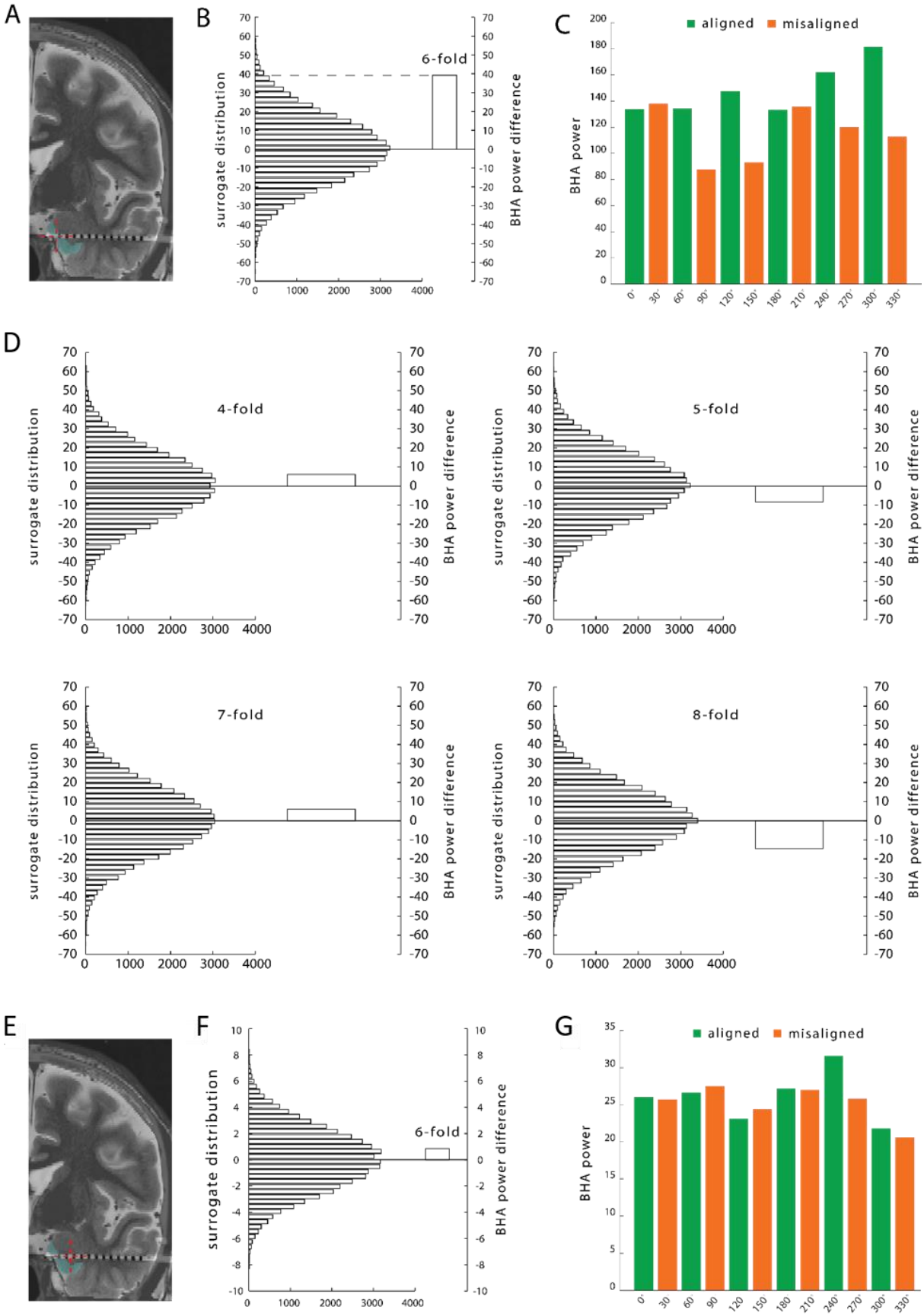
A
B
6-fold
surrogate distribution
BHA power difference
C
aligned
misaligned
BHA power
0°
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
D
4-fold
5-fold
7-fold
8-fold
E
F
6-fold
G
aligned
misaligned
BHA power

Figure S1. Intracranial data. Related to Figure 2.

(A-C) Hexadirectional signal in intracranial entorhinal data. To investigate the possible electrophysiological origin and spatial specificity of the MEG results, we analyzed intracranial data recorded from the entorhinal cortex of an epilepsy patient, while the patient was performing a free viewing task. As for the MEG data, intracranial data were aligned to saccade onsets and re-referenced using a bipolar montage to provide high spatial specificity with respect to the underlying electric source. BHA power (60-120 Hz) was extracted during saccadic eye movements and the hexadirectional analysis approach was applied (see Figure 1c) (A) Electrode position. The red crosshair indicates the electrode position in the left entorhinal cortex (highlighted). (B) BHA power difference (aligned vs. misaligned, 60-120 Hz, 6-fold symmetry, bar plot) in the entorhinal electrode is significantly higher ($p < .011$) than the distribution of surrogate BHA power differences, replicating the MEG findings. (C) 6-fold symmetric modulation of the BHA power, visualizing the effect in (B), indicated that the effect is not driven by a single direction.

(D) Control periodicities in intracranial entorhinal data. Biological implausible rotational symmetries do not show higher BHA power (60-120 Hz) for aligned versus misaligned saccade directions (4-fold: $p = .7135$; 5-fold: $p = .5753$; 7-fold: $p = .9573$; 8-fold: $p = .9868$; one-sided tests). Bars represent BHA difference, (aligned vs. misaligned), histograms the respective distribution of surrogate BHA power differences.

(E-G) Intracranial control analyses. (E) Electrode position. The red crosshair indicates the electrode position in the left amygdala, adjacent to but clearly outside the entorhinal cortex (highlighted). (F) BHA power difference (aligned vs. misaligned, 60-120 Hz, 6-fold symmetry, bar plot) in the amygdala electrode (bipolar montage) is not significantly higher ($p > .36$) than the distribution of surrogate BHA power differences, confirming the spatial specificity of the hexadirectional modulation of BHA found in the entorhinal cortex. (G) 6-fold symmetric modulation of the BHA power, visualizing the effect in (F). The difference between the hexadirectional modulation of BHA in entorhinal cortex and amygdala was significantly higher than expected by chance ($p < .013$) when compared to a distribution of surrogate BHA power differences.

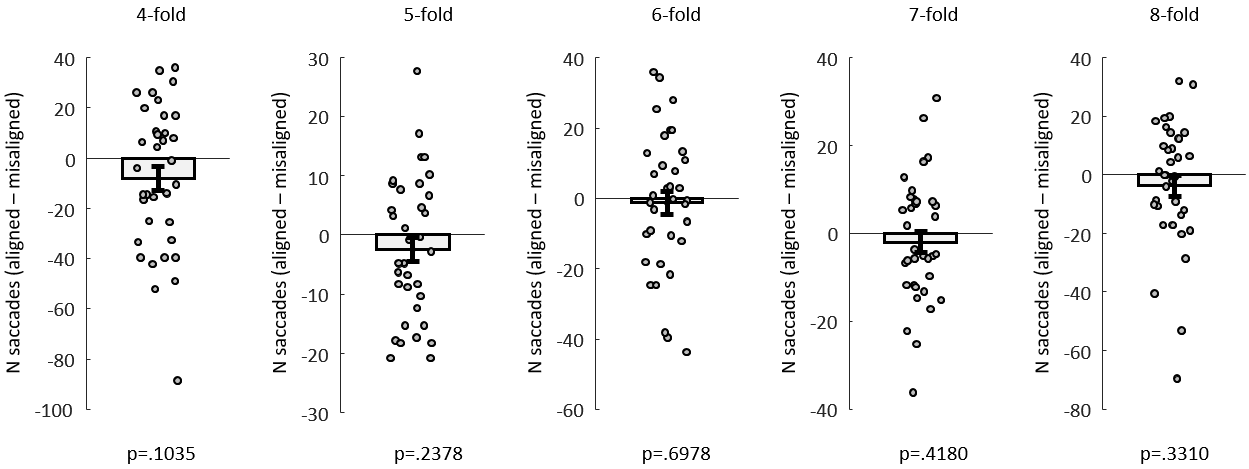

Figure S2. Hexadirectional modulation of saccade directions. Related to Figure 2. There was no significant difference in number of saccades aligned to the putative grid orientation versus number of saccades misaligned for 4-, 5-, 6-, 7- and 8-fold rotational symmetries (all t's > -1.6 and < 0, all p's > .1). The estimation of the hexadirectional modulation of the saccade direction followed a two-step procedure (see Figure 1c): First, the putative grid orientation was estimated on one half of the trials. BHA MEG activity during visual exploration in the left anterior temporal lobe was used during this step (analogous to the main analysis). Second, the number of saccades aligned and misaligned to the putative grid orientation were summed. The procedure was repeated with inversed assignment of data sets to the two steps, and the number of aligned and misaligned saccade directions was averaged across the repetitions (two-fold cross-validation design).