The critical role of the right anterior fusiform gyrus in unfamiliar face identity discrimination

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Abstract

The contribution of the anterior fusiform gyrus (AntFG) in human face identity recognition has been largely neglected, mainly due to a large signal dropout in functional magnetic resonance imaging (fMRI) affecting this region. Here, we report two cases in which direct electrical stimulation of the right face-selective AntFG induced transient face identity recognition (FIR) impairment. Upon stimulation in this region, patients were unable to select a photograph of a famous face among 3 exemplars, reporting that all the faces looked the same. Most interestingly, they also failed at matching concurrently presented pictures of unfamiliar faces against a distractor face, with all face identities once again perceived as identical. Together with large electrophysiological signals of unfamiliar face identity individuation recorded in the stimulated sites, these observations support a critical role of the right AntFG, together with connected contralateral and posterior face-selective regions, in extracting idiosyncratic facial features independently of long-term familiarity.

Key Words:

Anterior fusiform gyrus, electrical brain stimulation, face identity recognition, effective connectivity, Stereo-EEG.

Introduction

Face identity recognition (FIR)[1] is a critical social skill in humans, supported by face-selective regions distributed along the ventral occipitotemporal cortex (VOTC), predominantly in the right hemisphere. Specifically, functional magnetic resonance imaging (fMRI) consistently identified face-selective regions in the lateral section of the posterior/middle fusiform gyrus (LatMidFG, "fusiform face area" or FFA; Kanwisher et al., 1997) and the lateral part of the inferior occipital lobe (IOG, "occipital face area" or OFA; Gauthier et al., 2000), showing their involvement in FIR (fMRI-adaptation: Hermann et al., 2017; Rotshtein et al., 2005; Schiltz and Rossion, 2006); Intracranial studies: Davidesco et al., 2014; Jacques et al., 2020; Quian Quiroga et al., 2023); fMRI with multivariate pattern analysis : Anzellotti et al., 2014; Axelrod and Yovel, 2015; Goesaert and Op de Beeck, 2013; Kriegeskorte et al., 2007; Nestor et al., 2011; Tsantani et al., 2021). In addition, lesion and direct electrical stimulation studies provided evidence for these regions' critical role in FIR (e.g., Barton et al., 2002; Bouvier and Engel, 2006; Jonas et al., 2012; Rossion et al., 2003; Sergent and Signoret, 1992; Volfart et al., 2023). Regional face-selectivity has also been more rarely reported in the ventral anterior temporal lobe (ATL; Avidan et al., 2014; Nasr and Tootell, 2012; Rajimehr et al., 2009; Rossion et al., 2012), usually close to the temporal pole, with these 'ATL-faces' regions consistently linked to multidomain person-recognition (person semantic knowledge: Collins et al., 2016; Collins and Olson, 2014; Rice et al., 2018; or recognition of familiar faces: Deen et al., 2024; Eger et al., 2005; Leveroni et al., 2000; Sergent et al., 1992; Von Der Heide et al., 2013). In between these posterior and anterior face-selective regions lies the anterior fusiform gyrus (AntFG), which is unfortunately affected by a large signal dropout in fMRI caused by magnetic susceptibility artefacts (Deng et al., 2009; Ojemann et al., 1997; Rossion et al., 2024; Shum et al., 2013; Wandell, 2011; Zhang et al., 2016). Only a limited number of fMRI studies

[1] In this study, FIR is not restricted to the judgment of a previous occurrence of familiar faces. Here, FIR is defined more generally as the production of a unique response to a given face, based on its individually distinctive characteristics, and applies to both familiar and unfamiliar faces.

reported significant AntFG activations, most of which employed specific methodologies to improve SNR in this region (optimization strategies to reduce susceptibility artifacts with standard gradient-echo: Visconti di Oleggio Castello et al., 2017; frequency-tagging approach: Gao et al., 2022, 2018; distortion-corrected fMRI sequences: Collins et al., 2016; Deen et al., 2024; Rice et al., 2018; without specific methodology: Pyles et al., 2013; Rossion et al., 2012). While significant AntFG activations to faces have been reported by early neuroimaging studies with positron emission tomography which are not affected by this artifact (Kuskowski and Pardo, 1999; Rossion et al., 2001; Wiser et al., 2000), the strongest and most consistent evidence supporting the role of this region in face (identity) recognition comes from intracranial electroencephalography (iEEG) studies conducted with depth electrodes implanted in the brains of patients affected by drug-resistant epilepsy (stereo-EEG or SEEG; Hagen et al., 2020; Jacques et al., 2022; Jonas et al., 2016; Rossion et al., 2024; see also Allison et al., 1999 using subdural electrodes). In two reported cases, direct electrical stimulation of electrodes implanted in the right face-selective AntFG evoked impressive transient FIR impairments (subject CD: Jonas et al., 2015; subject DN: Volfart et al., 2022). For both cases, the critical contacts were located in a fifth, recently defined, cytoarchitectonic area of the fusiform gyrus (‘FG5’), clearly demarcated from posterior fusiform face-selective regions (‘FFAs’, in FG2 and FG4; Dietermann et al., 2025).

An outstanding issue is whether the AntFG, in particular in the right hemisphere, is involved in extracting individual-specific visual cues, independently of semantically related memories (Rossion et al., 2024). Supporting this view, a large-scale intracranial EEG study showed differences between unfamiliar face identities in the right AntFG (Jacques et al., 2020). Most recently, electrical stimulation to the right AntFG of subject DN impaired his ability to recognize famous faces but also to match concurrently presented pictures of familiar and unfamiliar faces for their identity (Volfart et al., 2022). However, numerical evidence of impaired/slowed down unfamiliar face identity matching during stimulation did not reach significance, presumably due to the limited number of trials that could be administered (Volfart

et al., 2022). Hence, whether the right AntFG is critically involved in behavioral tasks that require matching and discriminating concurrently presented pictures of unfamiliar faces for their identity, typically defined as a 'perceptual' task, remains unknown.

Here, we report two new cases in which electrical stimulation to the right AntFG evoked strong FIR impairment for both famous and, most importantly, unfamiliar faces. Applying a recently developed original approach of stimulation concurrent with frequency-tagged visual stimulation (Angelini et al., 2024b, 2024a), we also provide evidence regarding the effective connectivity of the critical functional region with posterior and contralateral face-selective regions in the two cases in order to help understand the deficit.

Methods

Cases description

Subject NL, a right-handed 53-year-old woman, and subject MD, an ambidextrous 25-year-old woman, underwent SEEG as part of a clinical investigation for their focal refractory epilepsy. Following SEEG exploration, the epileptogenic zone was delineated in the left medial temporal lobe for NL and in both the left and right medial temporal lobes for MD. They both underwent a comprehensive neuropsychological assessment prior to SEEG, indicating normal FIR ability, despite a general slowdown for MD at some face and non-face tasks (**Supplementary Tables 1** and **2**; see **Supplementary Information**), consistent with her right mesial temporal epilepsy (Volfart et al., 2020). This study was approved by the ethical committee of the University Hospital of Nancy (*Centre Hospitalier Universitaire de Nancy*). Informed consent for the testing and use of video recordings was obtained from the subjects involved in the study.

Intracerebral electrodes were stereotactically implanted in the patients' brains to delineate the seizure onset zone and seizure extent (Talairach and Bancaud, 1973). Fourteen and twelve electrodes were implanted in the bilateral VOTC in NL and MD, respectively, including two in the right VOTC (TM and B) for both patients. Both TM electrodes were located in the right ATL and targeted specifically the AntFG (**Figures 1A** and **2A**). The SEEG signal

was recorded at a 512Hz sampling rate. The reference electrode during data acquisition was a midline prefrontal scalp electrode (Fpz).

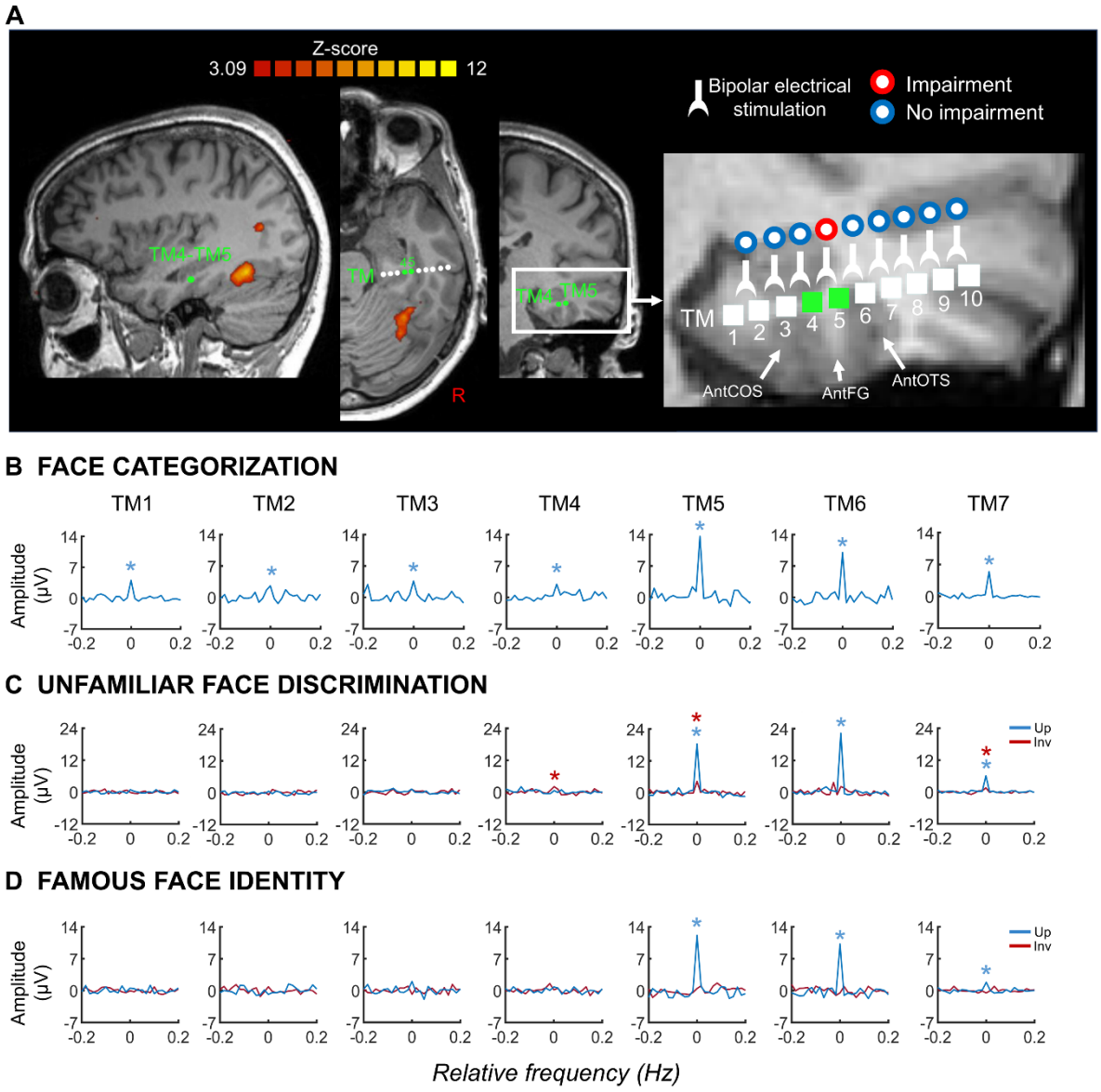

Fig. 1. Anatomical location of stimulated contacts and frequency-tagged responses in subject NL. ***A***. *Functional face-selective responses (recorded with fMRI face-localizer using the Fast Periodic Stimulation approach, see Gao et al., 2018; threshold of p < 0.001; z-score > 3.09, uncorrected), with the mapping of the effective contacts TM4-TM5 (in green). In order to display the two contacts on the same image, these slices were obtained using the coordinates of contact TM4. The location of all the contacts on the TM electrode is displayed on the right, with the results of the electrical stimulation conducted during an FIR task. AntCOS, anterior portion of the collateral sulcus; AntFG, anterior portion of the fusiform gyrus; AntOTS, anterior portion of the occipito-temporal sulcus.* ***B***. *Face-selective intracerebral responses (low-frequency band) recorded on electrode TM (Face Categorization paradigm, see* ***Supplementary Figure 1A****). These responses were quantified by summing the amplitude of the responses recorded at the face stimulation frequency and its harmonics up to 13.2Hz (i.e., 1.2, 2.4, 3.6, etc., removing the base frequency and its harmonics at 6 and 12Hz). The 0 mark corresponds to the face stimulation frequency.* ***C***. *Intracerebral responses (low-frequency band) to*

*unfamiliar face discrimination (Unfamiliar Face Discrimination experiment, see **Supplementary Figure 1A**) recorded on electrode TM for both upright and inverted faces. **D**. Intracerebral responses (low-frequency band) to famous face identity recognition (Famous Face Identity experiment, see **Supplementary Figure 1A**) recorded on electrode TM for both upright and inverted faces.*

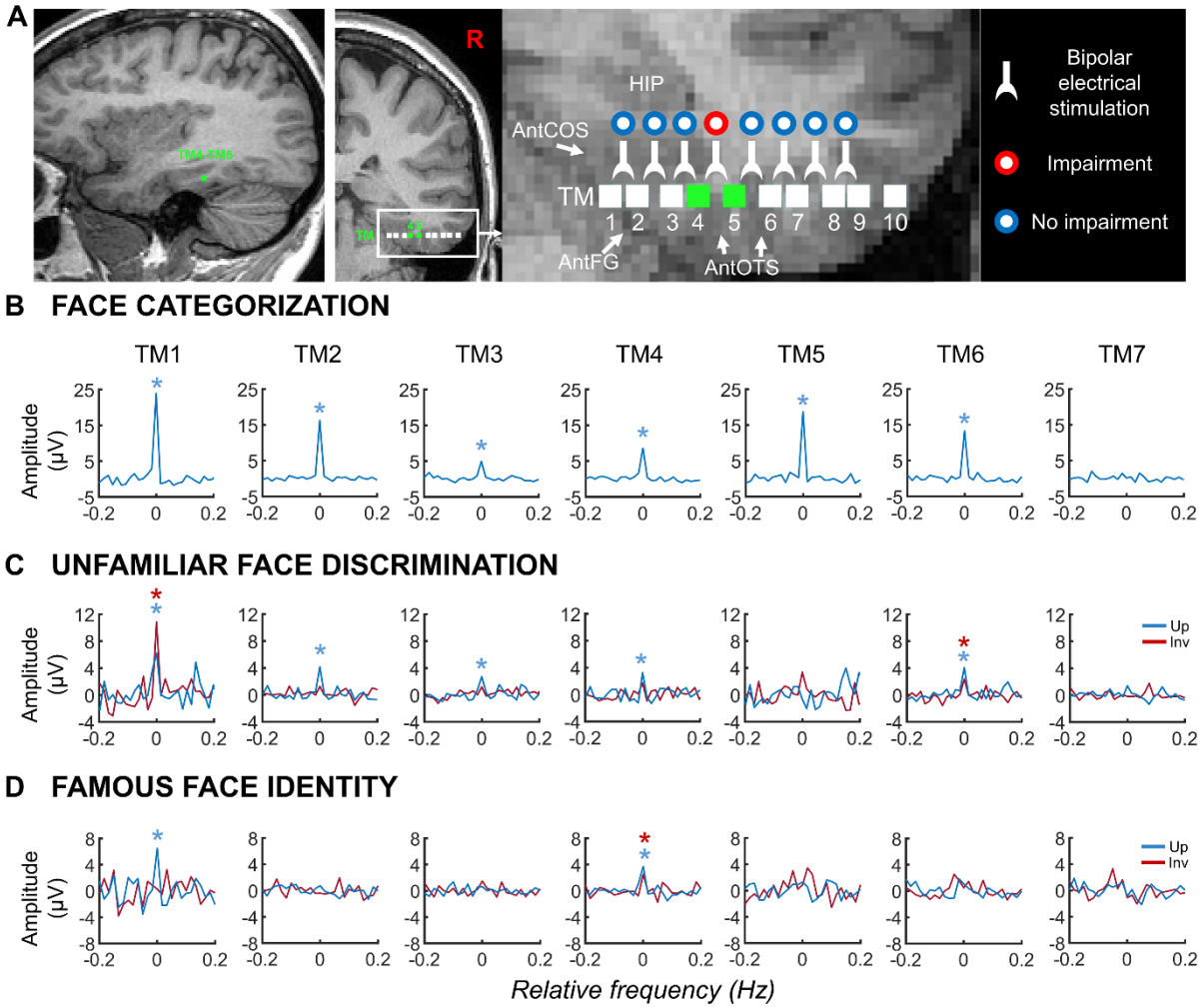

Fig. 2. Anatomical location of stimulated contacts and frequency-tagged responses in subject MD. ***A****. Anatomical location of electrode TM (in green) in sagittal and coronal MRI slices. The location of all the contacts on the TM electrode is displayed with the results of the electrical stimulation conducted during an FIR task. AntCOS, anterior part of the collateral sulcus; AntFG, anterior part of the fusiform gyrus; AntOTS, anterior part of the occipito-temporal sulcus; HIP, hippocampus. Same legend as in **Figure 1** for **B** to **D.***

Overview of the experimental plan

We reported two cases in which intracerebral electrical stimulations (5s, 1.0mA to 1.2mA) were applied between two adjacent intracerebral contacts during the administration of several tasks that did not require any verbal output: famous face and name pointing tasks in which

subjects have to point to the familiar item among 3 items (faces or names) and an unfamiliar face matching task in which they have to match unfamiliar faces with their identities (**Supplementary Figure 2**; see **Supplementary Information** for details on each task; see Volfart et al., 2023, 2022). Outside of stimulation, subjects NL and MD reported no problems during these tasks (e.g., 95,5% accuracy on unfamiliar face matching for both subjects; 100/82%, for NL and MD, and 98% accuracy on famous face and name pointing, respectively). To make the most out of the limited amount of time granted by the clinical context, we first identified the relevant electrode contacts for FIR through the administration of the famous face pointing task; after that, we used the other tasks to further investigate these contacts. Given that we identified an impairment during the stimulation of contacts TM4-TM5 (**Figures 1A** and **2A**) for both subjects, we focused on this electrode to maximize the number of tasks and trials. To assess the effects of stimulation, we statistically compared accuracy and response times (on correct trials) during stimulation versus outside stimulation (i.e., before and after stimulation) across stimulation sessions for each site and task as previously reported (Marchive et al., 2025; Volfart et al., 2022).

We also used well-validated frequency-tagging paradigms during SEEG recordings (Hagen et al., 2020; Jacques et al., 2020; Jonas et al., 2016) specifically to identify face-selective contacts (face categorization paradigm), contacts sensitive to unfamiliar and familiar face discrimination (unfamiliar face discrimination and famous face identity paradigms, respectively; see **Supplementary Figure 1A**; **Supplementary Information** for more details on experimental procedures and signal analyses). Subjects viewed sequences of images presented at a fixed frequency with an image category change inserted periodically throughout the sequences (faces among objects for the face categorization paradigm, various unfamiliar face identities among a single unfamiliar face identity for the unfamiliar face discrimination paradigm, and familiar faces among unfamiliar faces for the famous face identity paradigm). Amplitude responses were measured at each contact in the frequency domain at the image-change frequency (i.e., sum across the frequency of interest and its harmonics).

Finally, we tested the effective connectivity of critical sites for FIR using an original approach, combining concurrent electrical stimulation and frequency-tagged visual presentation (Angelini et al., 2024a, 2024b; Marchive et al., 2025). We stimulated TM4-TM5 (10s, 1 mA) again in both subjects, but this time while they viewed another frequency-tagged paradigm (famous faces presented at 6Hz). This approach provided recorded frequency-tagged face responses across all contacts and identified in real time remote contacts for which stimulation evoked a response amplitude decrease (**Supplementary Figure 1B**; see **Supplementary Information** for more details on experimental procedures and signal analyses). To identify those contacts, we statistically compared, for each contact, the face response (at 6Hz and harmonics in the frequency domain) measured during the stimulation period (10s) with that recorded during the 10s immediately before the stimulation (*Pre2* period; see **Supplementary Figure 1B**).

Results

Right AntFG stimulation elicits transient FIR impairment

Subjects NL and MD were transiently impaired in several tasks during electrical stimulation of contact TM4-TM5, located in the right AntFG and adjacent AntOTS (Talairach coordinates for the mean point between the two contacts for NL x: 34.9, y: -18.8, z: -15.8; coordinates for MD x: 38.1, y: -30.1, z: -20.5; **Figure 1A** and **2A**). As in the two previously reported cases (subject CD, Jonas et al., 2015; subject DN, Volfart et al., 2022), these critical contacts were located anteriorly to the fourth cytoarchitectonic area of the fusiform gyrus ('FG4'; Rosenke et al., 2018; see **Figure 3A**), but within the fifth cytoarchitectonic area of the fusiform gyrus ('FG5'), recently identified and added to the Julich Brain Atlas (Dietermann et al., 2025; see **Figure 3B**).

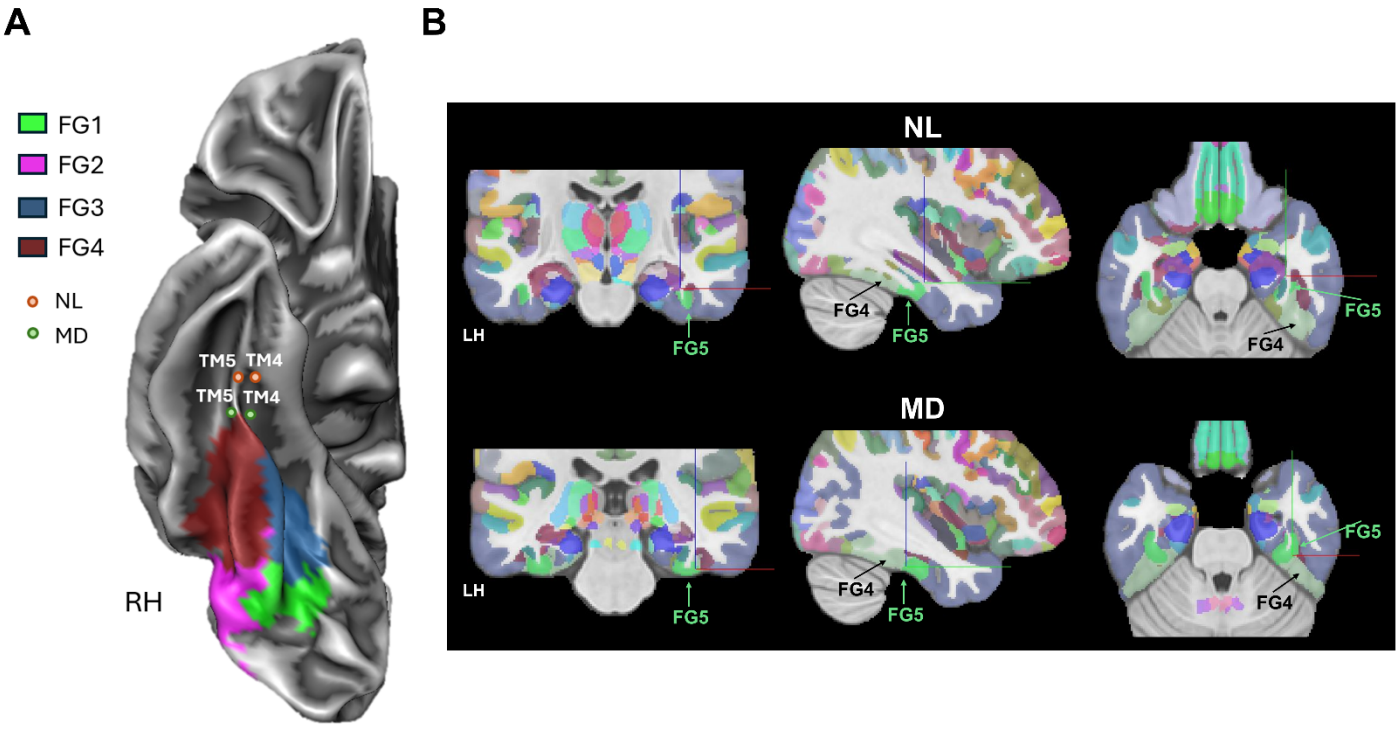

Fig. 3. Location of the critical sites for patients NL and MD compared to the FG4 and FG5 cytoarchitectonic areas defined in the VOTC. ***A.*** *The coordinates of the critical sites (red for NL and green for MD) are projected onto a cytoarchitectonic atlas of the visual ventral stream* (Rosenke et al., 2018) *to determine their localization relative to the cytoarchitectonic areas FG1, FG2, FG3, and FG4.* ***B.*** *The coordinates of the midpoint between the critical sites (indicated by the meeting point of the two perpendicular lines) are projected onto the Julich-Brain atlas (Amunts et al., 2023) to determine their localization relative to the cytoarchitectonic area FG5.*

By stimulating the AntFG, NL and MD were transiently impaired at recognizing the identity of faces (**Figure 4**, **Supplementary Tables 3** and **4**). For the famous face pointing task, their performance dropped significantly during the time of stimulation (NL: 5/8, 62.5%, $\chi(1) = 7.630$, p .0057; MD: 6/12, 50%, $\chi(1) = 13.72$, p .0002), along with a significant increase of response times for MD (during stimulation n = 12, mean = 2,52s ± 0,31s; outside stimulation, n = 43, mean = 1,64s ± 0,1s; Permutation p=.0005, number of permutations = 40000). Both subjects were fully aware of their transient difficulties in face identity recognition. After the stimulation, NL stated (in 3 out of 3 stimulation sessions) for example: "*They all looked alike*", "*they all looked like the same person*", "*they looked like normal faces, but unfamiliar*", and "*I*

couldn't recognize them"; while MD reported (in 2 out of 6 stimulation sessions) that "*they all looked alike", and "they all looked like somebody else"* (for examples, see **Videos 1** and **2**). When NL and MD were presented with the trials they failed during stimulation and were asked to perform the task again, they quickly pointed to the famous faces without errors. Stimulating outside TM4-TM5 never impaired accuracy (**Supplementary Tables 3** and **4**).

Although subjects were 100% correct at a similar pointing task with famous names throughout the stimulation procedure of contacts TM4-TM5, they both showed increases in response times during stimulation (**Figure 4**; **Supplementary Tables 3** and **4**; NL, during stimulation: n = 13, mean = 1.71s ± 0.19s; outside stimulation: n = 32, mean = 1.43s ± 0.1s, Permutation p=.00015; MD, during stimulation: n = 5, mean = 2.43s ± 0.47; outside stimulation: n = 18, mean = 1.7s ± 0.12s, Permutation p=.0136).

The critical stimulation sites TM4-TM5 were further tested in both subjects with the unfamiliar face matching task, the main objective of the present study. During stimulation, NL and MD were both transiently impaired at matching simultaneously presented unfamiliar faces (**Figure 4**, **Supplementary Tables 3** and **4**, see **Videos 3** and **4**). Their performance dropped significantly during stimulation (NL: 7/13, 53.8%, $\chi(1) = 15.62$, $p < .0001$; MD: 5/10, 50%, $\chi(1) = 20.20$, $p < .0001$). After stimulation, NL stated (in 3 out of 5 stimulation sessions) for example: "*they had the same face*", while MD reported (in 3 out of 5 stimulation sessions) that: "*they all looked alike, like a mix of the two people"* and "*they looked alike*". NL and MD never reported face distortions such as changes of the first-order face configuration. Once again, when NL and MD were presented with the trials they failed during stimulation and were asked to perform the task again, they quickly pointed to the correct faces without errors. Stimulations outside TM4-TM5 were only performed in NL and did not affect her performance (**Supplementary Tables 3** and **4**).

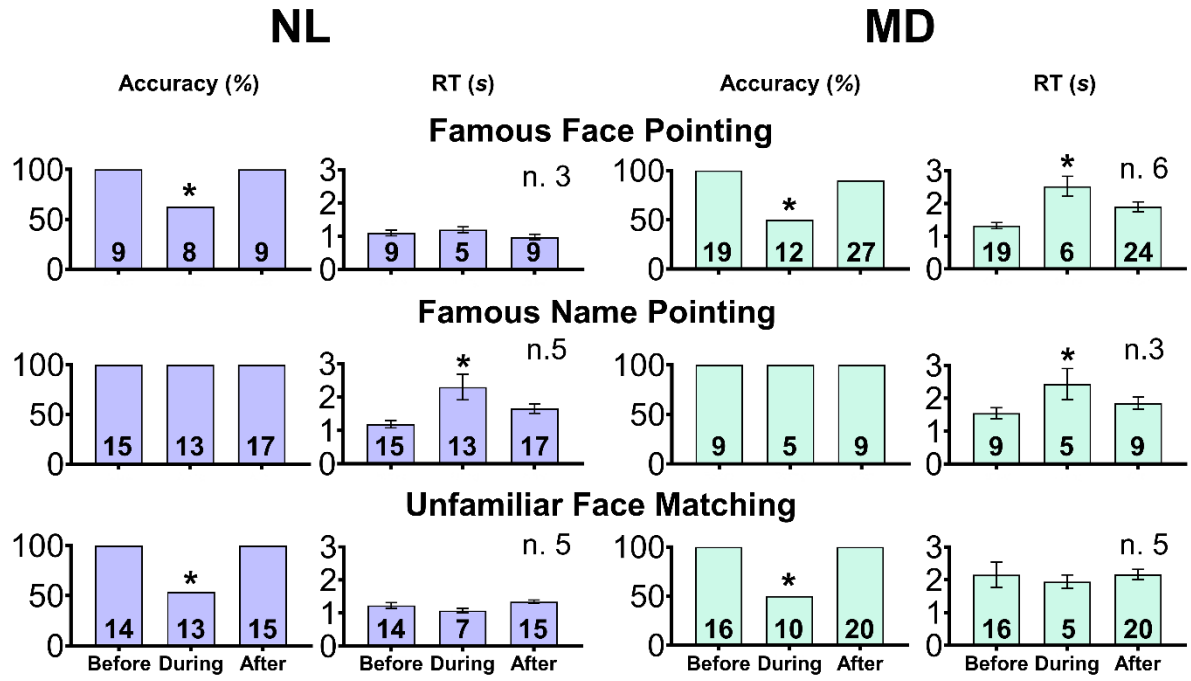

Fig. 4. Accuracy and response times for correct trials before, during, and after electrical stimulation of contacts TM4-TM5 for all the tasks administered to subject NL (on the left, in purple) and MD (on the right, in green). *In the famous face/name pointing tasks, subjects were shown trials consisting of three items (faces or names) presented next to each other, with one famous and two unfamiliar items. They were asked to point to the familiar items, without a verbal output (see **Supplementary Figure 2**). In the unfamiliar face matching task, subjects were shown trials consisting of three photographs of faces organized in two rows, with a target on the top and two probes on the bottom. The target was an unfamiliar individual, one of the probes consisted of another photograph of the target identity, and the other probe was a photograph of another identity. They had to point to the probe corresponding to the target (see **Supplementary Figure 2**). Error bars indicate standard error. RT, response times; (∗) indicates a significant difference at p < .05. The number inside the histograms indicates the number of trials included in the analyses, and the number on top of the graphs indicates the number of stimulation sessions administered for each task (for more details, see **Supplementary Tables 3** and **4**).*

Functional mapping of effective contacts

We measured electrophysiological face-selective activity on each contact in low-frequency bands with several frequency-tagging paradigms during SEEG recordings (**Figures 1** and **2**). Overall, across contacts recorded in the bilateral VOTC, we found 37 and 15 face-selective contacts for NL and MD, respectively (**Supplementary Figure 3A**). For both subjects, effective contacts TM5 were highly face-selective (**Figures 1B** and **2B**). For NL, contact TM5 recorded large responses indexing both unfamiliar and familiar face discrimination (unfamiliar face discrimination, famous face identity; **Figures 1C** and **1D**).

To localize effective contacts with respect to the cortical face network, NL was also tested (9 months after the SEEG procedure) with a Fast Periodic Stimulation fMRI paradigm (Gao et al., 2018; **Supplementary Information**). This approach provides an approximately twofold increase in signal-to-noise ratio compared to a conventional block-design approach that uses identical stimuli and scanning duration, thereby increasing the detectability of face-selective activations in the ATL (Gao et al., 2018). Despite using this highly sensitive approach, no face-selective activations were found around the contacts TM4-TM5 (**Figure 1A**). These contacts were located 21mm anteriorly to the most anterior activation in the LatMidFG. This absence of face-selective activations is likely due to the well-known fMRI signal dropout affecting the ventral ATL in echo-planar imaging, caused by field gradient distortions from magnetic susceptibility differences at air/tissue and bone/tissue interfaces. To test this assumption, we measured the mean tSNR and overlaid the electrode TM. Contacts TM4-TM5 were located at the edge of a severe signal loss in the right ventral ATL (**Supplementary Figure 4**).

Effective connectivity behind critical contacts

Contacts TM4-TM5 of subjects NL and MD were stimulated again, this time while they were shown a different frequency-tagging paradigm with famous faces presented at 6Hz on a computer screen (**Supplementary Figure 1B**; see **Supplementary Information**). Specifically, the sequences lasted 74 seconds, with stimulation starting 20 seconds in and lasting for 10 seconds. Neither subject reported any visual changes during these stimulations. To assess the neurophysiological impact of stimulation on the responses for faces at 6Hz, we compared the recordings of the 10s before stimulation (period *Pre2*) to the 10s of stimulation. We restricted our analyses to the pool of contacts that already showed a significant 6Hz face response when tested with the same paradigm independently of this stimulation procedure (**Supplementary Information**). Prior to the stimulation procedure, we identified 36 and 31 contacts with a significant 6Hz face response for NL and MD, respectively (**Supplementary Figure 3B**).

We observed that the stimulation of the right AntFG reduced the 6Hz face response amplitude (i.e., when comparing during stimulation and *Pre2* periods) in both local and distant sites bilaterally in the VOTC (**Figure 5A**; for examples of amplitude reduction in the frequency domain, see **Supplementary Figure 5**). Notably, stimulation of the right AntFG significantly reduced the 6Hz face responses in the left AntFG (1 contact) and LatMidFG (3 contacts) in NL and in the left AntFG in MD (1 contact).

To determine whether this effect was functionally specific, i.e., specific to the face-selective network, we computed correlations between the amplitude effect of the stimulation (6Hz face response amplitude difference between *Pre2* and the stimulation periods) and several independent face-related amplitude responses recorded independently of the stimulation procedure across the corresponding pool of non-stimulated contacts (36 for NL and 31 for MD). We found highly significant positive correlations between the amplitude effect of the stimulation and face-selective and unfamiliar face discrimination responses (**Figure 5B**). This shows that the more a contact was face-selective or sensitive to unfamiliar face discrimination, the more the 6Hz face response decreased during stimulation. There was no significant positive correlation for any of the stimulation sites when correlating the stimulation effect with the Euclidean distance from the stimulation site (NL: $r(31)= -.024$, $p= .893$; MD: $r(25)= -.237$, $p= .224$) or the amplitude of the stimulation artefact (NL: $r(30)= -.092$, $p= .617$; MD: $r(26)= .167$, $p= .404$) (**Supplementary Figure 6**). For NL, we had the opportunity to stimulate two face-selective control sites in the left hemisphere with the same experimental procedure (F'5-F'6 in the LatMidFG and TM'3-TM'4 in the anterior collateral sulcus). For each control site, only two contacts reported a significant decrease of the 6Hz response during stimulation, and no significant positive correlation was found (see **Supplementary Figure 7**).

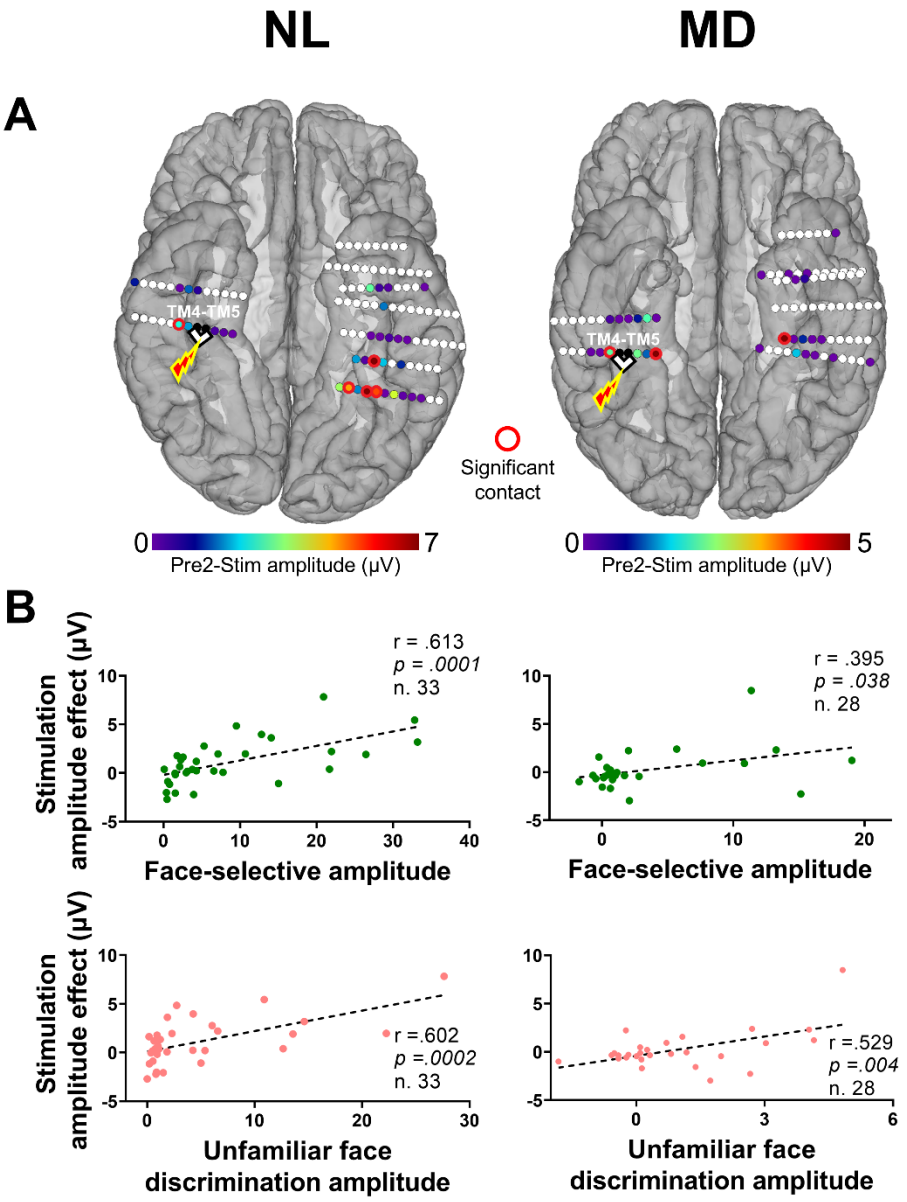

Fig. 5. Effective connectivity of the stimulated sites. A. *Spatial distribution of the 6Hz Face response amplitude decrease during stimulation of the right AntFG. Contacts of interest (significant contacts outside stimulation) are color-coded according to the baseline-corrected amplitude difference between Pre2 and the stimulation periods (stimulation effect). Contacts with a significant difference are circled in red (z-score>2.32, p < 0.01).* ***B.*** *Correlation plots between the stimulation amplitude effect (baseline-corrected amplitude difference between Pre2 and stimulation periods) and independent face responses (face-selective and unfamiliar face discrimination responses acquired independently from the stimulation procedure with the frequency-tagging paradigms shown in Supplementary Figure 1A) across the contacts of interest (stimulated contacts excluded) for both subjects. Outliers (Z-score>3) were removed. The Pearson correlation coefficient, the p-values, and the number of contacts included in the analyses are indicated for each correlation.*

Discussion

Electrical stimulation of the right face-selective AntFG evoked a massive transient inability to recognize the identity of famous faces and to match the identity of unfamiliar faces in two subjects (NL and MD). These observations strengthen previous electrical stimulation studies conducted in the same anatomical region, with subjects CD (Jonas et al., 2015; impairment at identifying pictures of famous faces presented one by one with a verbal output, but no tasks with unfamiliar faces) and DN (Volfart et al., 2022; impairment at the same nonverbal face tasks used here). As for DN, and also for a previous case stimulated in the right LatFG (CJ, Volfart et al., 2023), right AntFG stimulation was not able to impair famous name selection, in stark contrast to the same task with faces. Yet, we also found increased response times for the name pointing task during stimulation, suggesting that the deficit in this task is not specific to faces, which was not the case in the previously reported cases. The stronger impact of stimulation on face compared to written stimuli is consistent with the view that nonverbal and verbal semantic knowledge may be processed (relatively more) respectively in the right and left ATL (Ralph et al., 2017; see Shimotake et al., 2015 for a stimulation study of the left ATL affecting semantic knowledge linked to language). To fully assess the face specificity of this region, it would have been informative to compare the unfamiliar face matching task with another matching task involving objects of comparable complexity (e.g., cars) while applying electrical stimulation. Nevertheless, this observation is consistent with the theoretical framework of a gradual increase in sensitivity from visual to semantic features in the VOTC (Rossion et al., 2024). Indeed, the simulated sites are located more posteriorly within the ATL, where, according to this framework, both visual and name-related person representations exist, with visual representations being more prominent.

The right AntFG is critically involved in visual face individuation

In the previous case of patient DN, stimulation performed during unfamiliar face matching suggested failure at this task (4 errors out of 8 trials). However, there was no significant

impairment due to a lack of power, and several failed trials after stimulation (Volfart et al., 2022). Here, we demonstrate clear impairment at this task across a higher number of stimulations in the right AntFG of two different subjects (5 stimulation sessions each for NL and MD). Altogether, these results are highly valuable since they provide unique evidence that the right AntFG is critically involved in face identity recognition independently of long- or even short-term episodic or semantic memory of the faces. This is supported by frequency-tagged responses indexing unfamiliar face identity discrimination recorded on the critical sites of the 3 subjects, NL, MD, and DN (although with a lower amplitude in MD). At a larger scale, an iEEG group study using the same frequency-tagging paradigm showed that the right AntFG is among the 3 main regions showing the highest proportion of responses and the largest response amplitude (Jacques et al., 2020). Therefore, the right AntFG appears as a critical node of the human visual cortical network for face identity recognition, unfortunately overlooked in past decades, mainly because of an emphasis on (artifact-ridden) fMRI signals (Rossion et al., 2024). Nevertheless, the present study, along with recent evidence identifying the AntFG as having a distinct cytoarchitectonic signature in the human brain ('FG5'; Dietermann et al., 2025), helps clarify both the functional and anatomical specificity of this region.

A cortical network view of stimulation-related recognition impairments

Behavioral effects elicited by electrical stimulation, especially in the human association cortex, are caused by a disturbance of distributed networks beyond the stimulation site (Borchers et al., 2012). It is therefore fundamental to assess the spatial distribution and the functional specificity of these remote effects to understand the cortical networks underlying behavioral impairment linked to stimulation. This has not been performed in the two previous AntFG stimulation studies (subject CD: Jonas et al., 2015; subject DN: Volfart et al., 2022). Here, we applied a recently developed effective connectivity approach - concurrent intracerebral electrical stimulation and frequency-tagged visual presentation (Angelini et al., 2024b, 2024a) - to objectively quantify remote effects of the right AntFG stimulation.

Stimulation of the right AntFG reduced frequency-tagged responses to famous faces not only in this region but also in remote regions, especially in the left AntFG for both subjects and in the (posteriorly located) left LatMidFG for NL (i.e., the only LatMidFG region sampled across the two subjects). Despite limited sampling, we were able to show that the right AntFG stimulation predominantly affected the face-selective network and the network supporting unfamiliar face identification, since the magnitude of the stimulation effect correlated with these two independent measures in both subjects. No such correlations were found when stimulating two face-selective control sites in NL. Altogether, these results suggest that transient FIR impairments during stimulation are linked to the disturbance of remote nodes within the ventral face-selective network (see also (Angelini et al., 2024b) for stimulation in the right LatMidFG inducing FIR impairment and affecting the AntFG). This view is supported by numerous similarities between FIR impairment following stimulation to the right AntFG and more posterior face-selective regions in the right hemisphere, i.e., the LatMidFG (subject CJ; Angelini et al., 2024b; Volfart et al., 2023) and IOG (subject KV; Jonas et al., 2014, 2012): (1) impairment at identifying famous faces; (2) impairment at matching concurrently presented unfamiliar faces for their identities; (3) subjective report that faces simultaneously presented “looked the same” (except for DN); (4) large responses indexing visual discrimination of unfamiliar face identities recorded on the stimulation site. The transient FIR impairments following AntFG stimulation may also be linked to the disruption of more anterior face-selective regions close to the temporal pole (Axelrod and Yovel, 2013; Deen et al., 2024; Von Der Heide et al., 2013), as suggested by effective connectivity between these two regions observed in a single subject using a similar approach as here (Angelini et al., 2024a).

Conclusions

The AntFG, which has been recently defined as having a distinct cytoarchitectonic signature in the human brain (‘FG5’, Dietermann et al., 2025), appears to be a critical region in the right hemisphere to extract idiosyncratic facial features independently of long-term familiarity, in concert with connected contralateral and posterior face-selective regions.

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Statements & Declarations

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Author contributions

L.A. Conceptualization, Data recordings, Data analysis, Interpretation, Manuscript writing, Figures; M.L. Data recordings, Data analysis; S.C-C. Ethics Approval, Intracerebral electrodes implantation, Epilepsy surgery, Medical patient care; B.R. Conceptualization; Data recordings, Interpretation, Manuscript writing, Figures; J.J. Conceptualization; Ethics Approval, Data recordings, Interpretation, Manuscript writing, Figures.

Data Availability

The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy restrictions.

Ethics approval

The study was conducted in accordance with the Declaration of Helsinki and was approved by the ethical committee of the University Hospital of Nancy (*Centre Hospitalier Universitaire de Nancy*).

Consent to participate and publish

Informed consent was obtained from all individual participants included in the study.