Démence à corps de Lewy: biomarqueurs en IRM cérébrale

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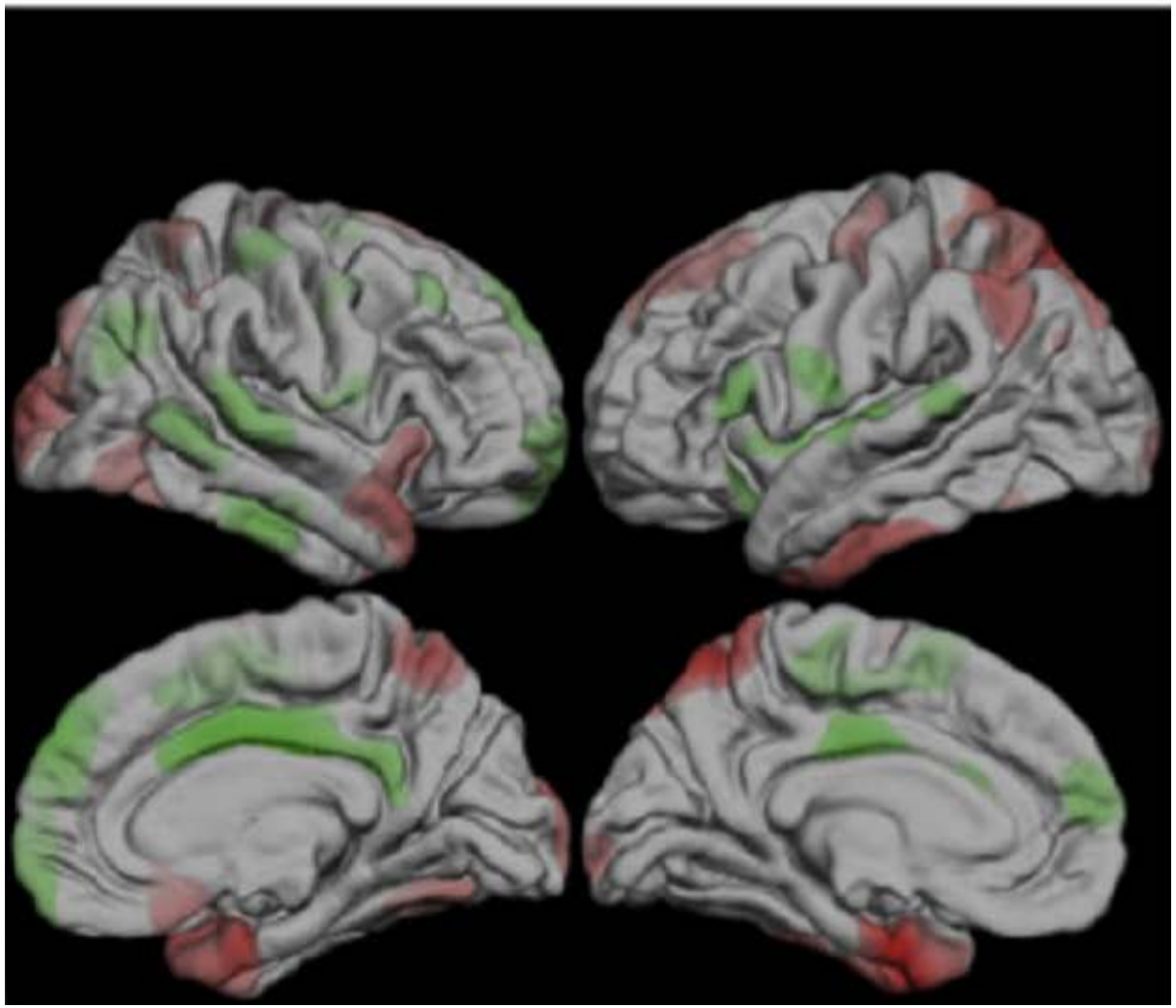
Plan

- Atrophie dans la maladie à corps de Lewy comparativement à la maladie d'Alzheimer et des sujets sains
  - Epaisseur cortical
  - Atrophie (VBM: voxel-based morphometry)
- Autres séquences: perfusion (Asl), Diffusion (DTI)
- Conclusion et points clefs

Atrophie dans la démence à corps de Lewy comparativement à la maladie d'Alzheimer: stade prodromal et de démence

Frederic Blanc, Sean J. Colloby, Nathalie Philippi, Xavier de Pétigny, Barbara Jung, Catherine Demuynck, Clelie Phillipps, Pierre Anthony, Alan Thomas, Fabrice Bing, Julien Lamy, Catherine Martin-Hunyadi, John T O'Brien, Benjamin Cretin, MD, Ian McKeith, Jean-Paul Armspach, **John-Paul Taylor**.

Epaisseur cortical au stade de démence (1)



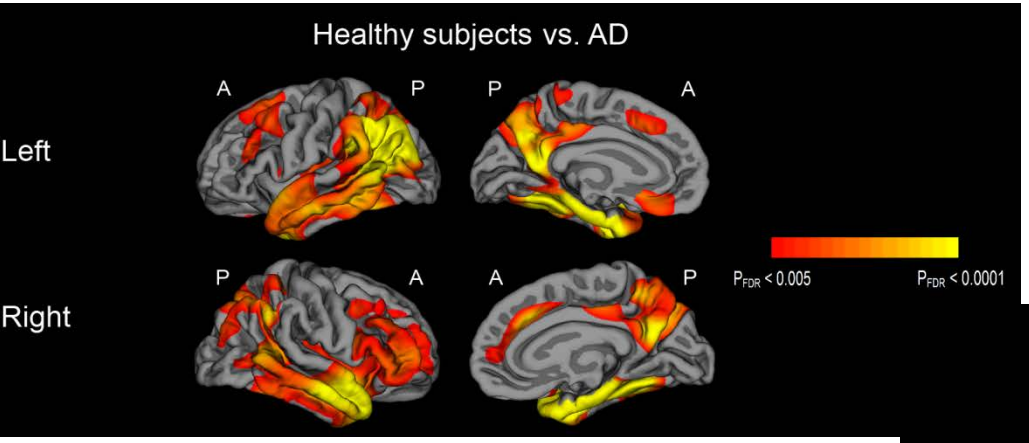
AD DLB

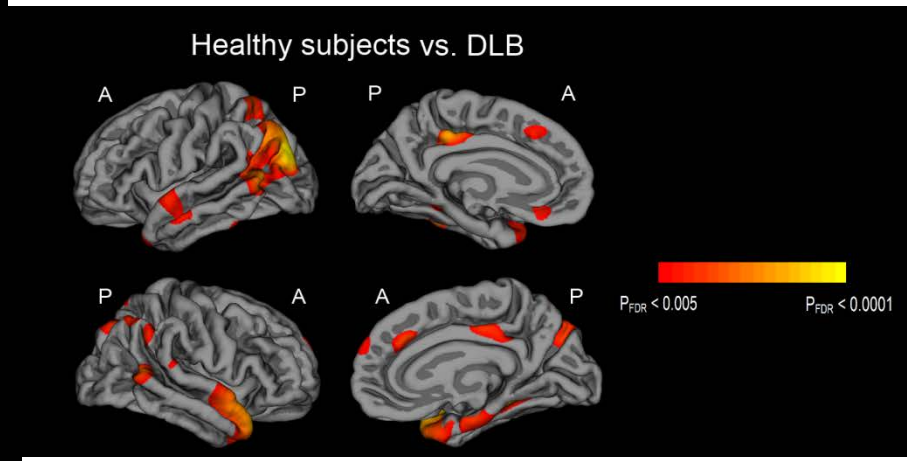
Cohortes de Stavenger, Haugesund, Bergen, (Norway) and (Ljubljana) Slovenia

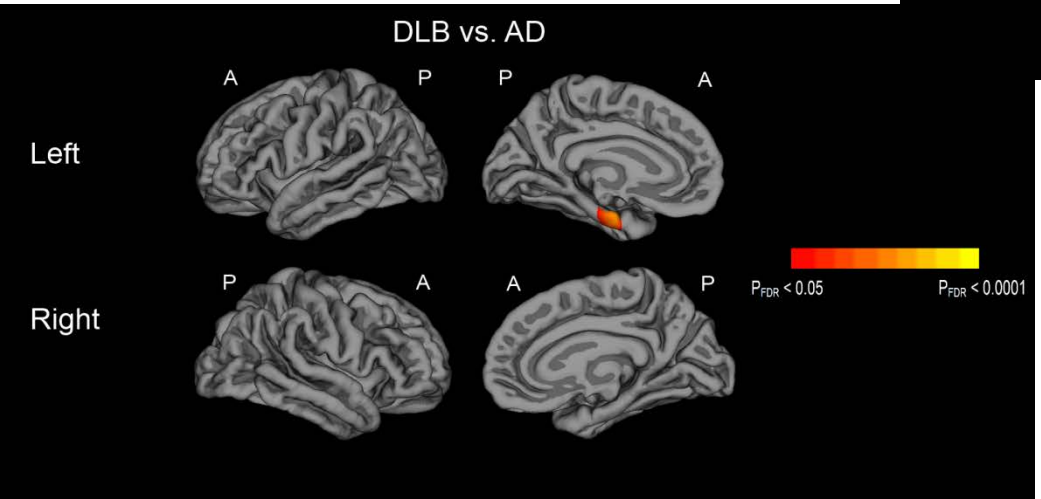
Mixed sample (26/26 and 36/9 AD/DLB)

Lebedev et al, J Neurol, 2013

Epaisseur cortical au stade de démence (2)







Cohorte de Newcastle, UK

Watson et al., 2014, AJGP

Etude Strasbourg et Newcastle

- 5 groupes:
  - Un groupe Lewy prodromal: pro-DLB
  - Un groupe Lewy avec démence: DLB-d
  - Un groupe Alzheimer prodromal: pro-AD
  - Un groupe Alzheimer avec démence: AD-d
  - Un groupe contrôle: HC

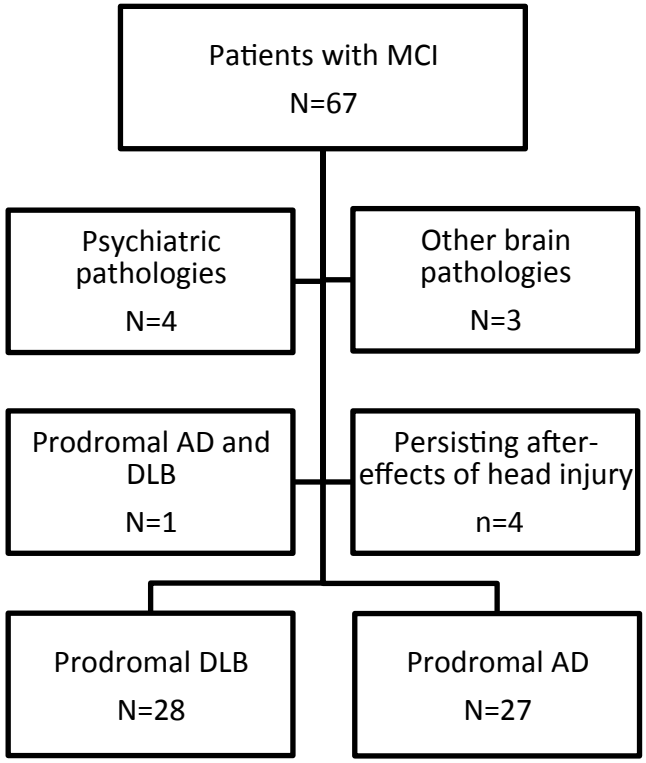
- Critères de diagnostic:
  - McKeith et al., 2005: Lewy
  - Dubois et al., 2007: Alzheimer

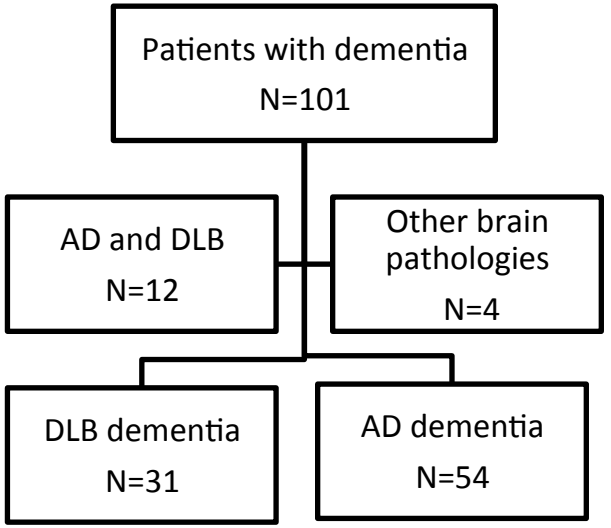
Méthodes (simplifiées)

- Acquisition des images cérébrales 3D T1:
  - 80 sujets de NCL avec IRM 3 Teslas Philips InteraAchieva.
  - 88 sujets de SXB avec IRM 3 Teslas Siemens Veriosyngo

- Utilisation logiciels Freesurfer et Qdec

Strasbourg/Newcastle





33 elderly healthy controls without any cognitive impairment

Excluded MCI patients: Psychiatric pathologies: 2 patients with depression, 1 with bipolar disorder, and 1 histrionic personality disorder. Other brain pathologies: 1 cognitive impairment due to severe sleep apnoea, 1 vitamin B12 encephalopathy, and 1 mitochondriopathy.

Excluded dementia patients: Other brain pathologies: 1 PDD, 1 DLB with primary Sjögren's syndrome, 1 chronic brain autoimmune encephalitis and 1 dementia without evolution for more than 10 years.

		Pro-DLB N=28	DLB-d N=31	Pro-AD N=27	AD-d N=54	HC N=33	Test statistic,P	Post hoc†
Age, years*		67.5 (9.2)	77.7 (6.9)	69.3 (7.8)	75.7 (9.4)	72.4 (10.4)	F=7.184, P<.0001*	Pro-DLB<DLB-d and AD-d Pro-AD<DLB-d and AD-d
Education ᵇ 1/2/3		11/4/8	5/10/2	11/3/12	10/26/7	1/14/11	H=7.465, P=.113	
Gender (F/M)		16/12	10/21	7/20	22/32	18/15	χ^2=8.860, P=.065	
Handedness (R/L)		26/2	26/5	24/3	50/4			
MMSE score*		27.6 (2.1)	20.5 (4.6)	26.9 (1.9)	20.8 (3.6)			
TMTA ᶜ impaired subjects		60.7%	82.3%	32.0%	43.2%	0%	H=21.791, P<.0001*	Pro-DLB<AD-d and DLB-d Pro-AD<AD-d and DLB-d HC>DLB-d and pro-DLB Pro-AD>DLB-d
TMTB ᶜ impaired subjects		71.4%	88.2%	44.0%	72.0%	0%	H=27.536, P<.0001*	HC>DLB-d, AD-d, pro-DLB
CDR sum of box 0/0.5/1/2/3		2/26/0/0/0	0/0/22/8/1	1/26/0/0/0	0/0/42/12/0	33/0/0/0/0	H=157.167, P<.0001*	HC< AD-d, DLB-d, pro-DLB and pro-AD Pro-DLB<AD-d and DLB-d Pro-AD<AD-d and DLB-d
Parkinsonism ᶜ	Rigidity 0/1/2/3/4	7/20/1/0/0	8/8/8/5/2	23/4/0/0/0	49/5/0/0/0	33/0/0/0/0	H=84.874, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
	Akinesia 0/1/2/3/4	10/14/3/1/0	3/13/12/3/0	23/4/0/0/0	40/12/2/0/0	31/2/0/0/0	H=73.814, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
	Tremor at rest 0/1/2/3/4	17/9/2/0/0	11/9/10/1/0	27/0/0/0/0	52/2/0/0/0	33/0/0/0/0	H=63.608, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
Hallucinations ᵈ		60.7%	90.3%	0%	1.8%	0%	χ^2=119.071, P<.0001*	
Fluctuations ᵈ		92.9%	90.3%	0%	22.2%	0%	χ^2=102.417, P<.0001*	
CAF*		3.5 (3.6)	6.8 (4.9)	0.0 (0)	1.0 (2.7)	0 (0)	H=81.063, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
RBD ᵈ		56.0%	56.6%	7.7%	3.7%	0%	H=65.852, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
Treatment ᵈ	ChEI	28.6%	83.8%	48.1%	81.5%	0.0%	χ^2=72.997, P<.0001*	
	Dopa	28.6%	35.5%	0.0%	0.0%	0.0%	χ^2=41.804, P<.0001*	
	NL	10.7%	22.6%	0.0%	1.9%	0.0%	χ^2=20.177, P=.0001*	
CSF*	Abeta-42	859.3 (3367, 23)	796.3 (2773, 3)	579.0 (2874, 23)	525.8 (1040, 11)	-	F=5.194, P=.003*	Pro-DLB>AD-d and pro-AD
	P-Tau	43.6 (13.9, 23)	66.0 (1.7, 3)	93.7 (36.8,23)	99.5 (39.5, 11)	-	F=14.111, P<.0001*	Pro-DLB<AD-d and pro-AD
	Tau	313.0 (2863, 23)	430.7 (28.6, 3)	660.6 (3554, 23)	679.0 (2461, 11)	-	F=6.266, P=.001*	Pro-DLB<AD-d and pro-AD
Hippocampi atrophy ᶠ 0/1/2/3/4	Left hippocampus	14/10/2/2/0	5/12/9/4/1	5/16/4/2/0	4/18/15/15/2	27/5/1/0/0	H=61.935, P<.0001*	HC<AD-d, DLB-d and pro-AD Pro-DLB<AD-d and DLB-d
	Right Hippocampus	14/10/4/0/0	7/9/11/3/1	5/14/7/1/0	4/16/19/13/2	22/8/2/1/0	H=50.544, P<.0001*	HC<AD-d, DLB-d and pro-AD Pro-DLB<AD-d and DLB-d

Patients with dementia are older

		Pro-DLB N=28	DLB-d N=31	Pro-AD N=27	AD-d N=54	HC N=33	Test statistic, P	Post *hoc*[†]
Age, years[a]		67.5 (9.2)	77.7 (6.9)	69.3 (7.8)	75.7 (9.4)	72.4 (10.4)	F=7.184, P<.0001*	Pro-DLB<DLB-d and AD-d Pro-AD<DLB-d and AD-d
Education[b] 1/2/3		11/4/8	5/10/2	11/3/12	10/26/7	1/14/11	H=7.465, P=.113	
Gender (F/M)		16/12	10/21	7/20	22/32	18/15	χ^2=8.860, P=.065	
Handedness (R/L)		26/2	26/5	24/3	50/4	29/4	χ^2=3.264, P=.515	
MMSE score[a]		27.6 (2.1)	20.5 (4.6)	26.9 (1.9)	20.8 (3.6)	29.4 (0.9)	H=119.397, P<.0001*	HC< AD-d, DLB-d and pro-AD Pro-DLB<AD-d and DLB-d Pro-AD<AD-d and DLB-d
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Parkinsonism[c]	Rigidity 0/1/2/3/4	7/20/1/0/0	8/8/8/5/2	23/4/0/0/0	49/5/0/0/0	33/0/0/0/0	H=84.874, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
	Akinesia 0/1/2/3/4	10/14/3/1/0	3/13/12/3/0	23/4/0/0/0	40/12/2/0/0	31/2/0/0/0	H=73.814, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
	Tremor at rest 0/1/2/3/4	17/9/2						
Hallucinations[c]		60.7%						
Fluctuations[c]		92.9%	90.3%	0%	22.2%	0%	χ^2=102.417, P<.0001*	
CAF[a]		3.5 (3.6)	6.8 (4.9)	0.0 (0)	1.0 (2.7)	0 (0)	H=81.063, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
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	Dopa	28.6%	35.5%	0.0%	0.0%	0.0%	χ^2=41.804, P<.0001*	
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	Right Hippocampus	14/10/4/0/0	7/9/11/3/1	5/14/7/1/0	4/16/19/13/2	22/8/2/1/0	H=50.544, P<.0001*	HC<AD-d, DLB-d and pro-AD Pro-DLB<AD-d and DLB-d

Patients with dementia have worse MMSE scores
Patients groups but pro-AD are different from HC group for TMTB

		Pro-DLB N=28	DLB-d N=31	Pro-AD N=27	AD-d N=54	HC N=33	Test statistic, P	Post hoc[†]
Age, years[a]		67.5 (9.2)	77.7 (6.9)	69.3 (7.8)	75.7 (9.4)	72.4 (10.4)	F=7.184, P<.0001*	Pro-DLB<DLB-d and AD-d Pro-AD<DLB-d and AD-d
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TMTB[c] impaired subjects							27.536, P<.0001*	HC>DLB-d, AD-d, pro-DLB
CDR sum of box 0/0.5/1/2/3		2/26/0/0/0	0/0/22/8/1	1/26/0/0/0	0/0/42/12/0	33/0/0/0/0	H=157.167, P<.0001*	HC< AD-d, DLB-d, pro-DLB and pro-AD Pro-DLB<AD-d and DLB-d Pro-AD<AD-d and DLB-d
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	Tremor at rest 0/1/2/3/4	17/9/2/0/0	11/9/10/1/0	27/0/0/0/0	52/2/0/0/0	33/0/0/0/0	H=63.608, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
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	Right Hippocampus	14/10/4/0/0	7/9/11/3/1	5/14/7/1/0	4/16/19/13/2	22/8/2/1/0	H=50.544, P<.0001*	HC<AD-d, DLB-d and pro-AD Pro-DLB<AD-d and DLB-d

Pro-DLB and DLB-d have more hallucinations, parkinsonism, fluctuations and RBD than HC, pro-AD and AD-d

		Pro-DLB N=28	DLB-d N=31	Pro-AD N=27	AD-d N=54	HC N=33	Test statistic, P	Post hoc†
Age, years*		67.5 (9.2)	77.7 (6.9)	69.3 (7.8)	75.7 (9.4)	72.4 (10.4)	F=7.184, P<.0001*	Pro-DLB<DLB-d and AD-d Pro-AD<DLB-d and AD-d
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Gender (F/M)		16/12	10/21	7/20	22/32	18/15	χ^2=8.860, P=.065	
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	Akinesia 0/1/2/3/4	10/14/3/1/0	3/13/12/3/0	23/4/0/0/0	40/12/2/0/0	31/2/0/0/0	H=73.814, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
	Tremor at rest	17/9/2/0/0	11/9/10/1/0	27/0/0/0/0	52/2/0/0/0	33/0/0/0/0	H=63.608, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
Hallucinatio							9.071, P<.0001*	
Fluctuation							2.417, P<.0001*	
CAF*		3.5 (3.6)	6.8 (4.9)	0.0 (0)	1.0 (2.7)	0 (0)	H=81.063, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
RBD[d]		56.0%	56.6%	7.7%	3.7%	0%	H=65.852, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
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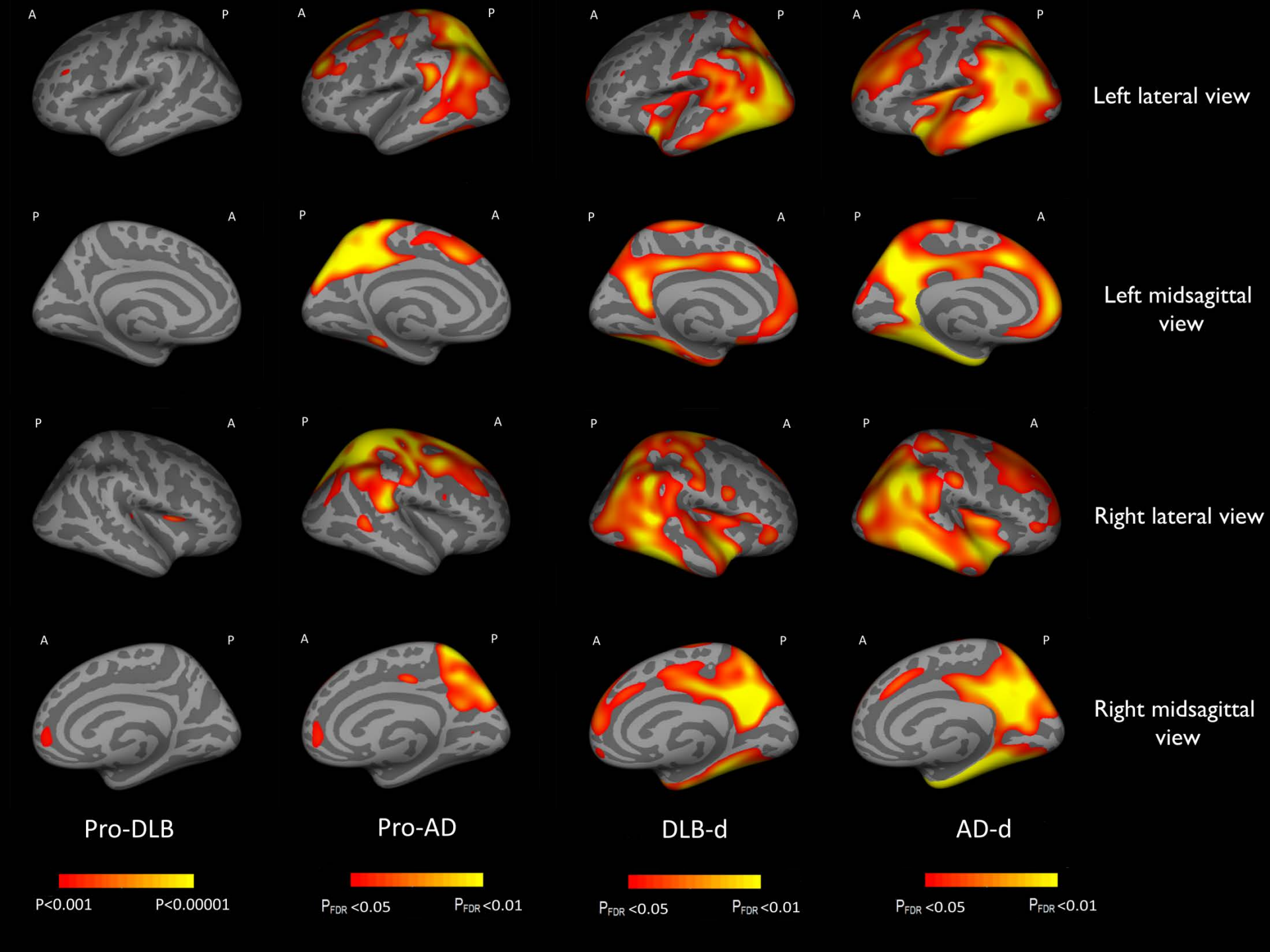
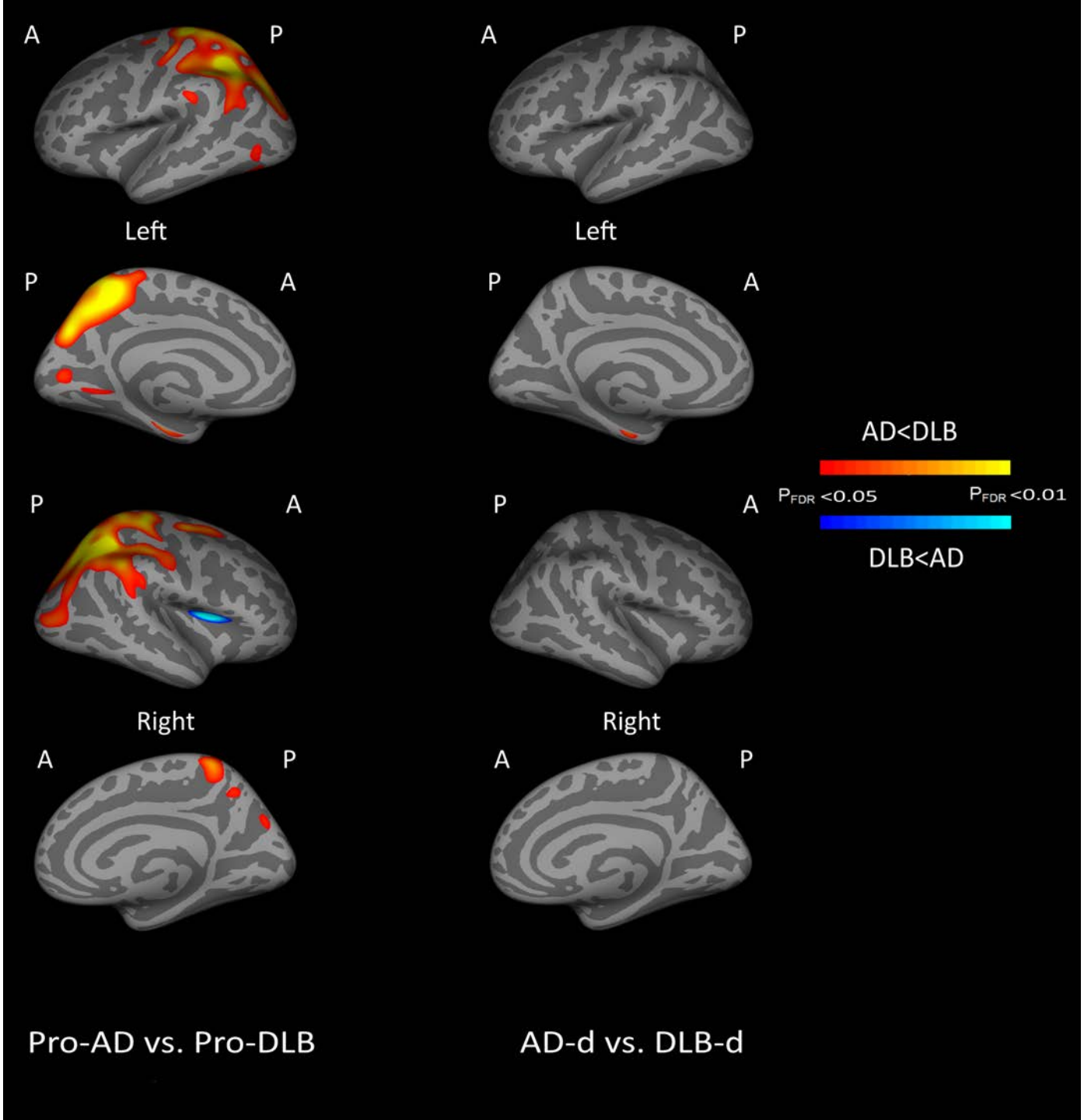
	Dopa	28.6%	35.5%	0.0%	0.0%	0.0%	χ^2=41.804, P<.0001*	
	NL	10.7%	22.6%	0.0%	1.9%	0.0%	χ^2=20.177, P=.0001*	
CSF*	Abeta-42	859.3 (3367, 23)	796.3 (2773, 3)	579.0 (2874, 23)	525.8 (1040, 11)	-	F=5.194, P=.003*	Pro-DLB>AD-d and pro-AD
	P-Tau	43.6 (13.9, 23)	66.0 (1.7, 3)	93.7 (36.8,23)	99.5 (39.5, 11)	-	F=14.111, P<.0001*	Pro-DLB<AD-d and pro-AD
	Tau	313.0 (2863, 23)	430.7 (28.6, 3)	660.6 (3554, 23)	679.0 (2461, 11)	-	F=6.266, P=.001*	Pro-DLB<AD-d and pro-AD
Hippocampi atrophy[f] 0/1/2/3/4	Left hippocampus	14/10/2/2/0	5/12/9/4/1	5/16/4/2/0	4/18/15/15/2	27/5/1/0/0	H=61.935, P<.0001*	HC<AD-d, DLB-d and pro-AD Pro-DLB<AD-d and DLB-d
	Right Hippocampus	14/10/4/0/0	7/9/11/3/1	5/14/7/1/0	4/16/19/13/2	22/8/2/1/0	H=50.544, P<.0001*	HC<AD-d, DLB-d and pro-AD Pro-DLB<AD-d and DLB-d

Pro-DLB group is different from pro-AD group and AD-d group for Tau, p-Tau and Abeta

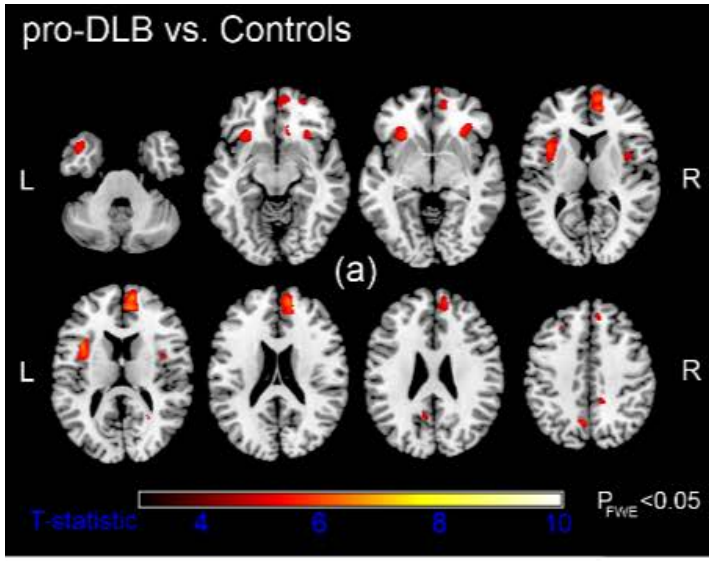
		Pro-DLB N=28	DLB-d N=31	Pro-AD N=27	AD-d N=54	HC N=33	Test statistic, P	Post hoc†
Age, years*		67.5 (9.2)	77.7 (6.9)	69.3 (7.8)	75.7 (9.4)	72.4 (10.4)	F=7.184, P<.0001*	Pro-DLB<DLB-d and AD-d Pro-AD<DLB-d and AD-d
Education[b] 1/2/3		11/4/8	5/10/2	11/3/12	10/26/7	1/14/11	H=7.465, P=.113	
Gender (F/M)		16/12	10/21	7/20	22/32	18/15	χ^2=8.860, P=.065	
Handedness (R/L)		26/2	26/5	24/3	50/4	29/4	χ^2=3.264, P=.515	
MMSE score*		27.6 (2.1)	20.5 (4.6)	26.9 (1.9)	20.8 (3.6)	29.4 (0.9)	H=119.397, P<.0001*	HC< AD-d, DLB-d and pro-AD Pro-DLB<AD-d and DLB-d Pro-AD<AD-d and DLB-d
TMTA[c] impaired subjects		60.7%	82.3%	32.0%	43.2%	0%	H=21.791, P<.0001*	HC>DLB-d and pro-DLB Pro-AD>DLB-d
TMTB[c] impaired subjects		71.4%	88.2%	44.0%	72.0%	0%	H=27.536, P<.0001*	HC>DLB-d, AD-d, pro-DLB
CDR sum of box 0/0.5/1/2/3		2/26/0/0/0	0/0/22/8/1	1/26/0/0/0	0/0/42/12/0	33/0/0/0/0	H=157.167, P<.0001*	HC< AD-d, DLB-d, pro-DLB and pro-AD Pro-DLB<AD-d and DLB-d Pro-AD<AD-d and DLB-d
Parkinsonism[c]	Rigidity 0/1/2/3/4	7/20/1/0/0	8/8/8/5/2	23/4/0/0/0	49/5/0/0/0	33/0/0/0/0	H=84.874, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
	Akinesia 0/1/2/3/4	10/14/3/1/0	3/13/12/3/0	23/4/0/0/0	40/12/2/0/0	31/2/0/0/0	H=73.814, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
	Tremor at rest 0/1/2/3/4	17/9/2/0/0	11/9/10/1/0	27/0/0/0/0	52/2/0/0/0	33/0/0/0/0	H=63.608, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
Hallucinations[c]		60.7%	90.3%	0%	1.8%	0%	χ^2=119.071, P<.0001*	
Fluctuations[c]		92.9%	90.3%	0%	22.2%	0%	χ^2=102.417, P<.0001*	
CAF*		3.5 (3.6)	6.8 (4.9)	0.0 (0)	1.0 (2.7)	0 (0)	H=81.063, P<.0001*	Pro-DLB>HC, pro-AD and AD-d DLB-d>HC, pro-AD and AD-d
RBD[c]								
Treatment[c]	ChEI							
	Dopa	28.6%	35.5%	0.0%	0.0%	0.0%	χ^2=41.804, P<.0001*	
	NL	10.7%	22.6%	0.0%	1.9%	0.0%	χ^2=20.177, P=.0001*	
CSF*	Abeta-42	859.3 (3367, 23)	796.3 (2773, 3)	579.0 (2874, 23)	525.8 (1040, 11)	-	F=5.194, P=.003*	Pro-DLB>AD-d and pro-AD
	P-Tau	43.6 (13.9, 23)	66.0 (1.7, 3)	93.7 (36.8,23)	99.5 (39.5, 11)	-	F=14.111, P<.0001*	Pro-DLB<AD-d and pro-AD
	Tau	313.0 (2863, 23)	430.7 (28.6, 3)	660.6 (3554, 23)	679.0 (2461, 11)	-	F=6.266, P=.001*	Pro-DLB<AD-d and pro-AD
Hippocampi atrophy[f] 0/1/2/3/4	Left hippocampus	14/10/2/2/0	5/12/9/4/1	5/16/4/2/0	4/18/15/15/2	27/5/1/0/0	H=61.935, P<.0001*	HC<AD-d, DLB-d and pro-AD Pro-DLB<AD-d and DLB-d
	Right Hippocampus	14/10/4/0/0	7/9/11/3/1	5/14/7/1/0	4/16/19/13/2	22/8/2/1/0	H=50.544, P<.0001*	HC<AD-d, DLB-d and pro-AD Pro-DLB<AD-d and DLB-d

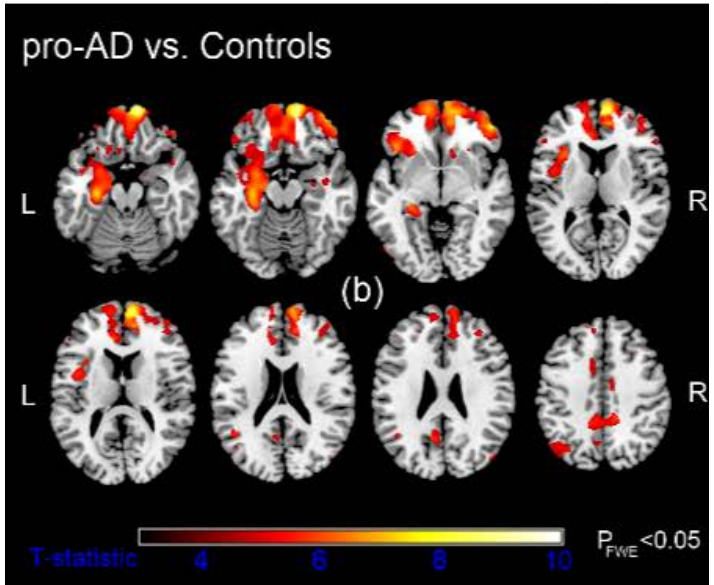
Groups with dementia and pro-AD have smaller hippocampi than Pro-DLB group


A
P
Left lateral view
Left midsagittal view
Right lateral view
Right midsagittal view
Pro-DLB
Pro-AD
DLB-d
AD-d
P<0.001
P<0.00001
PFDR <0.05
PFDR <0.01
PFDR <0.05
PFDR <0.01
PFDR <0.05
PFDR <0.01


A
P
Left
P
A
P
A
Right
A
P
A
P
Left
P
A
P
A
Right
A
P
AD<DLB
P_{FDR} <0.05
P_{FDR} <0.01
DLB<AD
Pro-AD vs. Pro-DLB
AD-d vs. DLB-d

VBM au stade prodromal de la MCL et de la MA (Strasbourg and Newcastle)



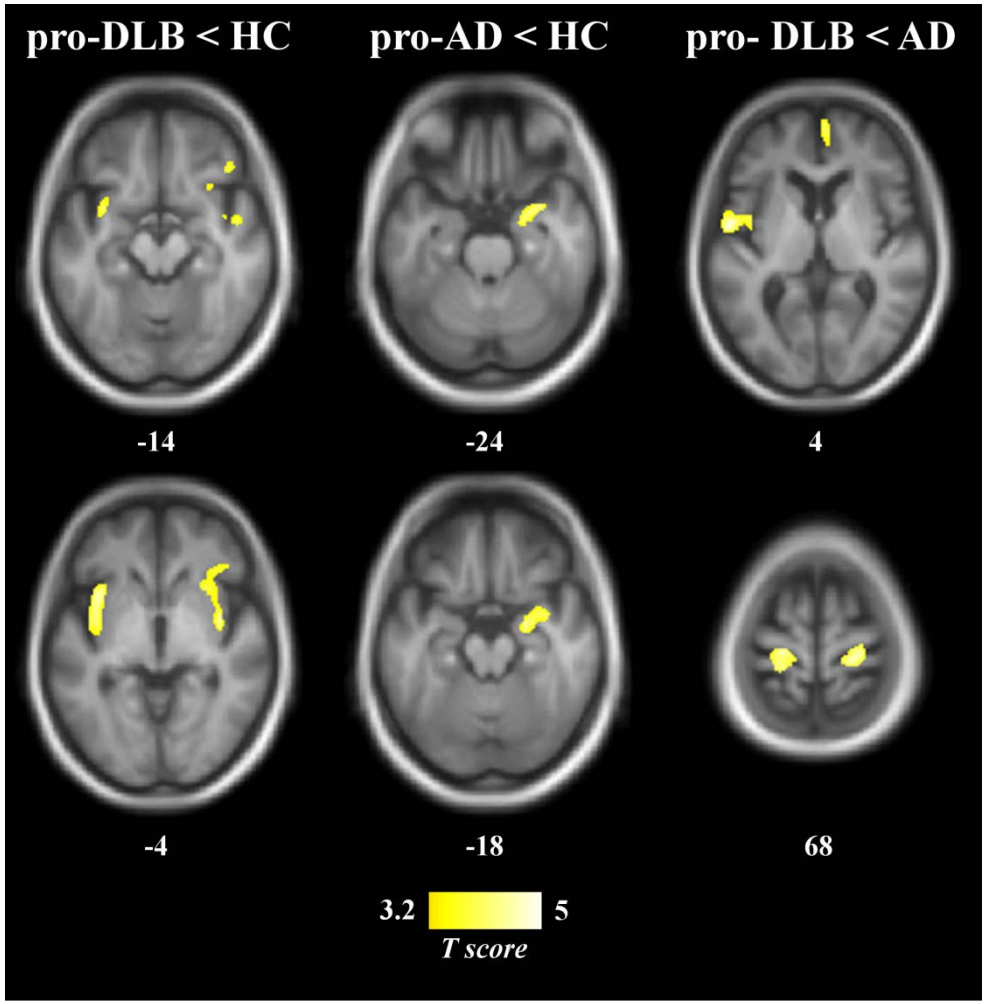


Stade prodromal MCL:
Atrophie insula et cingulaire antérieure
mais pas des hippocampes

Stade prodromal de la MA:
Atrophie des hippocampes, des régions
Frontales, insulaires et pariétales.

Blanc et al., Alz Res Therapy, 2016

VBM au stade prodromal de la MCL et de la MA (Strasbourg)



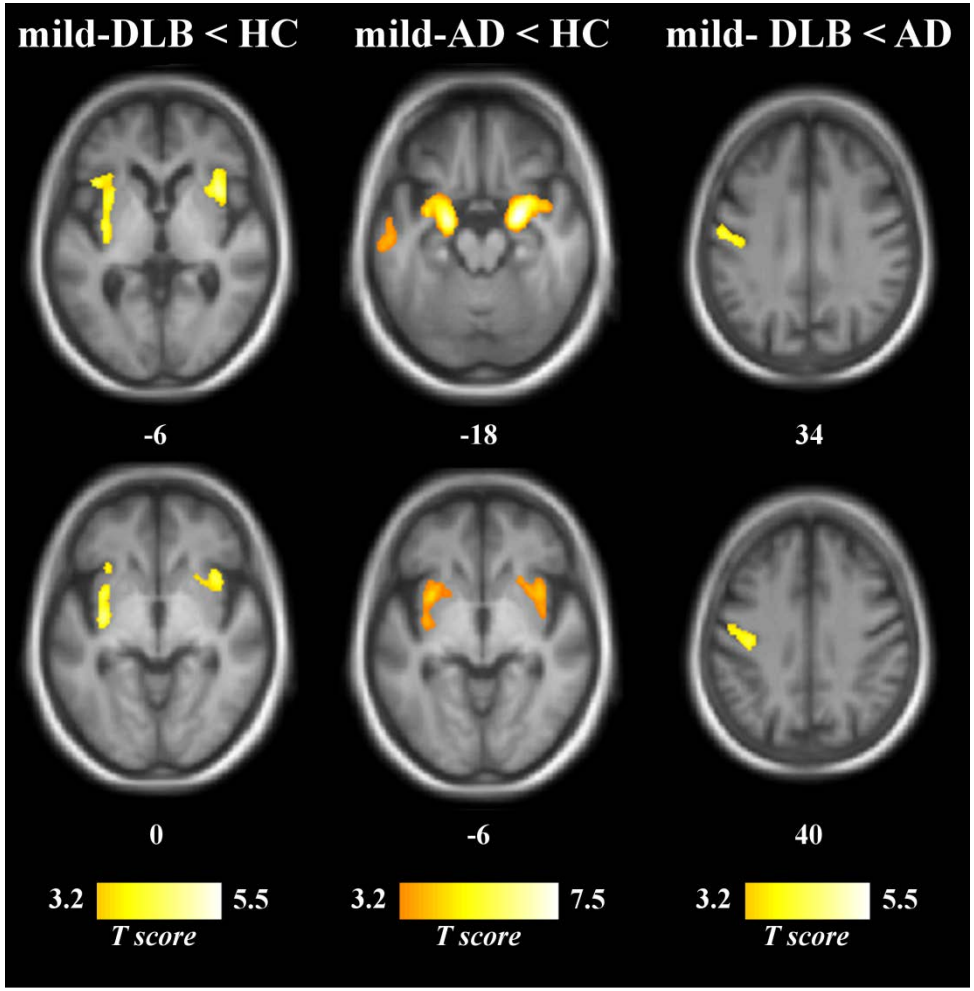
FWE $p < 0.05$
at the cluster level

Pro-DLB=54
Pro-AD=16
HC=22

Insula in proDLB
Hippoc, amygd proAD

Roquet et al., in revision

VBM au stade de démence de la MCL et de la MA (Strasbourg)

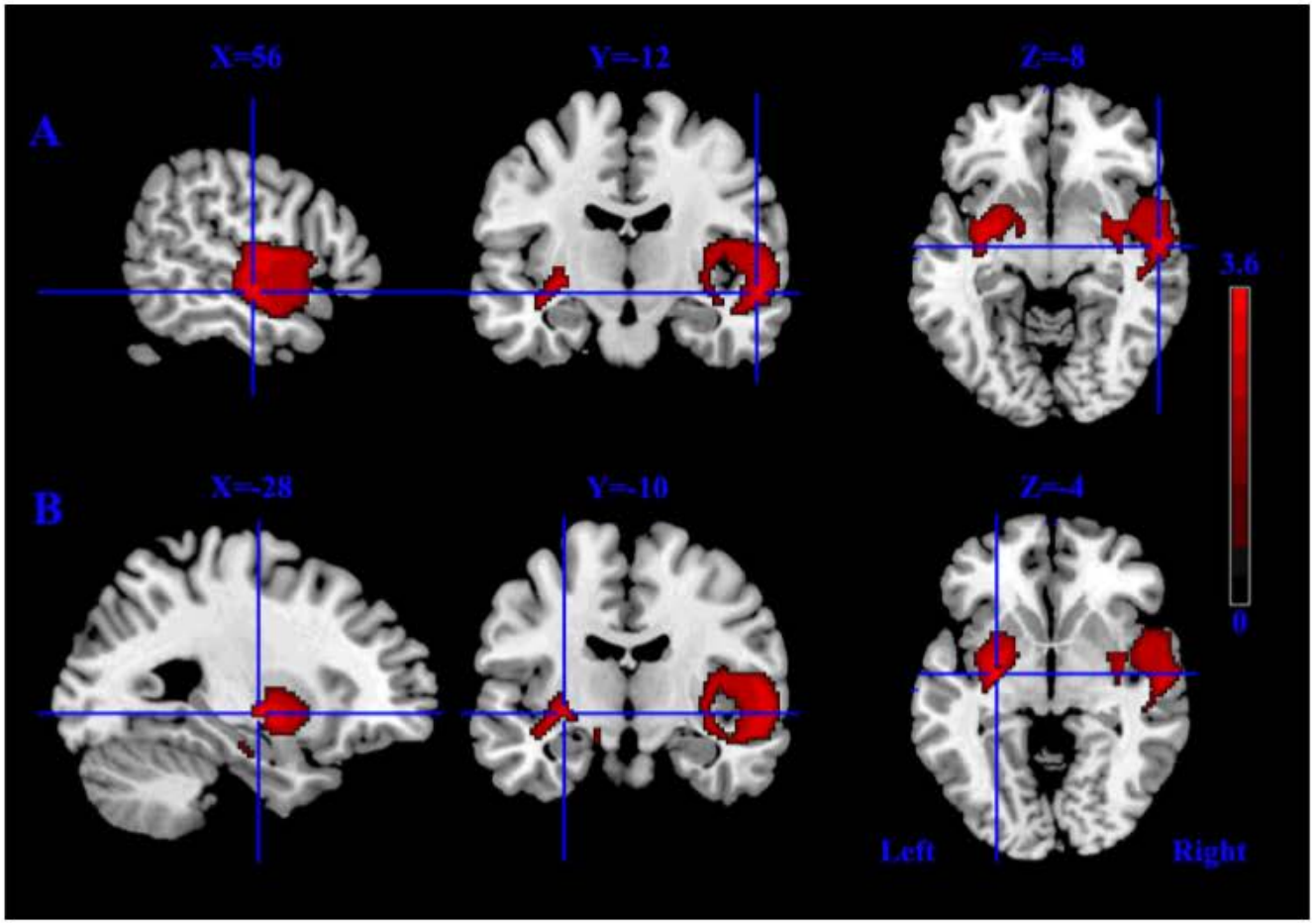


FWE $p < 0.05$
at the cluster level

DLB=15
AD=28
HC=22

Roquet et al., in revision

Métanalyse VBM démence à corps de Lewy



Zhong et al., EJR, 2014

Bases neuronales des hallucinations dans la maladie d'Alzheimer

Frédéric Blanc, Vincent Noblet, Nathalie Philippi,

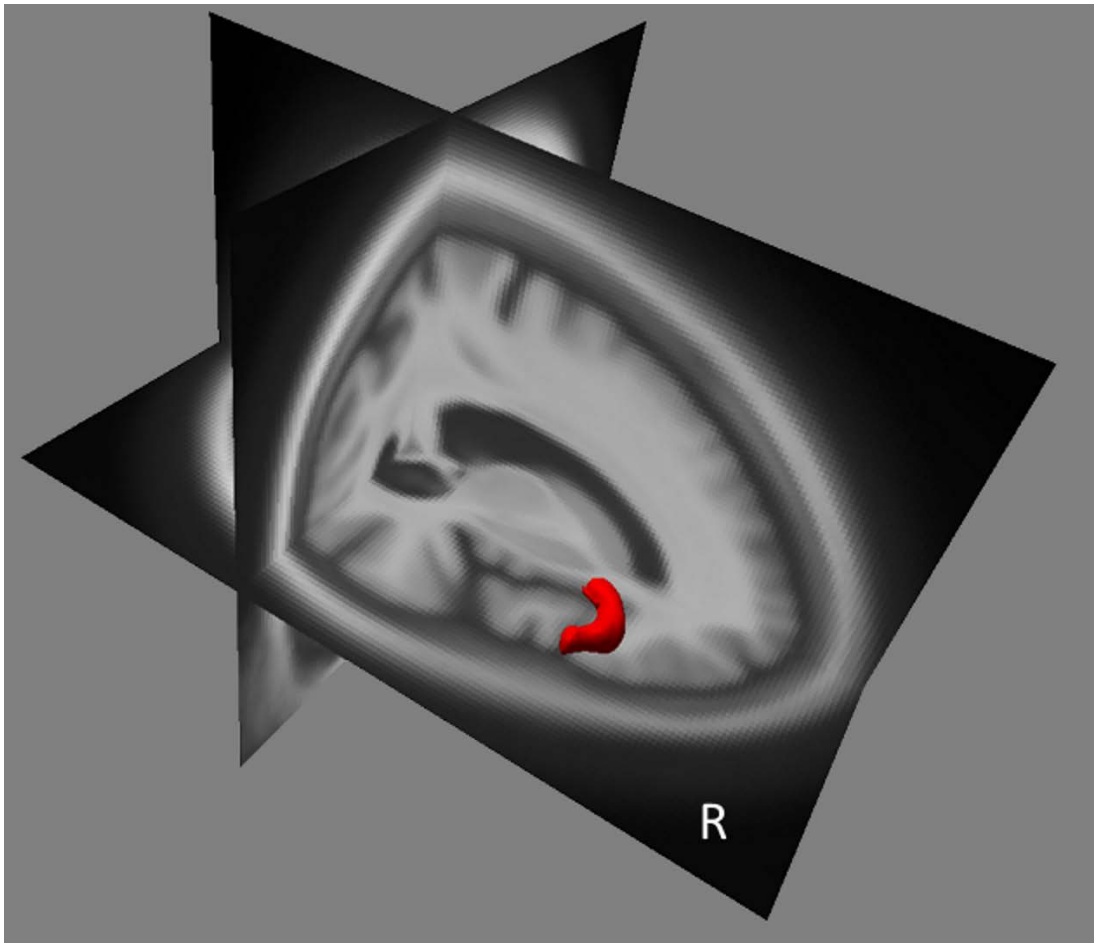
Benjamin Cretin, Jack Foucher, Jean-Paul Armspach, François Rousseau et

the Alzheimer's Disease Neuroimaging Initiative

Unité de Neuropsychologie, CMRR
Service de Neurologie
Hôpitaux Universitaires de Strasbourg
Et
ICube, équipe IMIS, groupe Neurocrypto,
Université de Strasbourg et CNRS

Blanc et al., Plos One , 2014

AD-hallu versus AD-c en IRM SG



Les 4 patients de ADNI autopsiés avec hallucinations avaient tous une double patho MA+MCL, cf Toledo et al., Acta Neuropath, 2013

Brain perfusion in dementia with Lewy bodies and Alzheimer's disease: an arterial spin labeling MRI study

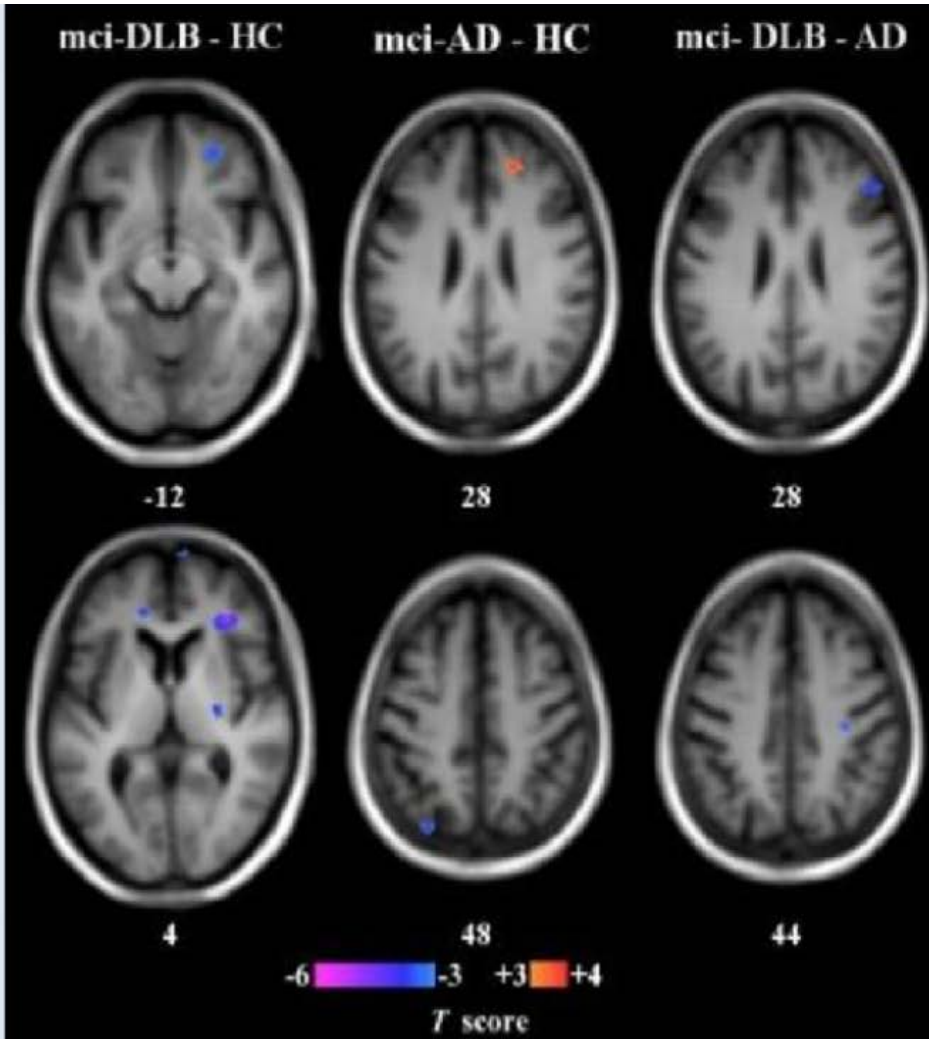
Daniel Roquet[a], Benjamin Cretin[a,b], Paulo Loureiro de Sousa[a] ,Nathalie Philippi[a,b], Marion Sourty[a], Barbara Jung[a,b], Catherine Demuynck[b], Pierre Anthony[b], Catherine Martin-Hunyadi[b], Jean-Paul Armspach[a], Frederic Blanc[a,b]

Roquet et al., Alzheimer Res and Therapy, 2016

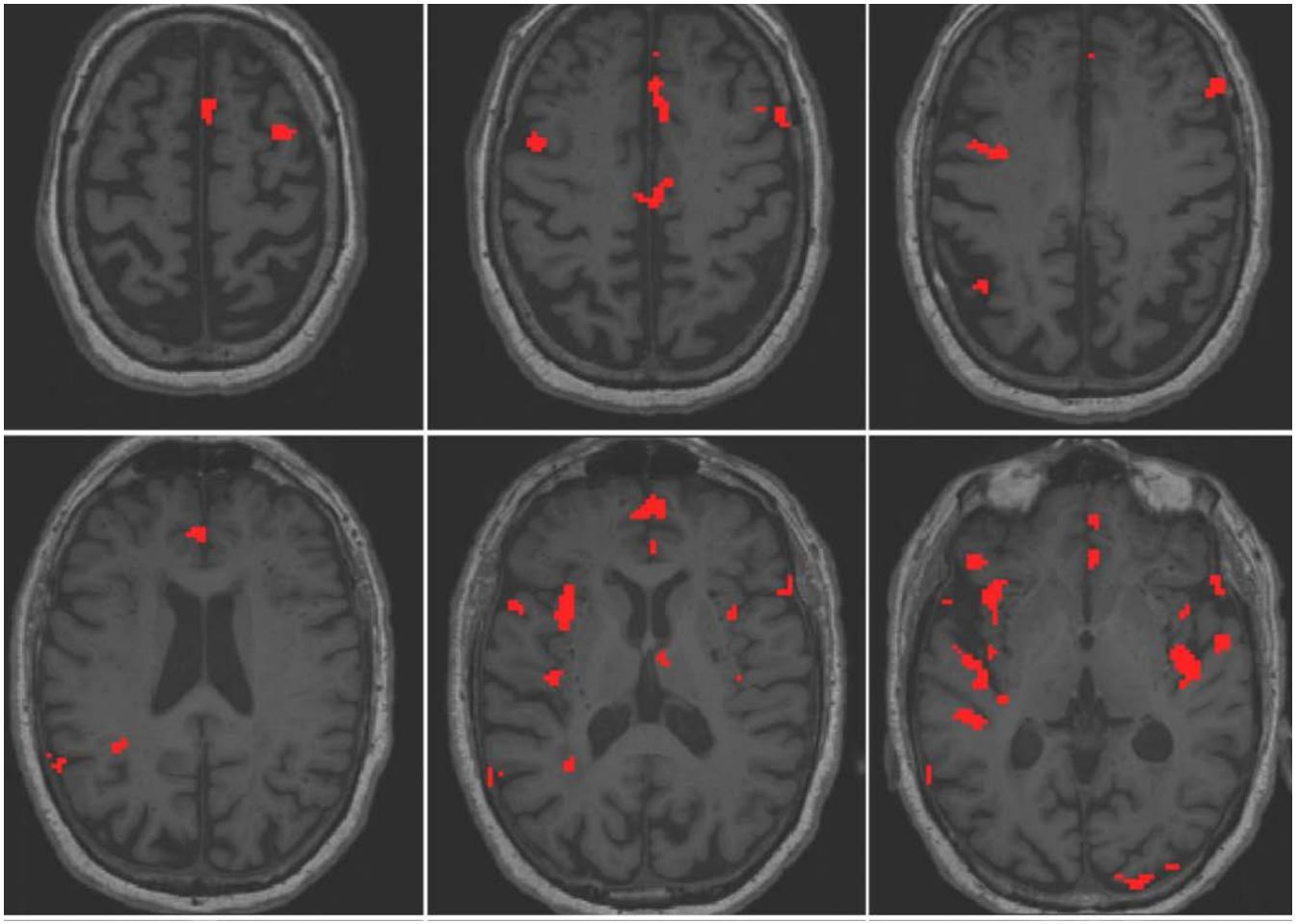
Patients et contrôles

Characteristic	MCI-DLB	d-DLB	MCI-AD	d-AD	HC
Participants	36	12	11	20	17
Female	21	6	0[a,b]	12	8
Age, years (SD)	67.9 (7.9)	73.5 (9.6)	70.6 (8.9)	72.2 (9.0)	67.8 (9.9)
MMSE (SD) (max 30)	28.1 (1.3)	20.3 (3.8)	27.8 (1.8)	19.8 (4.2)	28.9 (1.0)
Participants with hallucination	20	7	0	0	0

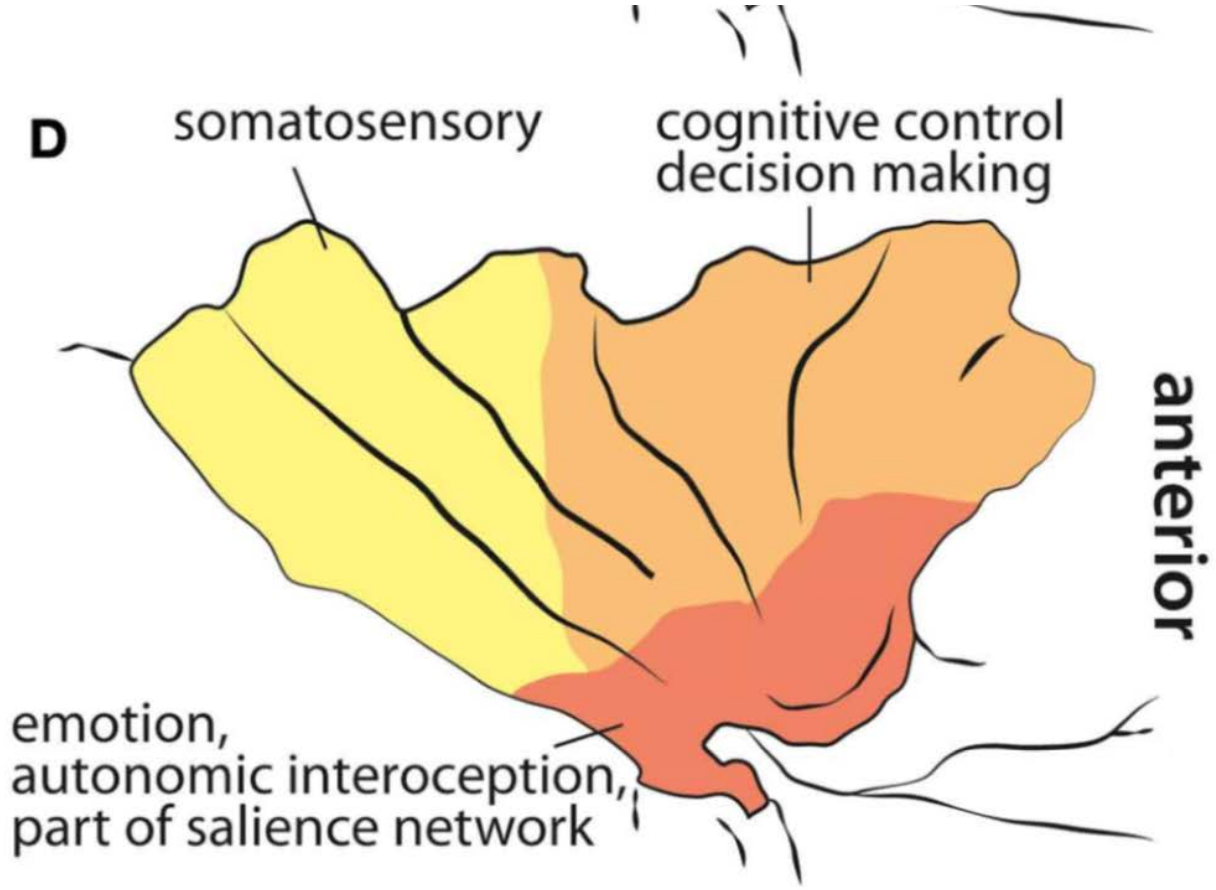
Asl in pro-DLB and pro-AD



Poster 227, Bouchon et al., ADPD 2015: diffusion MRI in prodromal DLB



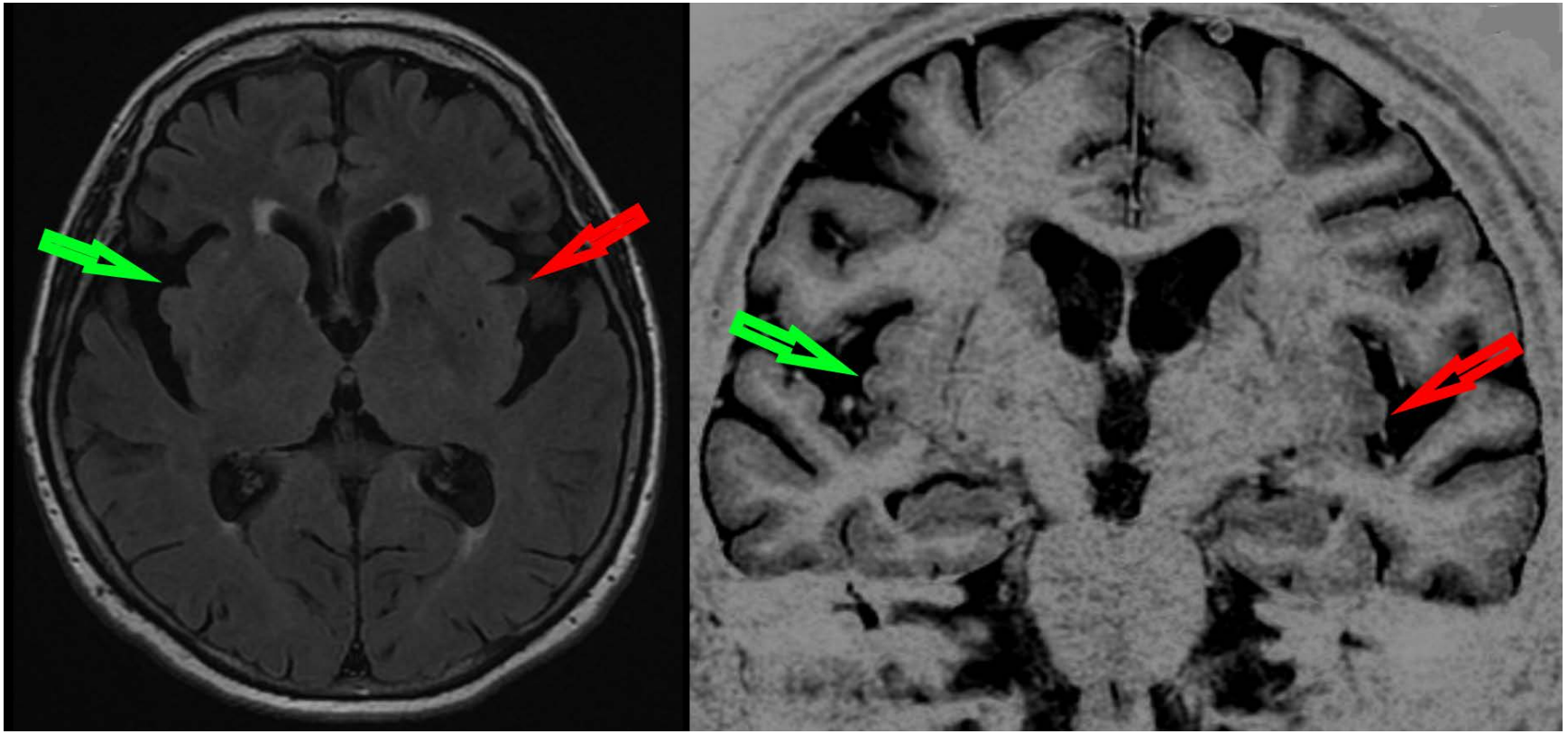
Pourquoi l'Insula?



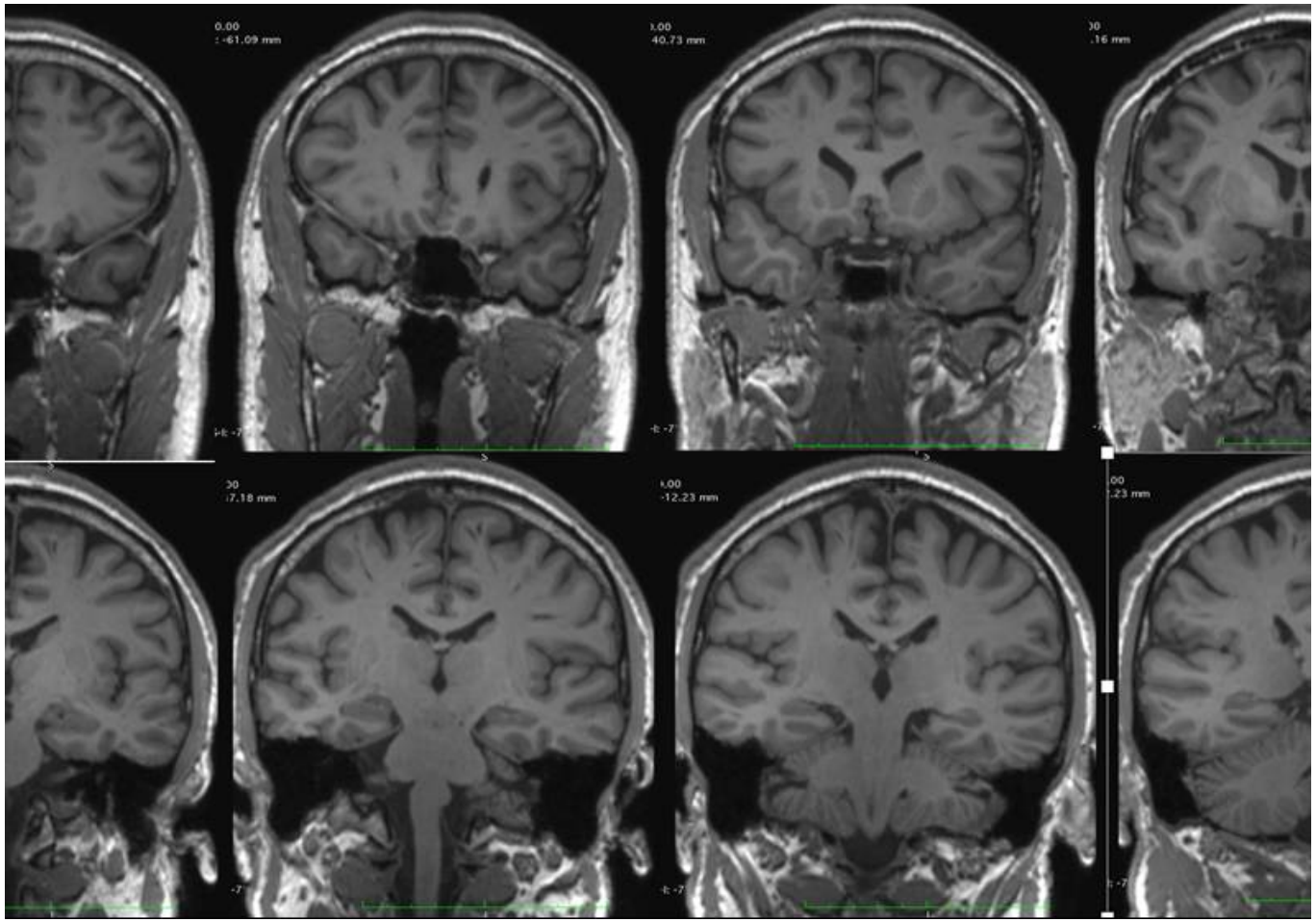
Klein et al., Front Human Neurosc 2013

Nécessité d’une échelle d’atrophie de l’Insula

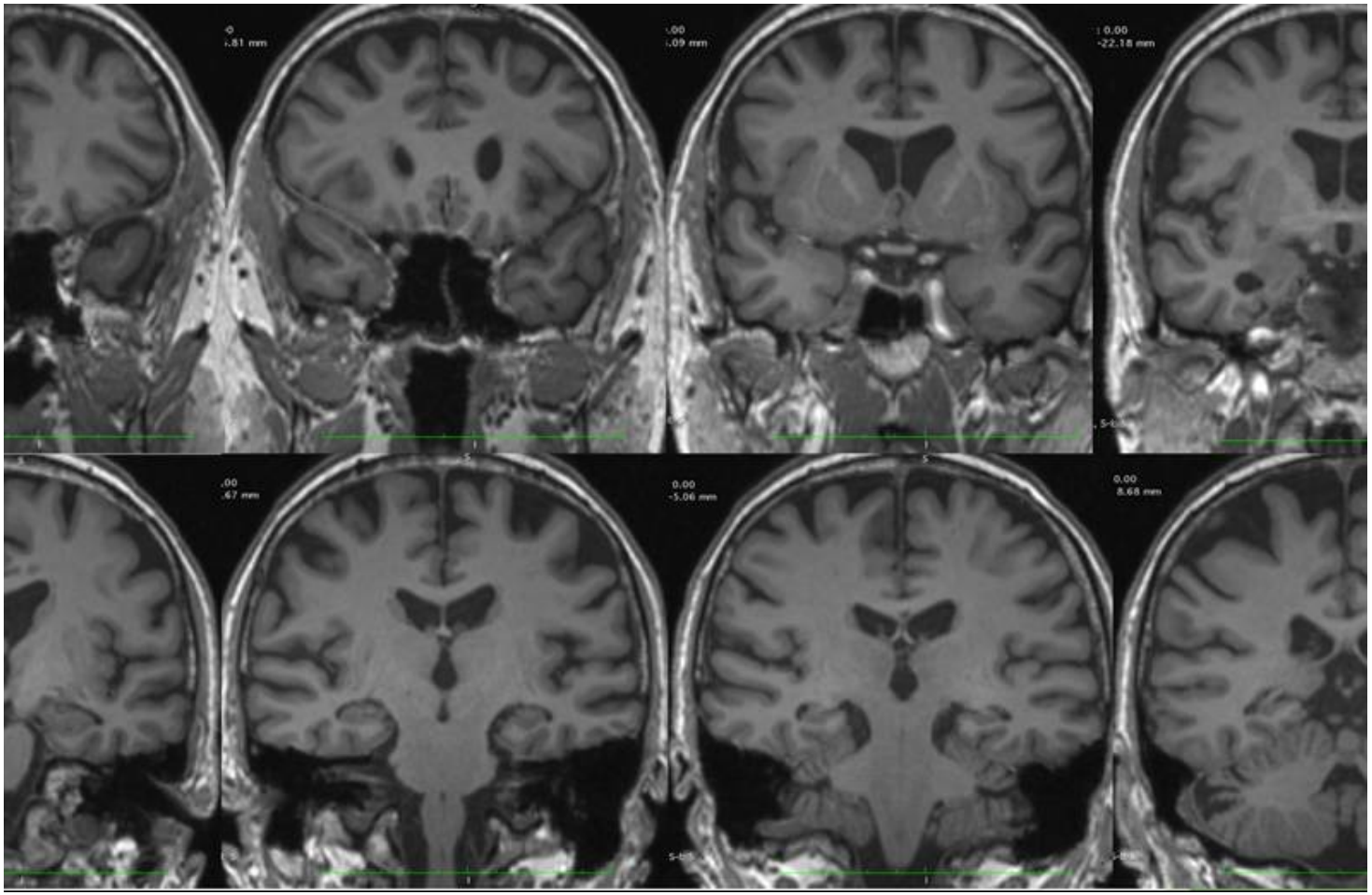
Clinical case



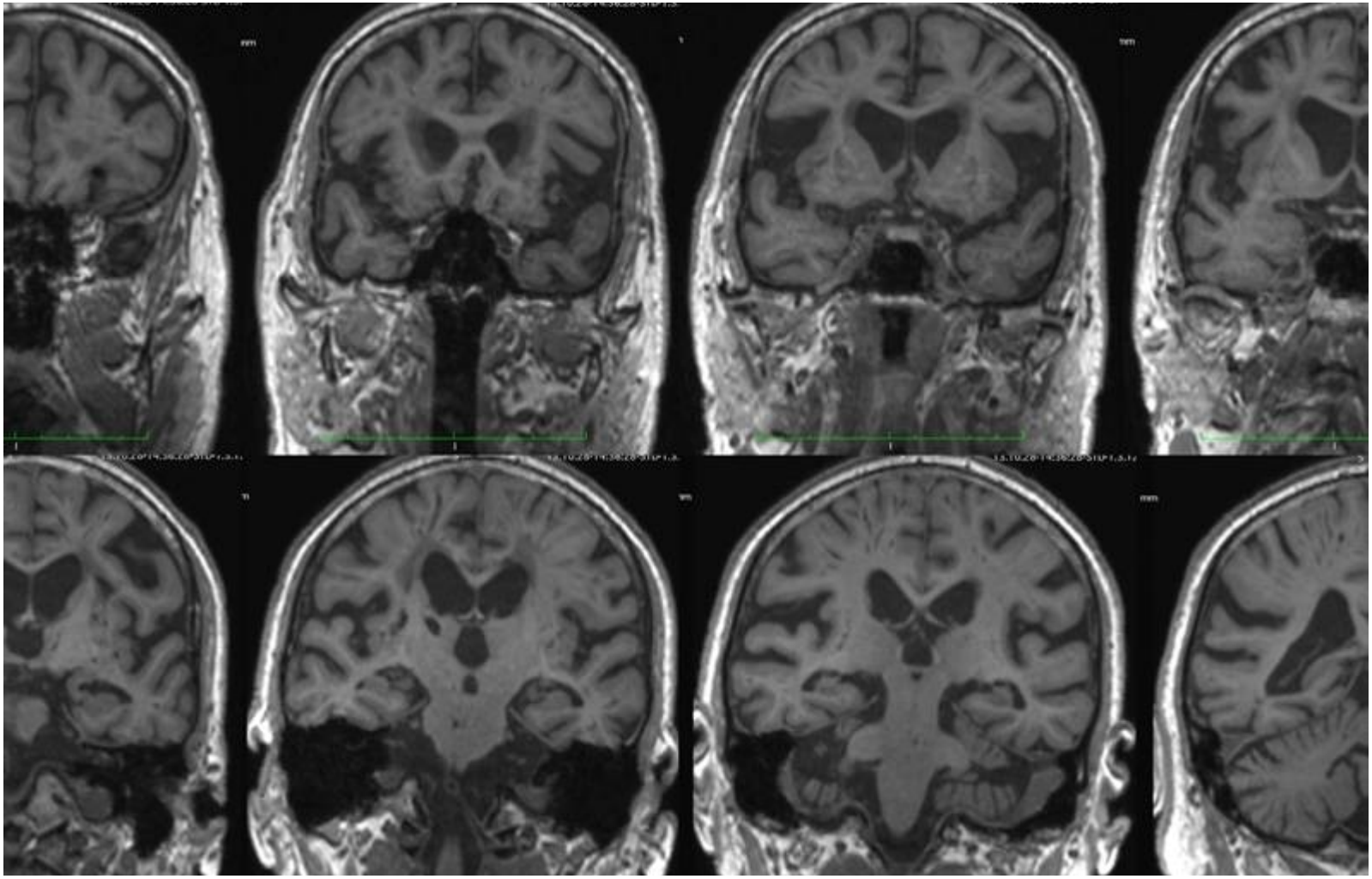
Absence d’atrophie: 0



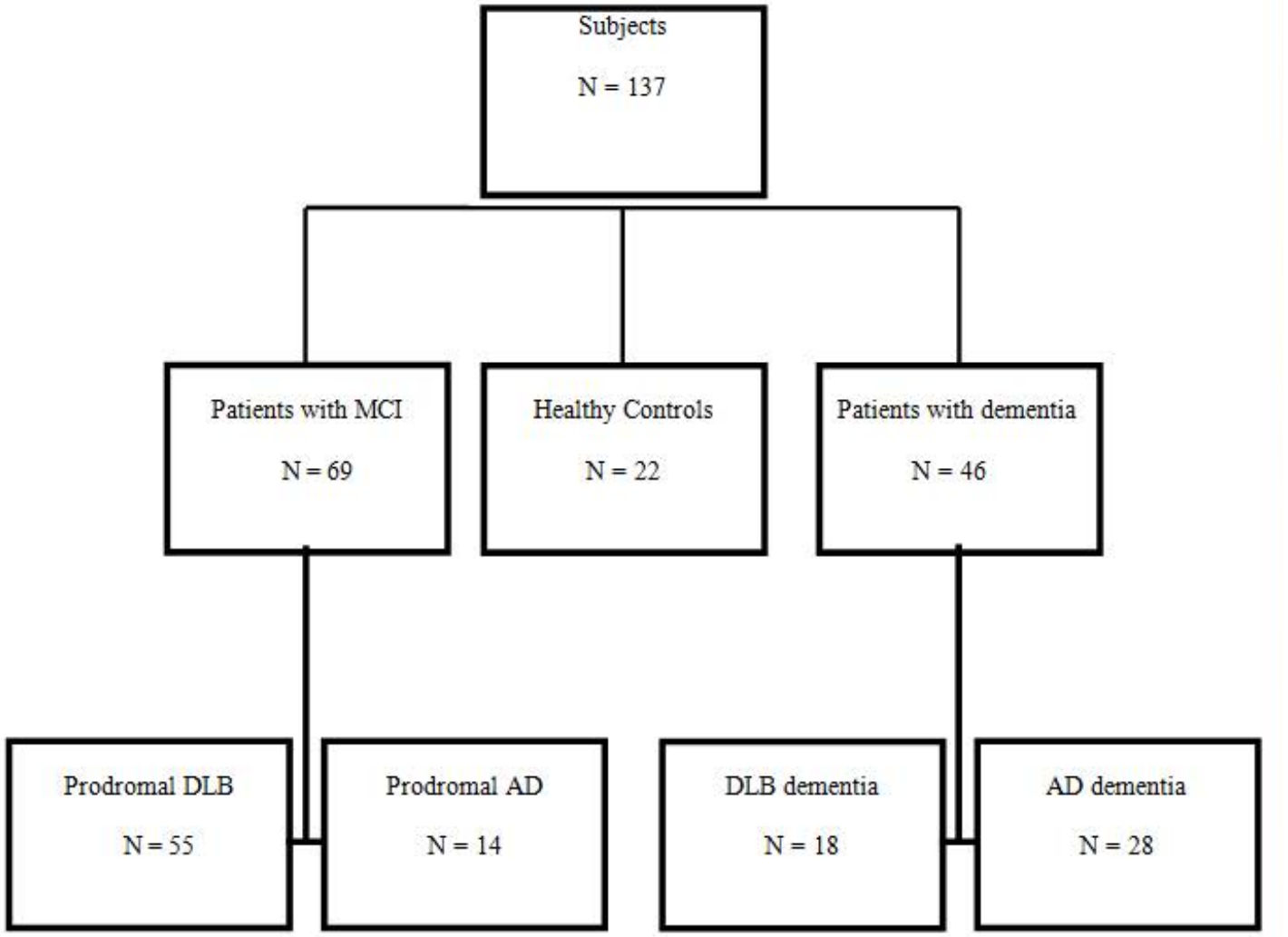
Début d’atrophie: 1



Atrophie maximale: 4



Flow chart


Subjects
N = 137
Patients with MCI
N = 69
Healthy Controls
N = 22
Patients with dementia
N = 46
Prodromal DLB
N = 55
Prodromal AD
N = 14
DLB dementia
N = 18
AD dementia
N = 28

Patients et contrôles

	Pro-DLB N = 55	DLB N = 18	Pro-AD N = 14	AD N = 28	HC N = 22
Age (years)	68.7 (15.7)	74 (20)	74.4 (17.4)	73.8 (17.8)	65.5 (20.5)
Education (1/2/3) [a]	19/14/22	12/3/3	5/5/4	15/7/6	5/4/13
Gender (M/F)	22/33	11/7	9/5	9/19	10/12
Handedness (R/L)	50/5	13/5	13/1	24/4	18/4
MMSE score	27.7 (3.7)	21,3 (6.3)	27.5 (2.5)	20 (8)	28.9 (1.9)

Bientôt les résultats …

Points clefs et conclusion

- Au stade de démence, peu de différence en termes d'atrophie entre MA et MCL, sauf une plus grande atteinte des hippocampes dans la MA.
- Une nouvelle piste sur une des premières zones atteintes dans la démence à corps de Lewy: l'insula.
- Intérêt dans le diagnostic individuel à démontrer.

Remerciements

CMRR

- Benjamin Cretin
- Nathalie Philippi
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- Thomas Lavaux
- Jennifer Kemp
- Clélie Philips
- Catherine Kleitz
- Camille Heitz
- Laure Di Bitonto
- Marie-Odile Kieffer

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- Fabrice Hubele
- Izzie Namer
- Arnaud Agin
- Luc Marlier
- Stéphane Kremer
- Line Pfaff
- Daniel Gounot

Insulae

Nora, Sardaigne

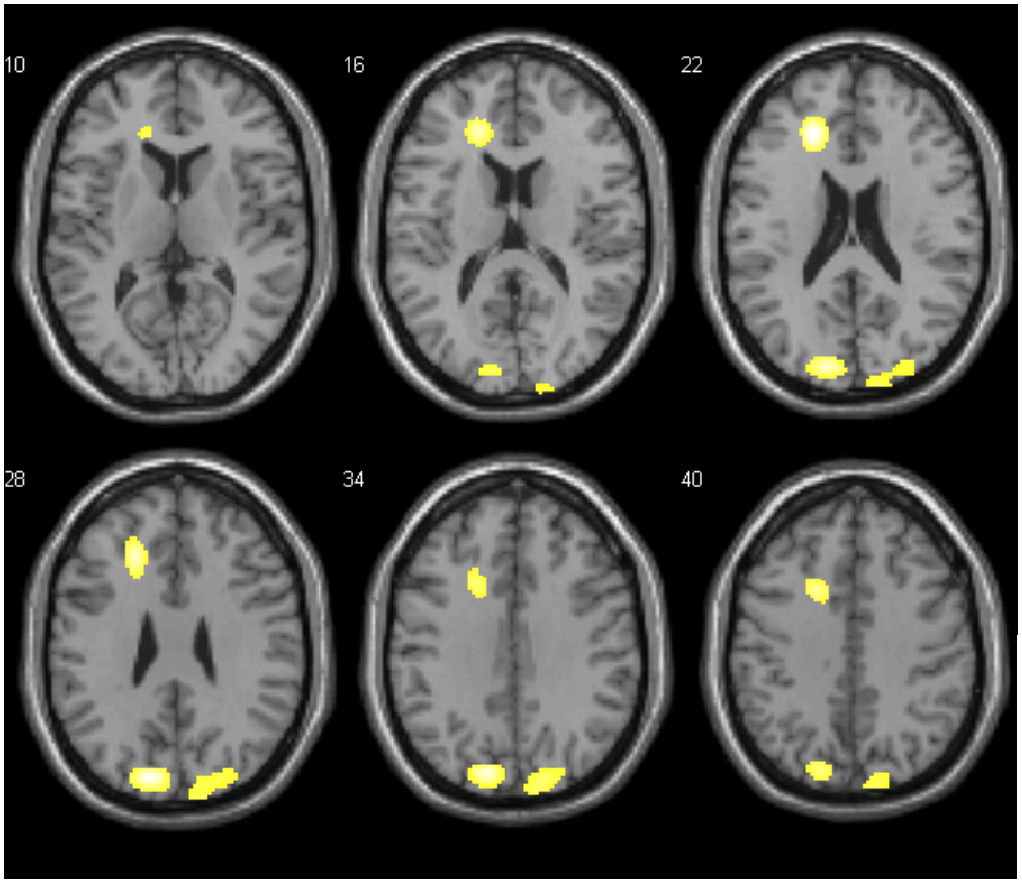
Hallucinations et maladie à Corps de Lewy: bases neuronales.

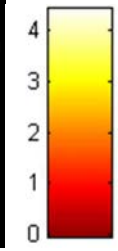
Camille Heitz, Benjamin Cretin,
Vincent Noblet, Nathalie Philippi, Mélanie Stackfleth, Laurent Kremer, Fabrice Hubele, Izzie Namer, Frédéric Blanc

Heitz et al., 2015, Alz Res Ther

Résultats

- **Perfusion cérébrale MCL-hallu versus MCL-c (p< 0,005)**





Hypoperfusion relative au niveau du **gyrus cingulaire antérieur gauche** (BA 32), du **cunéus bilatéral** (BA 19 et 7).