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# Characterization of Incomplete Hippocampal Inversions in a large dataset of young healthy subjects

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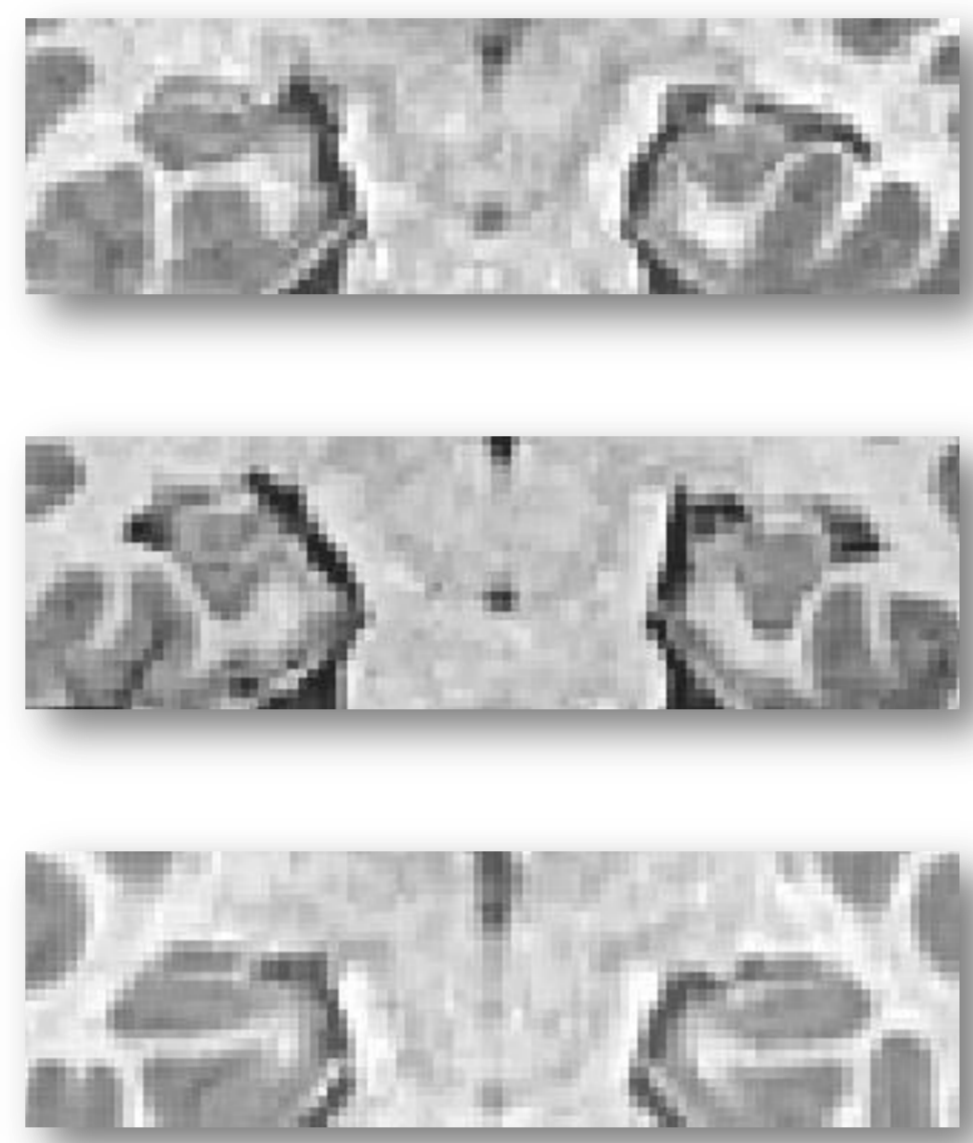
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## INTRODUCTION

**Incomplete hippocampal inversion (IHI) is an atypical anatomical pattern of the hippocampus.**

It has been mostly described in patients with epilepsy, malformations of cortical development and in temporal lobe epilepsy (Baulac et al. 1998; Bernasconi et al. 2005; Bajic et al. 2009), with a prevalence of 30%-50%. IHI are also found in healthy subjects, although with an apparently lower frequency (Bajic et al. 2008). However, these studies include a small number of subjects or included patients without epileptic seizures but referred for other neurological conditions.

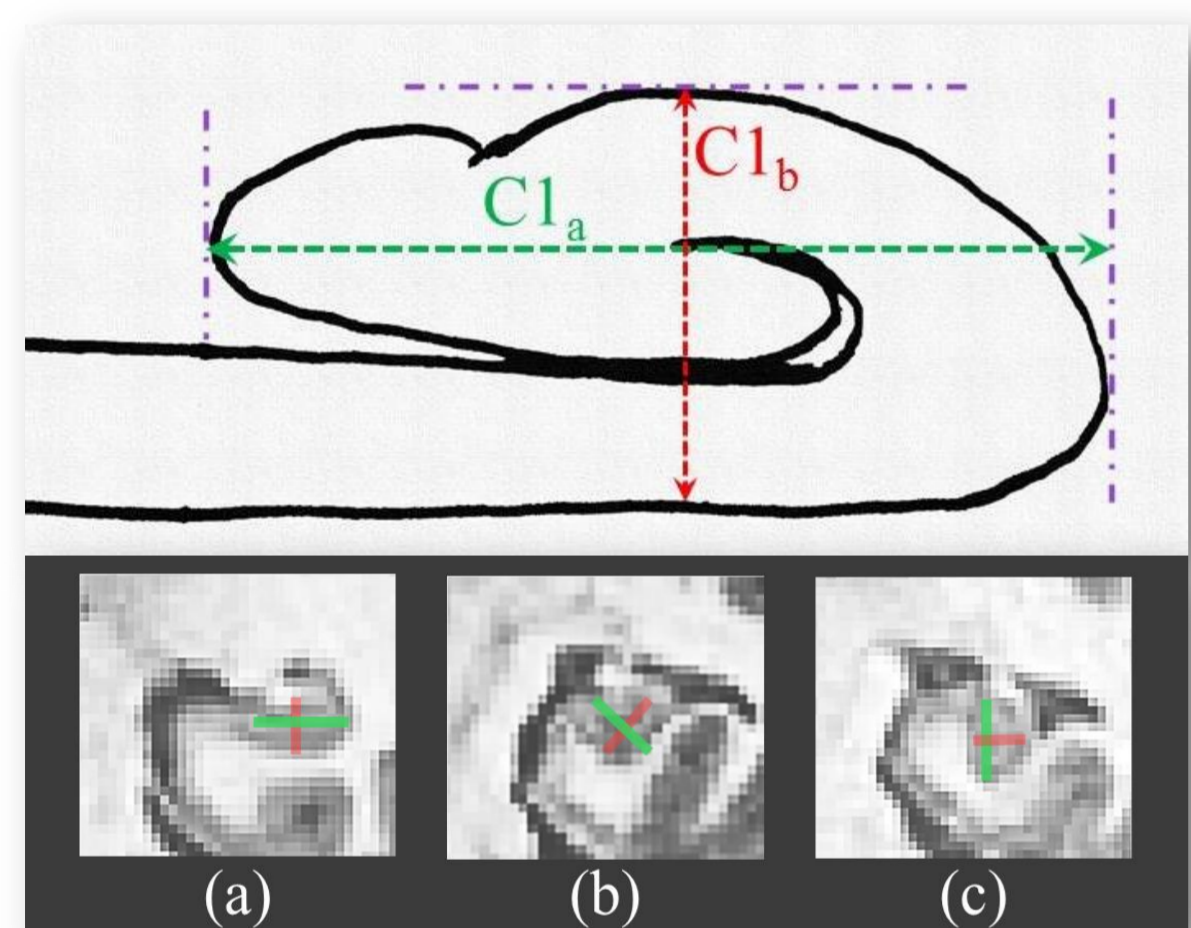
The purpose of our study was to investigate the prevalence of IHI in a large population of normal subjects.



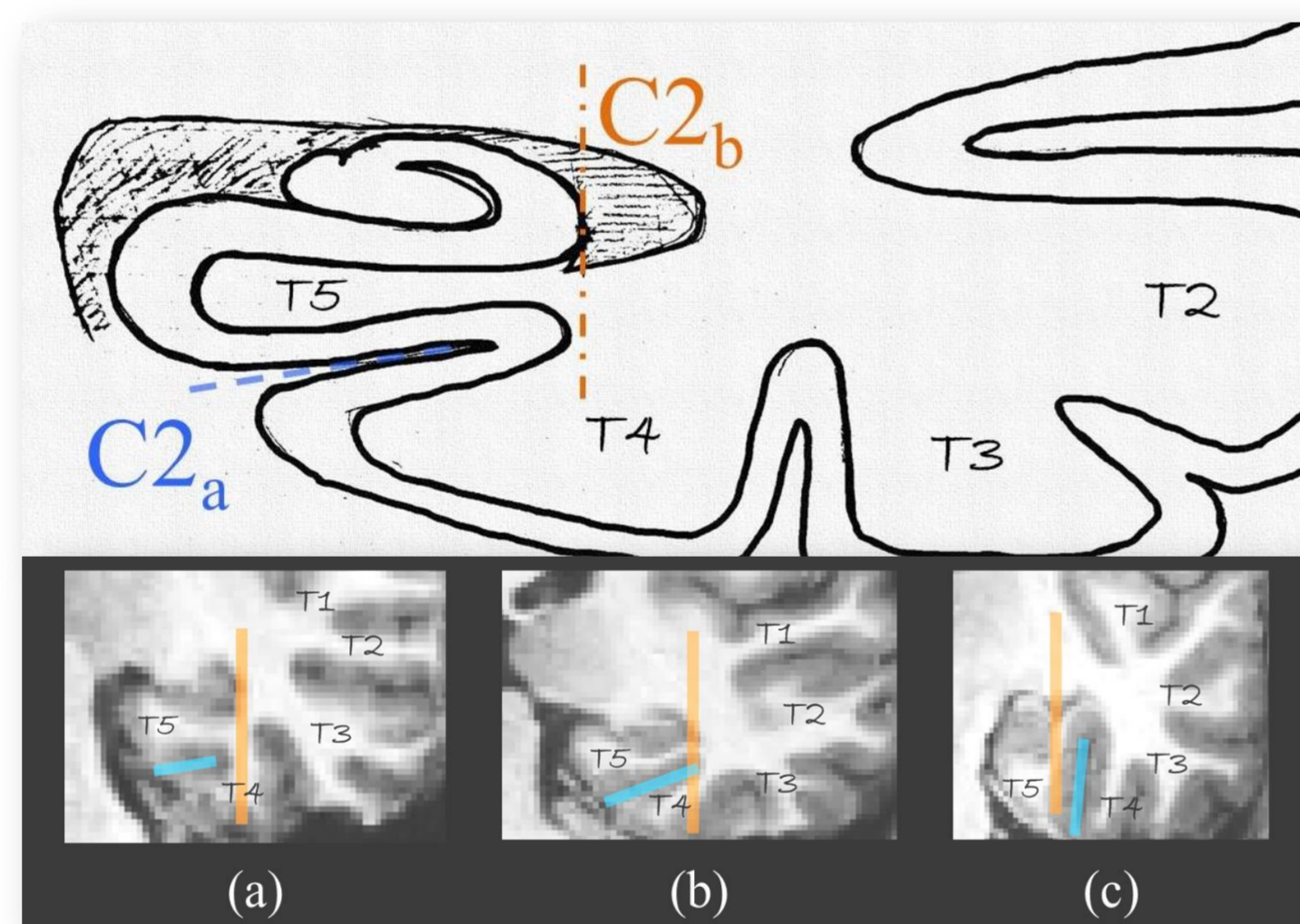
## METHODS

→ We studied **2008 subjects** of the European database **IMAGEN** (Schumann et al. 2010). IHI was assessed using a **visual scale** on T1-MRI. We adapted existing criteria to make feasible the evaluation of a large dataset. Each criterion have a note between 0 and 2.

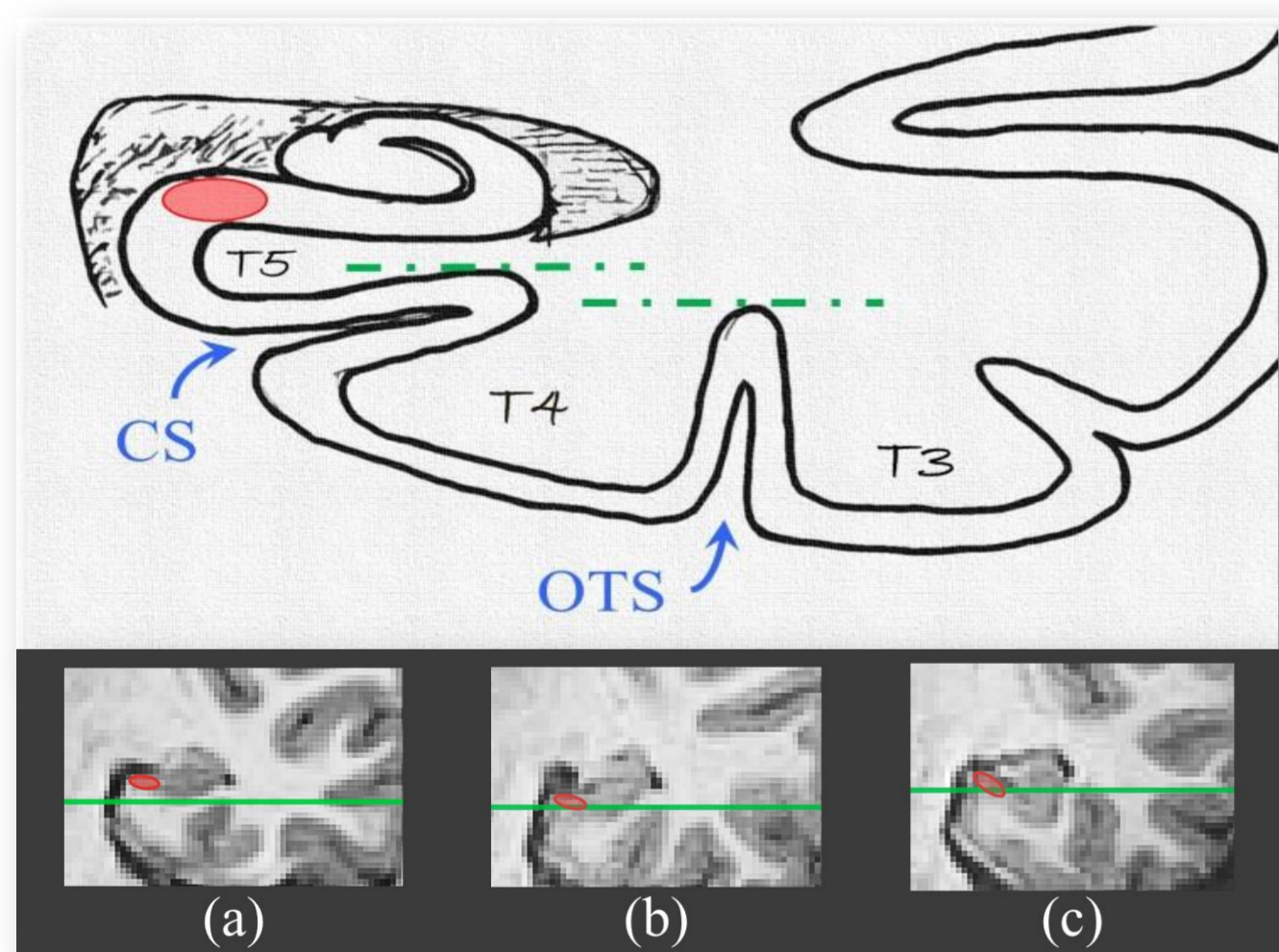
→ A global **criterion C0** indicates the presence of IHI on the global aspect of the hippocampus: 0 if there is no IHI, 2 if there is an IHI and 1 if the IHI is not obvious.



**criterion C1:** roundness of the hippocampal body and its verticality. *Atypical if  $C1_b \geq C1_a$  and  $C1_a$  verticalized.*

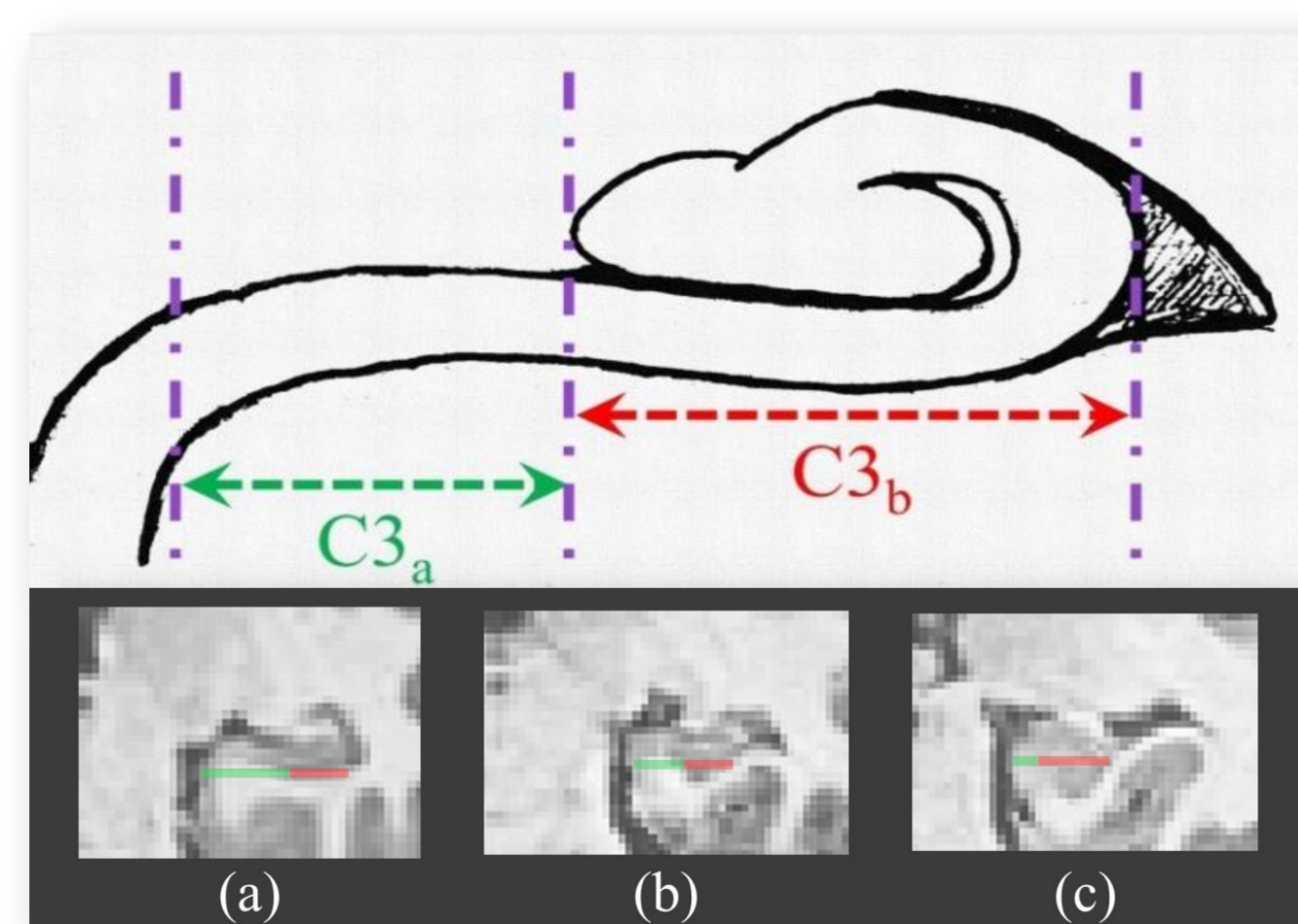


**criterion C2:** verticality and depth of the collateral sulcus relative to the size of the hippocampus. *Atypical if  $C2a$  is verticalized and crosses  $C2b$ .*



**criterion C4:** thickening of the subiculum. *Red area*

**criterion C5** evaluates if one of the sulci that limits the fusiform gyrus crosses the level of the subiculum. *Atypical if one of them crosses the subiculum.*



**criterion C3:** medial positioning of the hippocampus. *Atypical if  $C3_a$  is short compared to  $C3_b$ .*

→ The sum of individual criteria C1 to C5 to produce an **IHI score** between 0 and 10, indicating the degree of IHI.

→ IHI of the hippocampi of the database were assessed by 2 raters (CC and FC). 42 subjects were randomly selected to assess intra- and inter-rater reproducibility.

→ A kappa test were used to estimate the reproducibility of the criteria.

## RESULTS

→ The reproducibility was beyond 0.64 (substantial agreement).

→ Very **strong agreement** (>80) were observed in the majority of cases

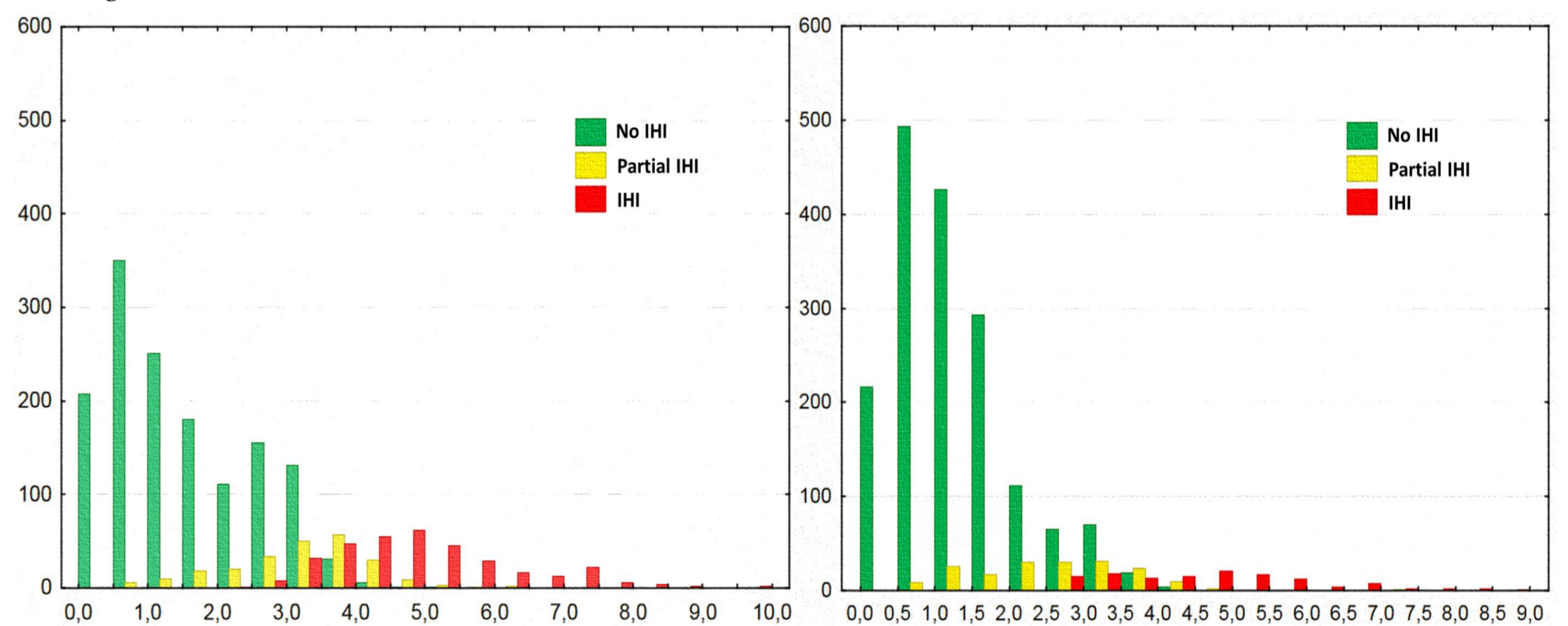
*Frequency of IHI, according to the global criterion C0, for left and right hippocampi. Confidence intervals (CI) are at 95%.*

C0	No IHI	Partial IHI	IHI
Left	70.9%	11.9%	17.1%
Right	84.6%	9.0%	6.5%

Left vs Right	No IHI Right	Partial IHI Right	IHI Right
No IHI Left	65.9%	3.1%	1.9%
Partial IHI Left	7.9%	3.5%	0.5%
IHI Left	10.8%	2.3%	4.0%

→ The distribution of the total IHI score reflect a **continuous** spectrum of atypical patterns.

*Histograms of the IHI score for left and right hippocampi. The colour indicates the value of the global criterion C0*



## CONCLUSION

→ Our results demonstrate that IHI are a common phenomenon in healthy subjects. Thanks to the study of a large dataset of over 2000 subjects, we were able to provide reliable estimates of the frequency.

→ We also proposed a visual scale of IHI that is applicable to large datasets.

→ IHI were much more frequent in the left hemisphere.

→ The IHI score shows a continuum between the absence and the presence of IHI, and therefore using a IHI score seems to be more adapted for the study of IHI than a global criterion.

## REFERENCES

- Bajic, D. et al. (2008), "Incomplete inversion of the hippocampus—a common developmental anomaly", *European radiology*, 18 (1): 138-142.
- Bajic, D. et al. (2009), "Incomplete hippocampal inversion—is there a relation to epilepsy?", *European radiology*, 19 (10): 2544-2550.
- Baulac, M. et al. (1998), "Hippocampal Developmental Changes in Patients with Partial Epilepsy: Magnetic Resonance Imaging and Clinical Aspects", *Annals of Neurology*, 44(2): 223-33.
- Bernasconi, N. et al. (2005), "Analysis of Shape and Positioning of the Hippocampal Formation: An MRI Study in Patients with Partial Epilepsy and Healthy Controls", *Brain*, 128(10): 2442-2452.
- Bronen, R. and Cheung G. (1991), "MRI of the normal hippocampus", *Magnetic resonance imaging*, 9 (4): 497-500.
- Gams, R. et al. (2009), "Prevalence of hippocampal malrotation in a population without seizures.", *AJNR Am J Neuroradiol*, 30 (8): 1571-1573.
- Schumann, G. et al. (2010), "The IMAGEN study: reinforcement-related behavior in normal brain function and psychopathology", *Molecular psychiatry*, 15 (12): 1128-1139.