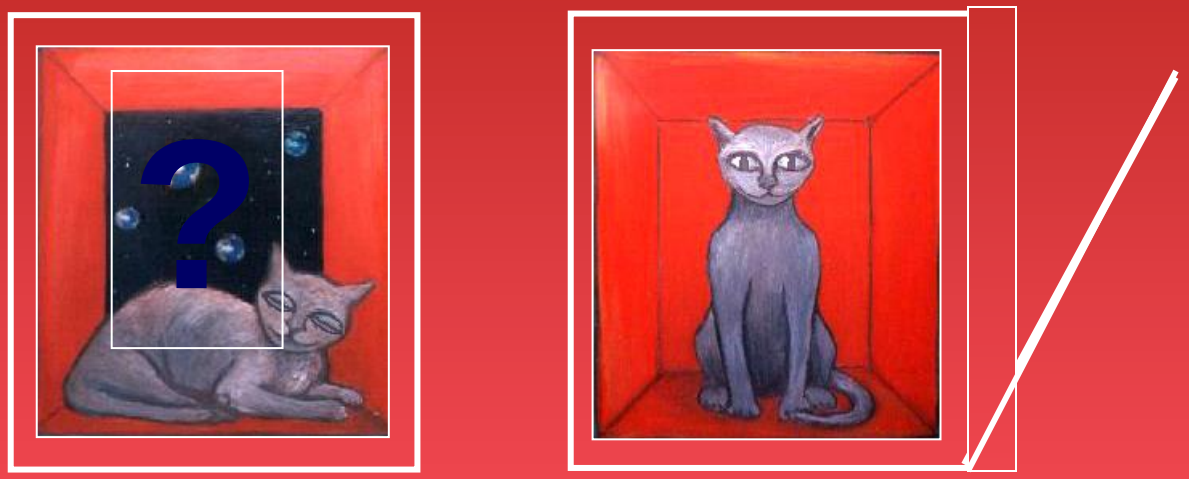
EEG correlates of dream recall upon awakening from REM and NREM sleep

Luigi De Gennaro

Il dilemma del gatto di Schroedinger

La misurazione di un fenomeno lo disturba e lo altera e, soprattutto, altera quello che stiamo misurando

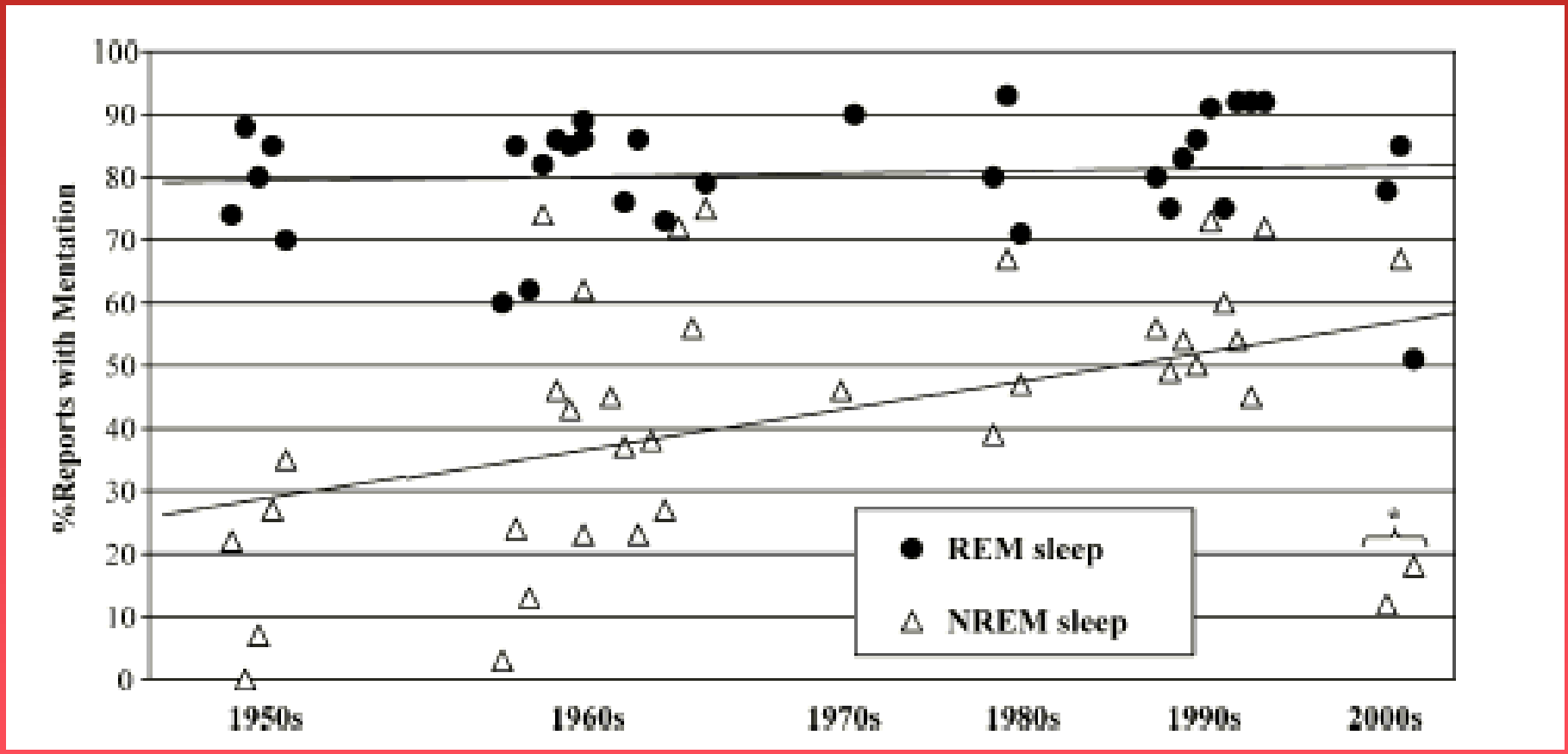


Finché il box è aperto, non sappiamo cosa accadeva al gatto.

Ma il punto è che "Cosa stava accadendo al gatto MENTRE il box era chiuso?"

L'accesso principale al contenuto del sogno necessariamente implica resoconti retrospettivi

Il sogno NON è un'esperienza limitata alla fase REM del sonno

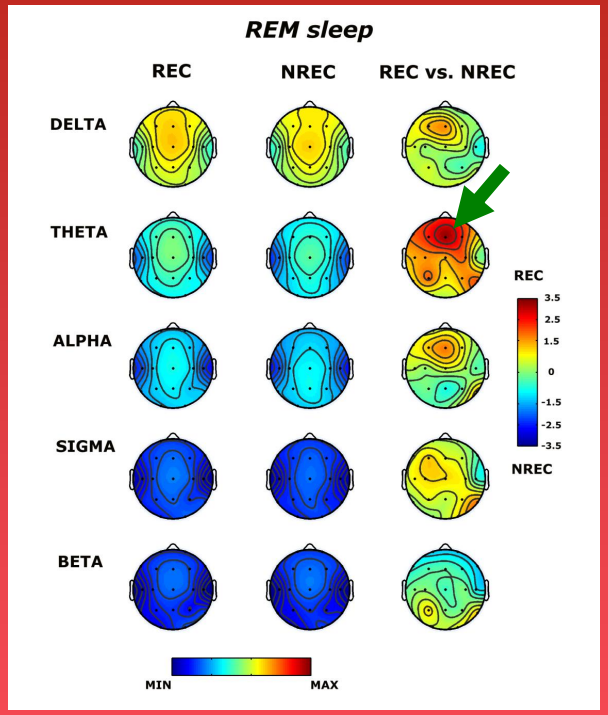


Approcci empirici

- **Cognitivo/psicolinguistico**
- **Neuropsicologico**
- **Neuroimaging**
- **Strutturale (morfo-anatomico)**
- **Elettrofisiologico (EEG)**

Al risveglio da sonno REM:
Onde theta (5-7 Hz)

Al risveglio da sonno NREM:
Onde alpha (8-12Hz)

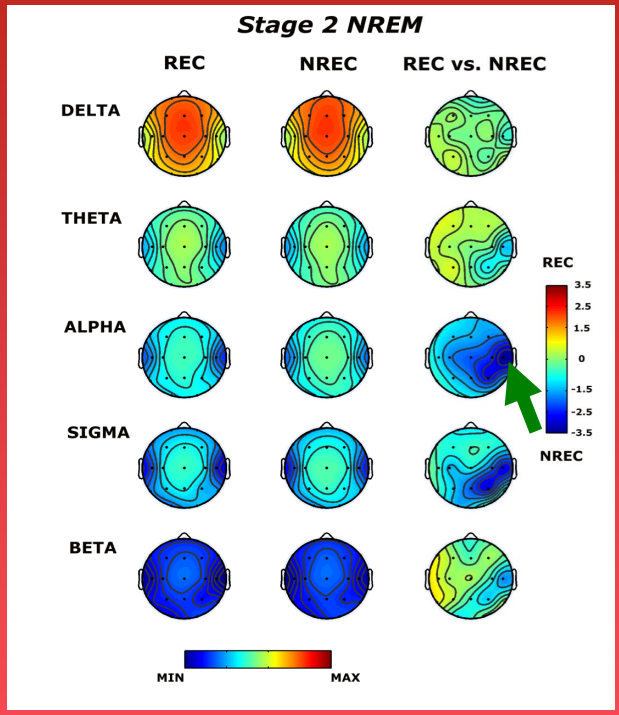



6674 • The Journal of Neuroscience, May 4, 2011 • 31(18):6674–6683

Behavioral/Systems/Cognitive

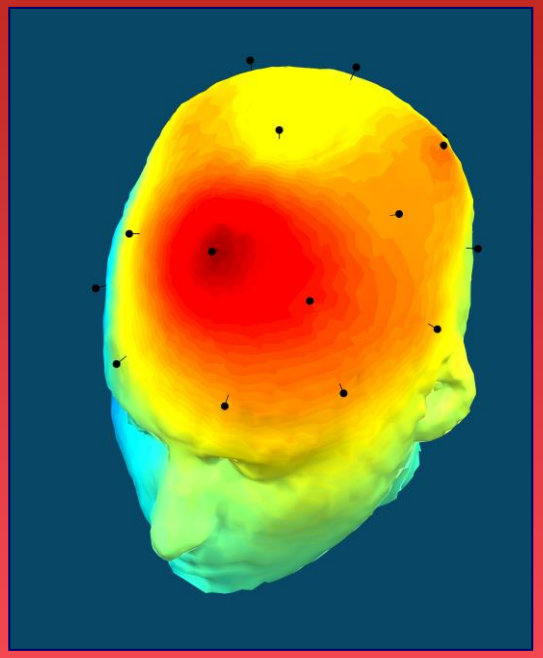
Recalling and Forgetting Dreams: Theta and Alpha Oscillations during Sleep Predict Subsequent Dream Recall

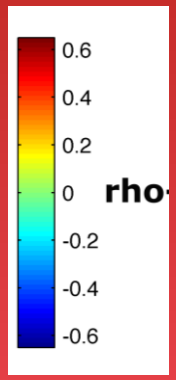
Cristina Marzano,[1] Michele Ferrara,[2] Federica Mauro,[1] Fabio Moroni,[1,3] Maurizio Gorgoni,[1] Daniela Tempesta,[2] Carlo Cipolli,[3] and Luigi De Gennaro[1,4]



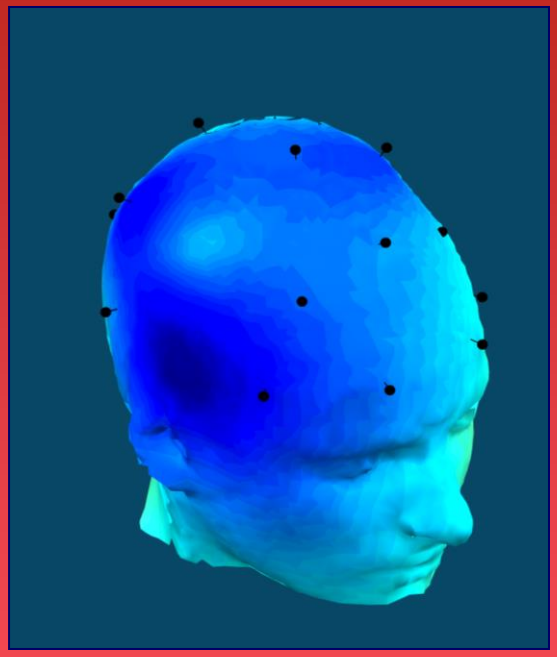
La presenza di più elevata attività elettrica theta sulla regione frontale si associa al ricordo dei sogni da sonno REM e una minore attività alpha sulla regione temporale destra ai sogni del sonno NREM

Al risveglio da sonno REM:
Onde theta (5-7 Hz) nella regione frontale





Al risveglio da sonno NREM:
Onde alpha (8-12Hz) nella regione temporale destra



La presenza di più elevata attività theta sulla regione frontale si associa linearmente alla frequenza del ricordo dei sogni da sonno REM e una minore attività alpha sulla regione temporale destra ai sogni del sonno NREM

QUESTIONI DI BASE

- **Relazione di stato o di tratto?**
- **Nuovi approcci che consentano un accesso più diretto all'esperienza onirica**
- **Dimensioni campionarie molto più ampie**

RELAZIONI *TRAIT-LIKE* O *STATE-LIKE*?

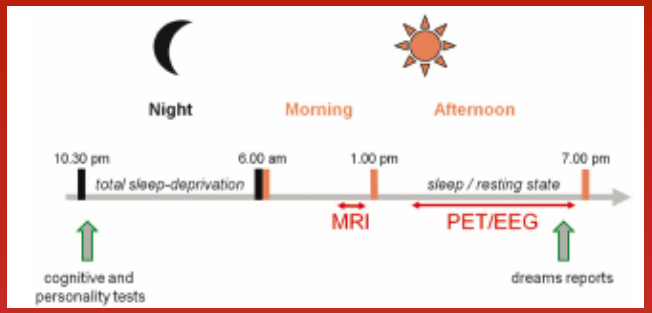
Neuropsychopharmacology (2014), 1–9

www.neuropsychopharmacology.org

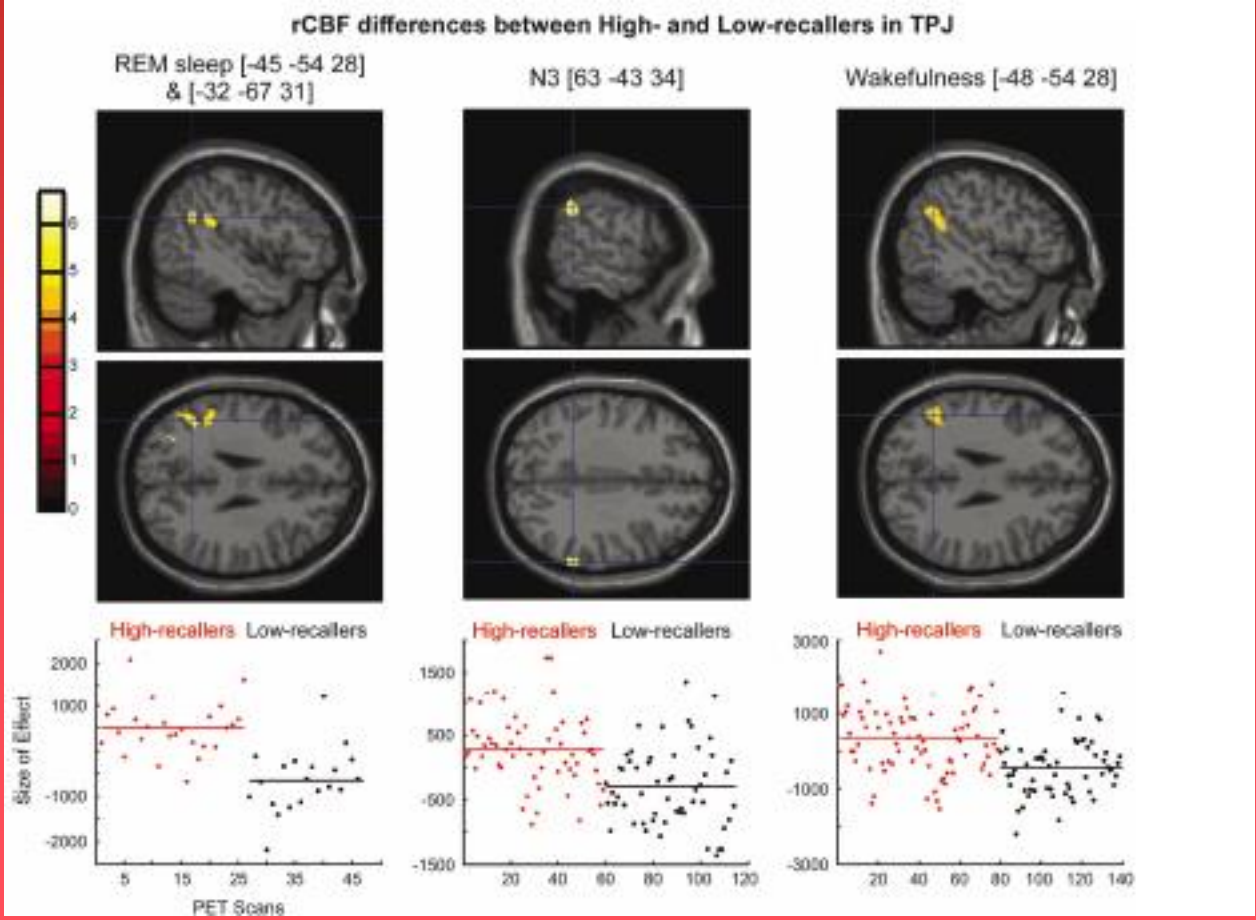
Resting Brain Activity Varies with Dream Recall Frequency Between Subjects

Jean-Baptiste Eichenlaub[1,2], Alain Nicolas[3], Jérôme Daltrozzo[1,2], Jérôme Redouté[4], Nicolas Costes[4] and Perrine Ruby*[1,2]

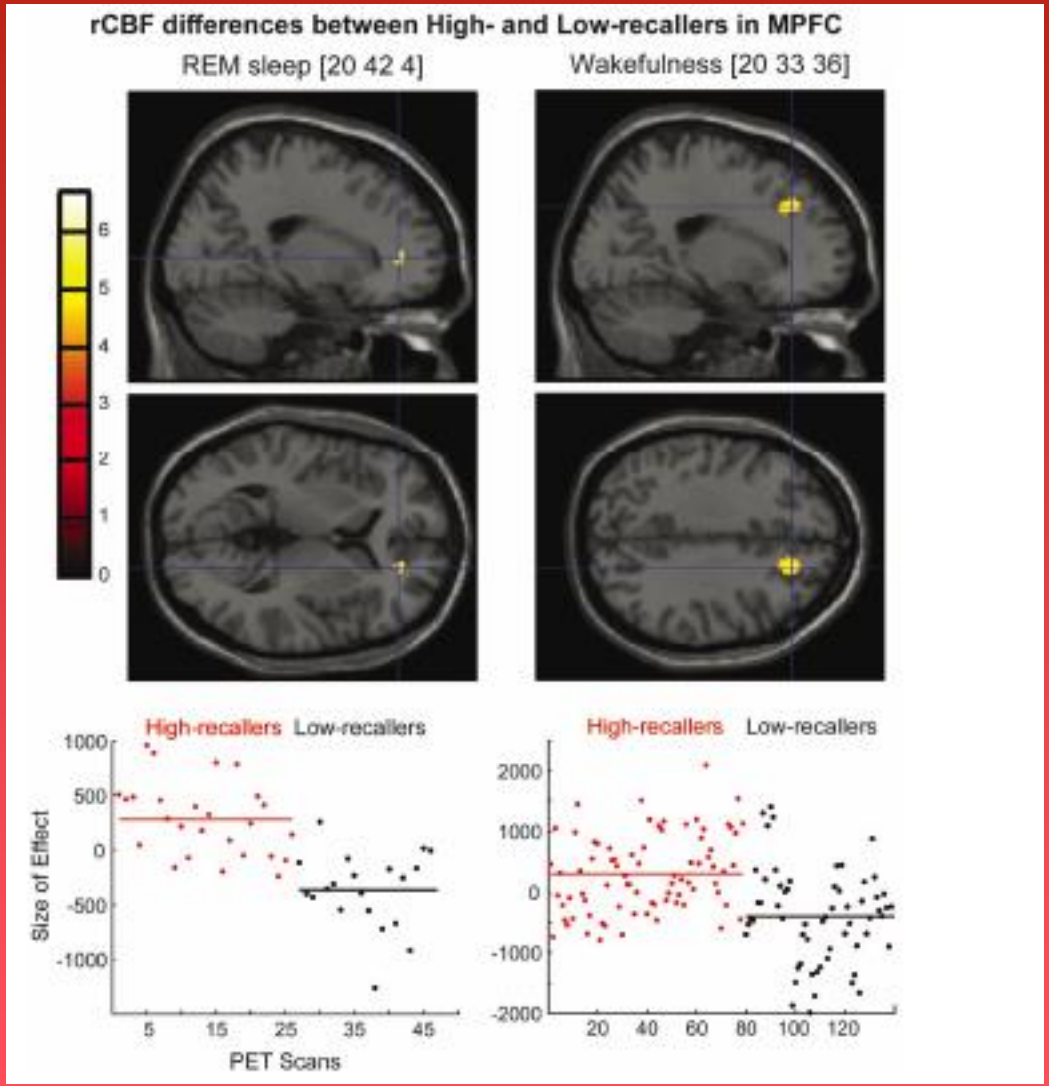
[1]CRNL—Lyon Neuroscience Research Center, INSERM UI 028, CNRS UMR 5292, Brain Dynamics and Cognition Team, Centre Hospitalier Le Vinatier (Bât. 452), Lyon, France; [2]University Claude Bernard Lyon 1, Lyon, France; [3]Unité d'Exploration Hypnologique, Centre Hospitalier Le Vinatier, Lyon, France; [4]CERMEP-Imagerie du Vivant, Lyon, France



Giunzione T-P-O



Corteccia mPFC



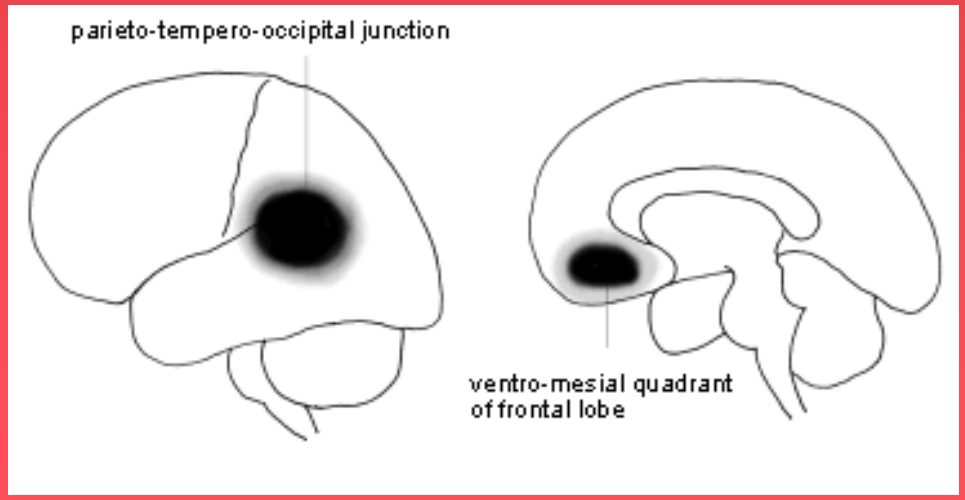
Anoneria: assenza dell'esperienza onirica

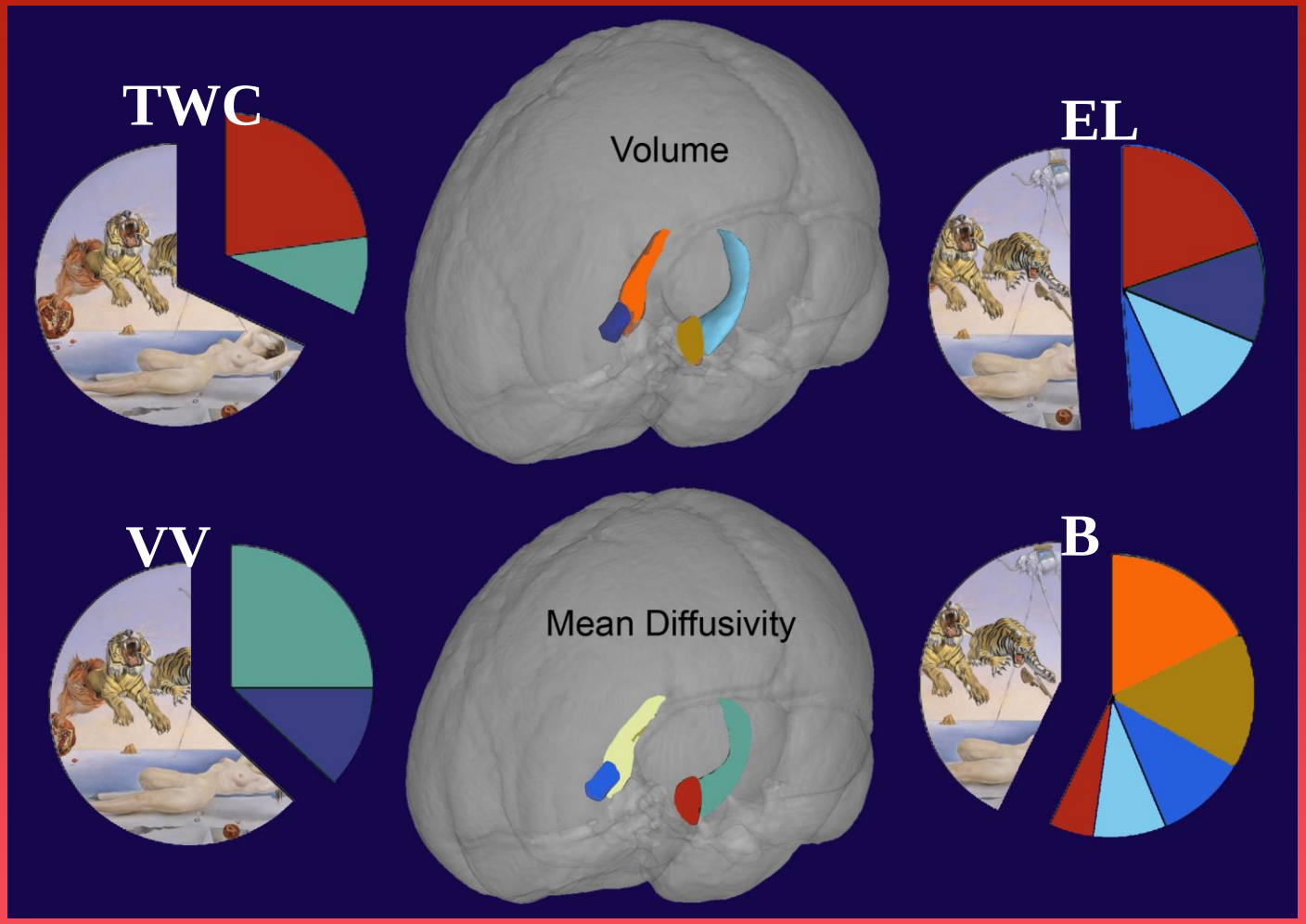
Solms 1997

Su una base di più di 100 casi di assenza di *dream recall* passati in rassegna, ipotizza che due sistemi siano implicati:

A) Giunzione P-T-O bilaterale (giro linguale inferiore destro, cortecce occipito-temporali mediali bilaterali, corteccie occipitali bilaterali), più frequentemente associato alla perdita delle caratteristiche visive dell'esperienza onirica

B) Materia bianca in area frontale ventromesiale (bilaterale)





Amygdala and Hippocampus Volumetry and Diffusivity in Relation to Dreaming

Luigi De Gennaro,[1]* Carlo Cipolli,[2] Andrea Cherubini,[3,4] Francesca Assogna,[3] Claudia Cacciari,[3] Cristina Marzano,[1] Giuseppe Curcio,[5] Michele Ferrara,[5] Carlo Caltagirone,[3,6] and Gianfranco Spalletta[3]

De Gennaro et al. Human Brain Mapping, 2011

TWC = lunghezza dei resoconti

VV = vividezza visiva

EL = intensità emozionale

B = bizzarrie

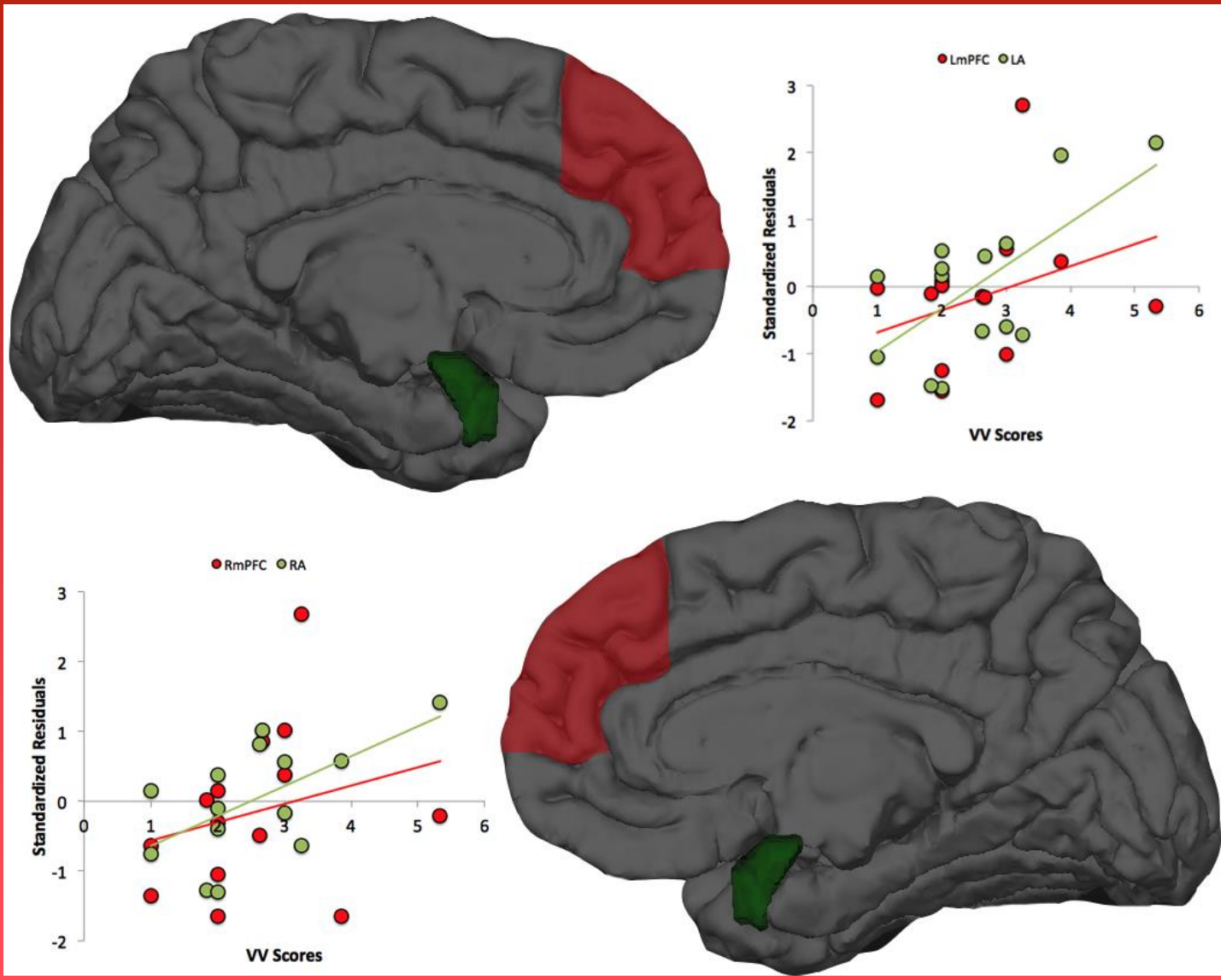
Il volume e l'integrità cellulare di due strutture, l'amigdala e l'ippocampo, spiegano un'ampia parte degli aspetti bizzarri, visivi ed emozionali dei sogni

Volume amigdala e thickness mPFC predicono la vividezza onirica

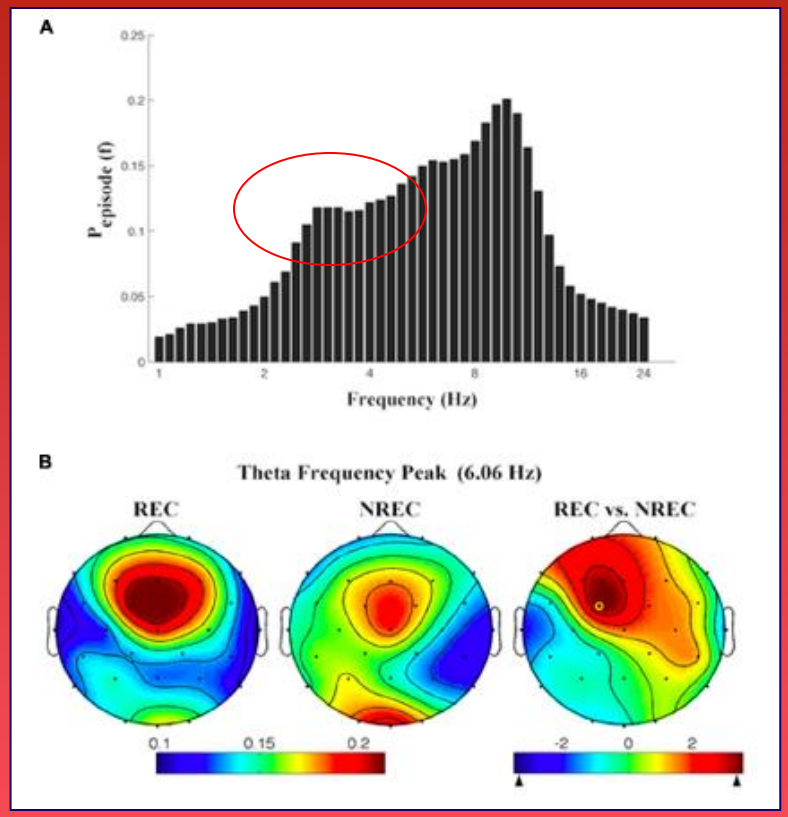
Relazione con il volume dell'amigdala

Relazione con la *tickness* prefrontale mediale

Relazione con sistema mesolimbico (amigdala-prefrontale mediale)



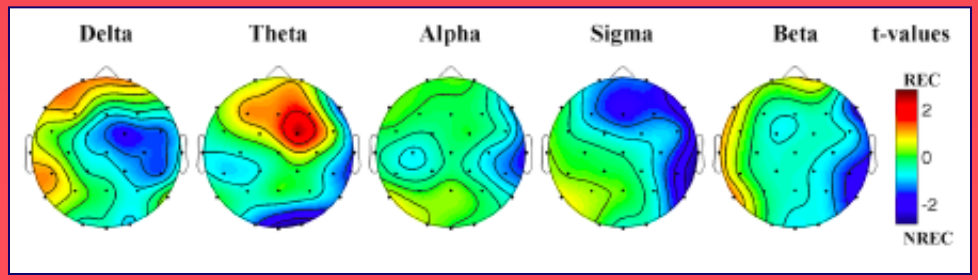
Studio *within-subjects in* sonno REM con protocollo di *nap* ripetuti



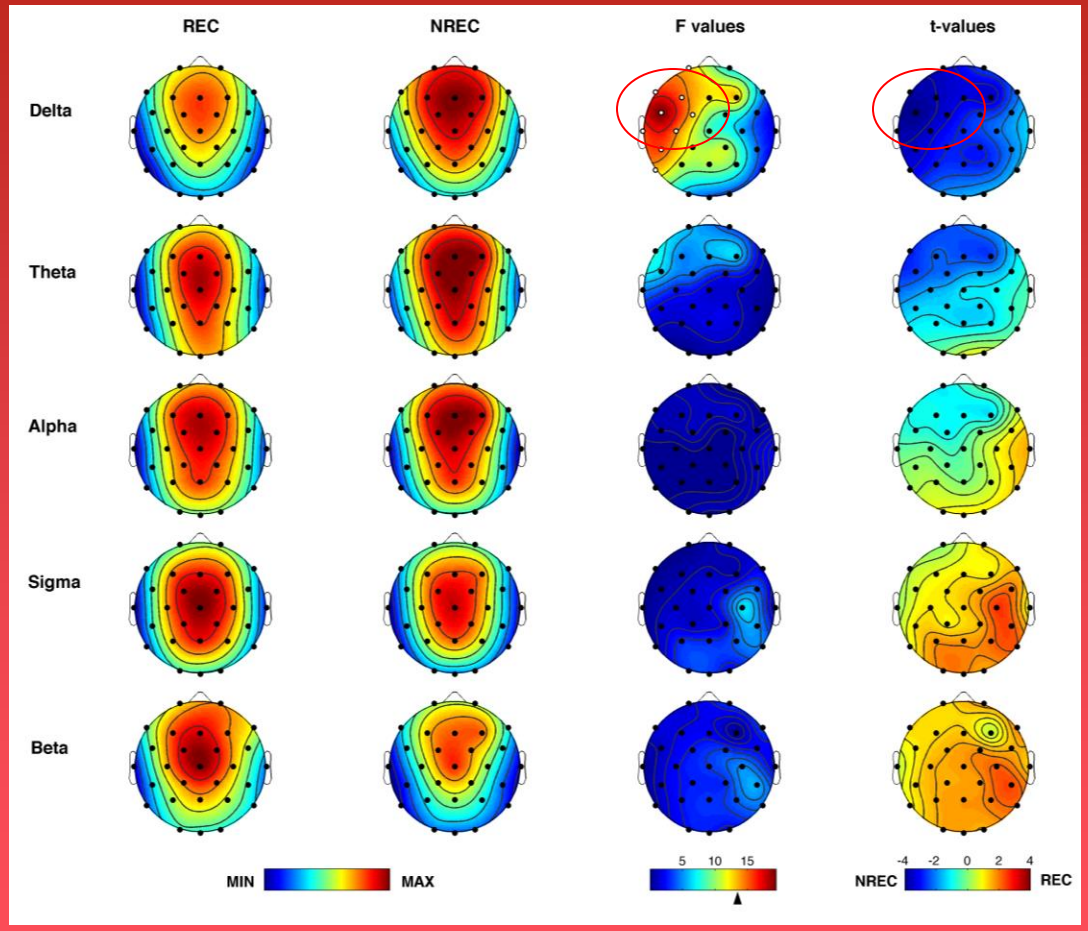
Incremento di oscillazioni theta frontali associata a presenza di ricordo dei sogni

State- or trait-like individual differences in dream recall: preliminary findings from a within-subjects study of multiple nap REM sleep awakenings

*Serena Scarpelli[1], Cristina Marzano[1], Aurora D'Atri[1], Maurizio Gorgoni[1], Michele Ferrara[2] and Luigi De Gennaro[1]**



Studio *within-subjects in* sonno NREM con protocollo di *nap* ripetuti



Decremento dell'attività delta frontale associata a presenza di ricordo dei sogni ("*activation hypothesis*")

Brain Topogr (2017) 30:629–638
DOI 10.1007/s10548-017-0563-1

ORIGINAL PAPER

Predicting Dream Recall: EEG Activation During NREM Sleep or Shared Mechanisms with Wakefulness?

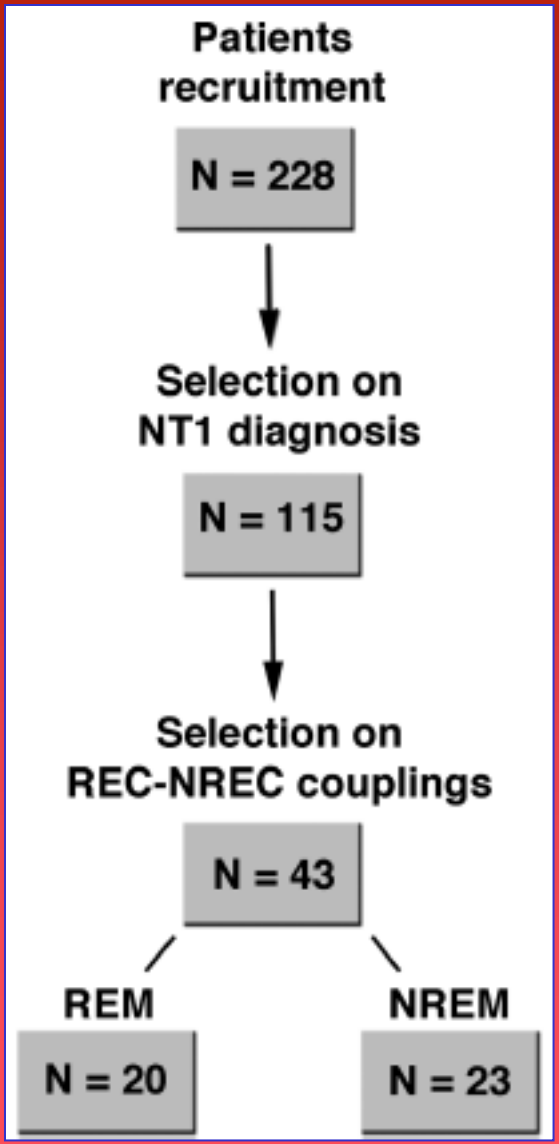
Serena Scarpelli[1] · Aurora D'Atri[1] · Anastasia Mangiaruga[1] · Cristina Marzano[1] · Maurizio Gorgoni[1] · Cinzia Schiappa[1] · Michele Ferrara[2] · Luigi De Gennaro[1]

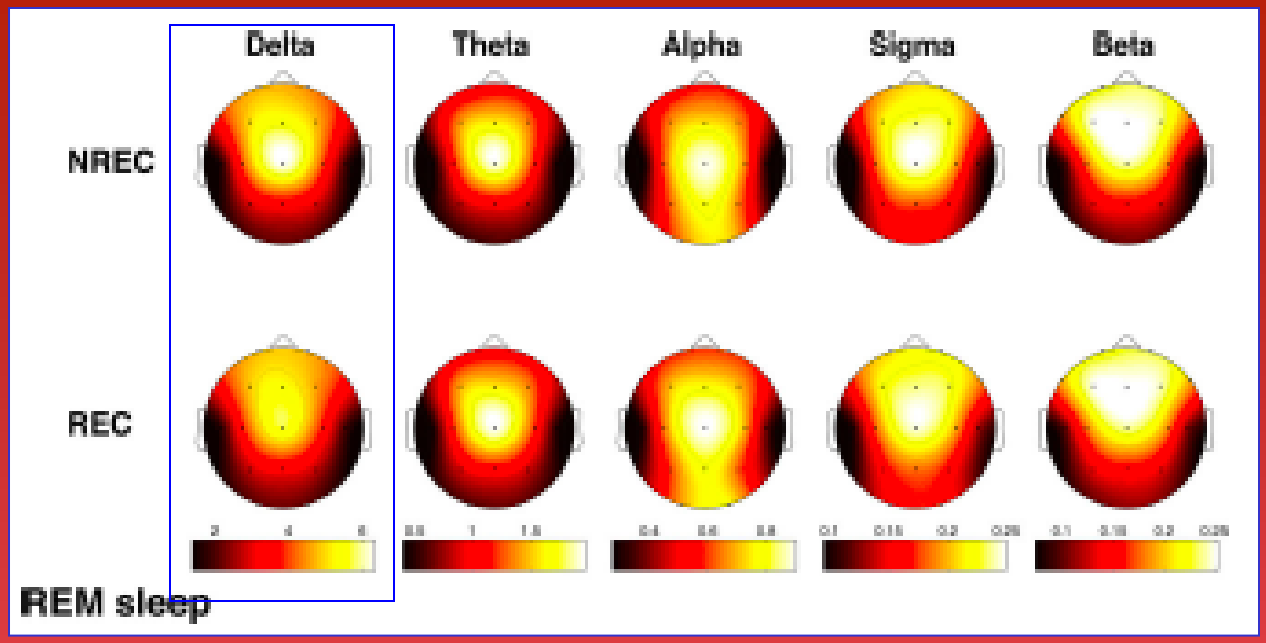
ANNALS of Clinical and Translational Neurology
Open Access
RESEARCH ARTICLE

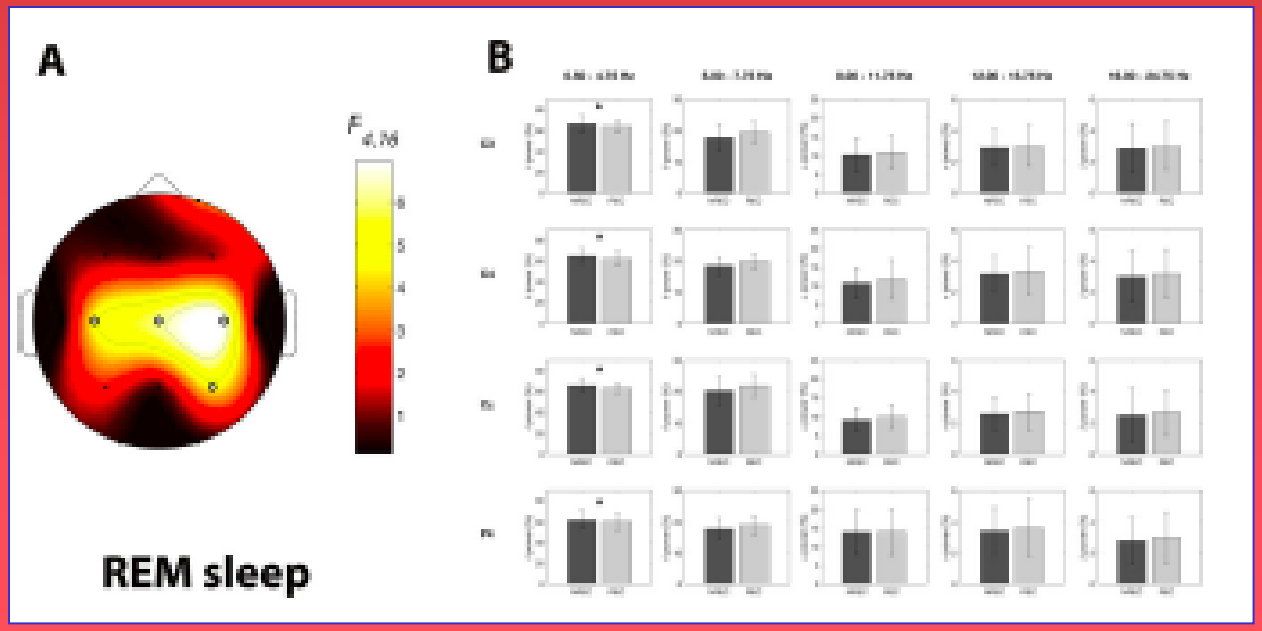
Cortical activation during sleep predicts dream experience in narcolepsy

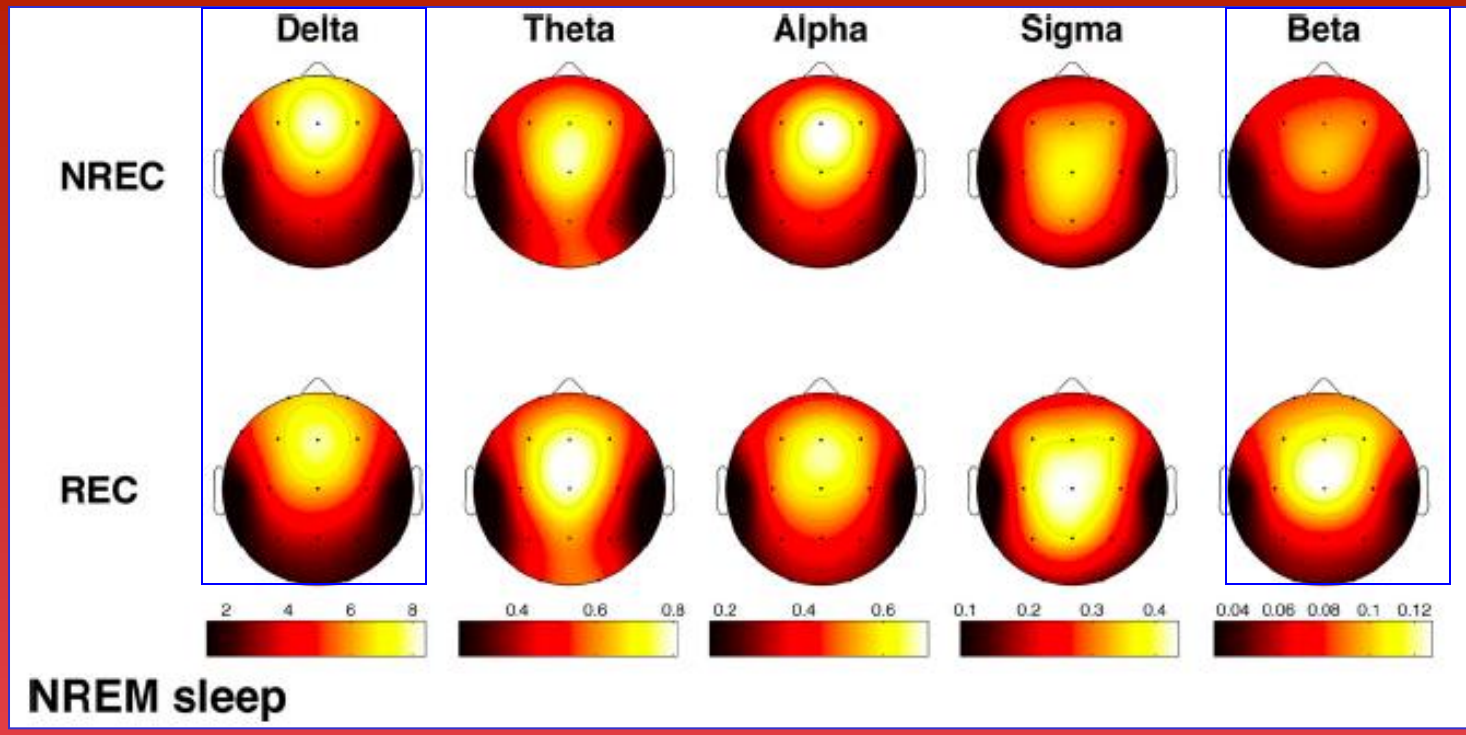
Aurora D'Atri[1], Serena Scarpelli[1], Cinzia Schiappa[1], Fabio Pizza[2,3], Stefano Vandi[2,3], Michele Ferrara[4], Carlo Cipolli[5], Giuseppe Plazzi[2,3,a] & Luigi De Gennaro[1,a]

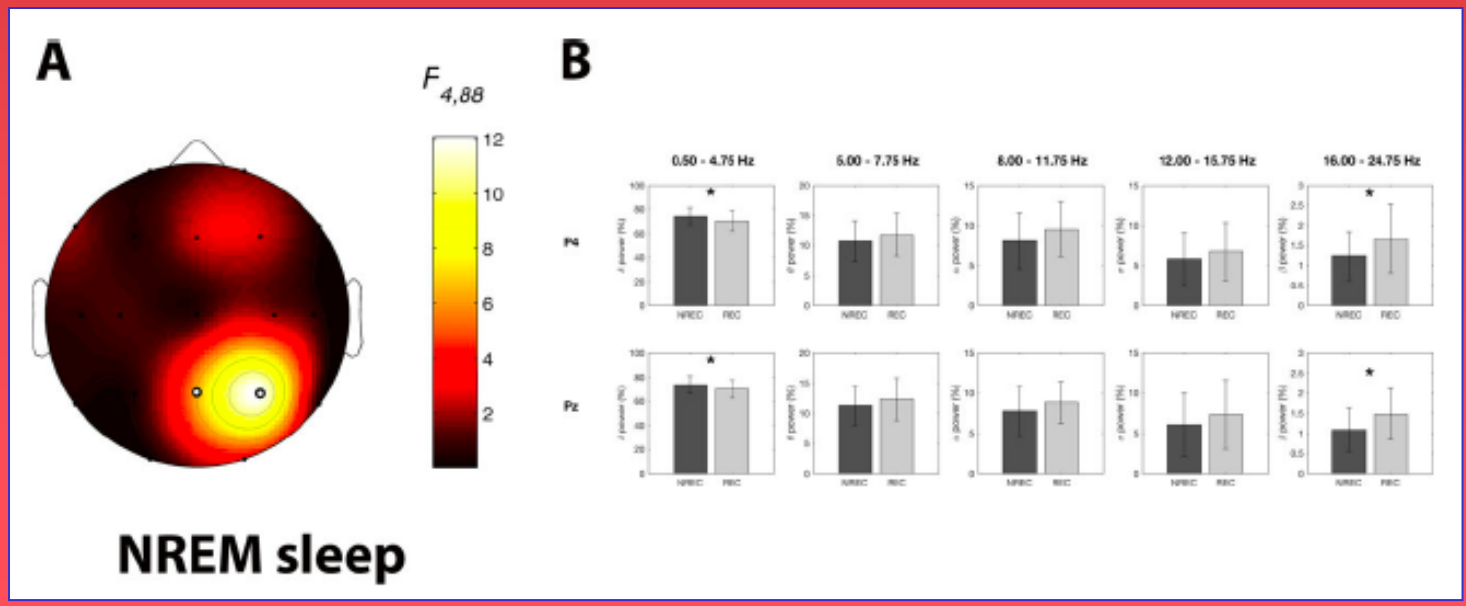
[1]Department of Psychology, University of Rome "Sapienza", Rome, Italy
[2]Department of Biomedical and Neuromotor Sciences (DIBINEM), University of Bologna, Bologna, Italy
[3]IRCCS Istituto delle Scienze Neurologiche di Bologna, Bologna, Italy
[4]Department of Biotechnological and Applied Clinical Sciences, University of L'Aquila, L'Aquila, Italy
[5]Department of Specialty, Diagnostic and Experimental Medicine (DIMES), University of Bologna, Bologna, Italy




Delta
Theta
Alpha
Sigma
Beta
NREC
REC
REM sleep


A
B
REM sleep

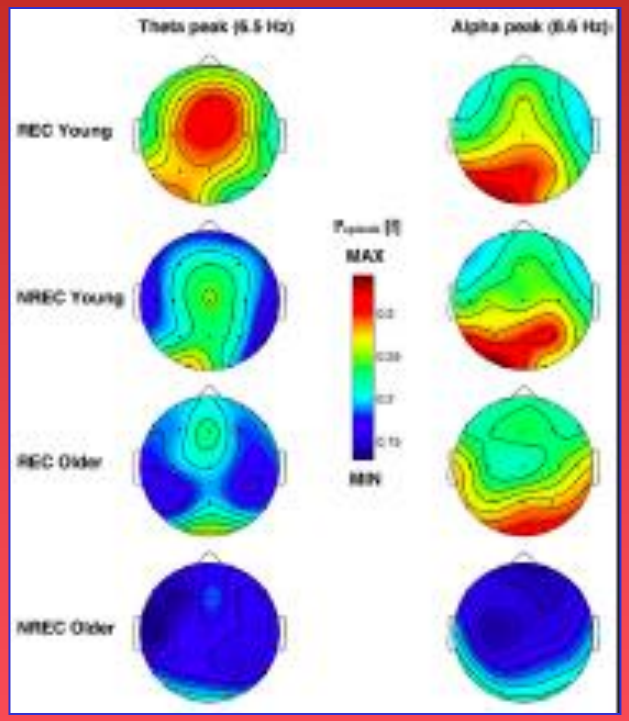

Delta
Theta
Alpha
Sigma
Beta
NREC
REC
2 4 6 8
0.4 0.6 0.8
0.2 0.4 0.6
0.1 0.2 0.3 0.4
0.04 0.06 0.08 0.1 0.12
NREM sleep

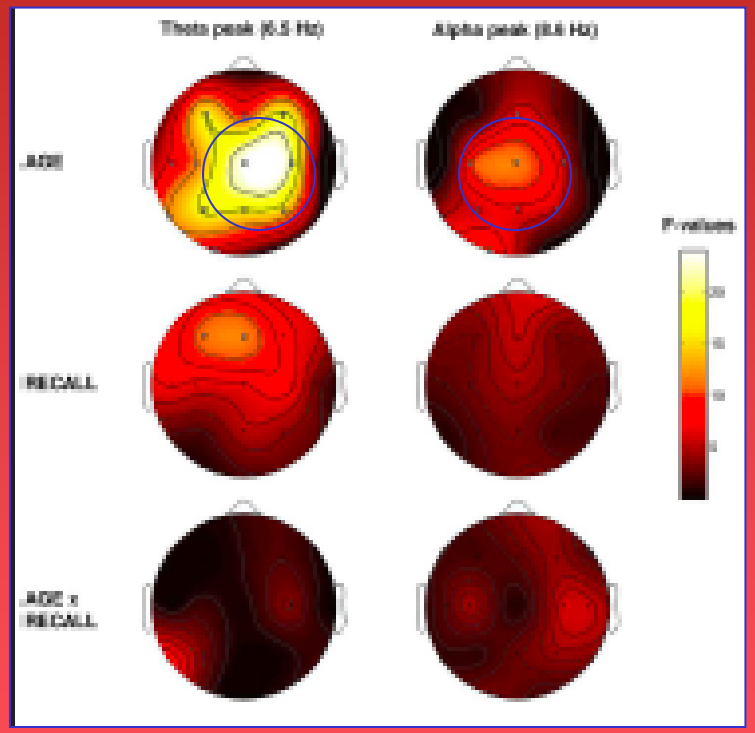

A
$F_{4,88}$
12
10
8
6
4
2
NREM sleep
B
0.50 - 4.75 Hz
5.00 - 7.75 Hz
8.00 - 11.75 Hz
12.00 - 15.75 Hz
16.00 - 24.75 Hz
P4
Pz
NREC
REC

Oscillatory EEG Activity During REM Sleep in Elderly People Predicts Subsequent Dream Recall After Awakenings

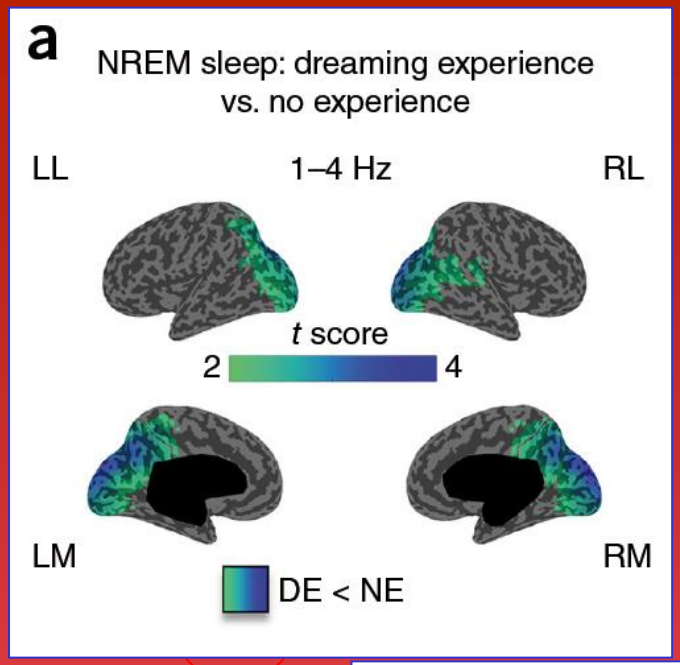
*Serena Scarpelli, Aurora D'Atri, Chiara Bartolacci, Anastasia Mangiaruga, Maurizio Gorgoni and Luigi De Gennaro**

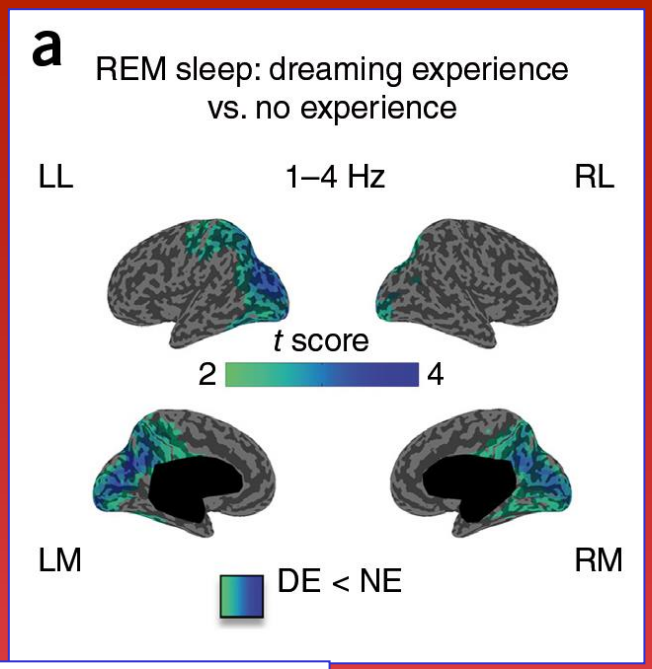
Department of Psychology, University of Rome "Sapienza", Rome, Italy

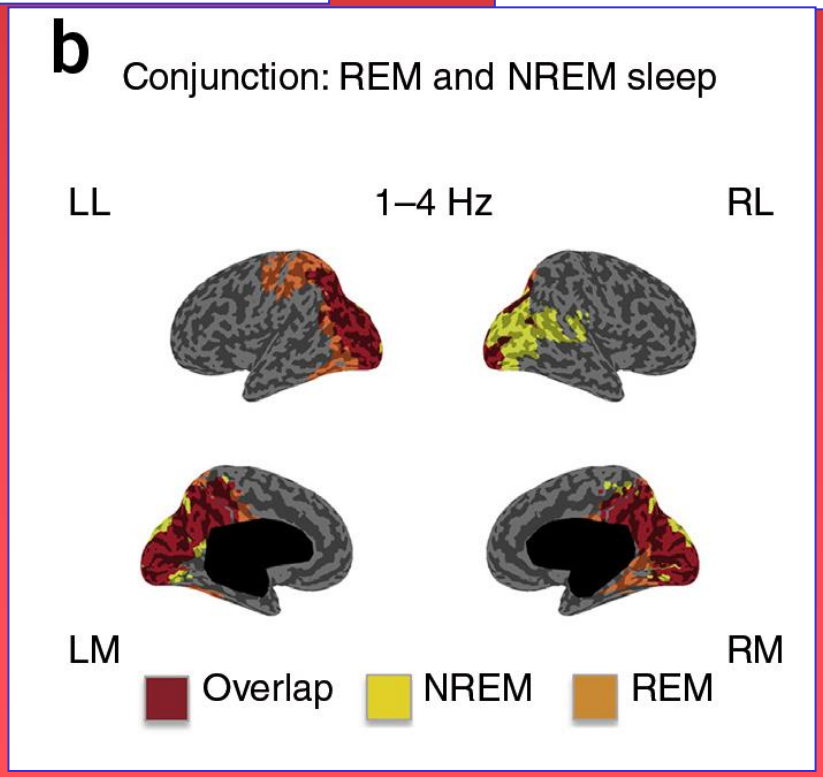




In sonno REM gli anziani presentano una minore attività alpha e theta, associate al ricordo dei sogni, rispetto ai giovani



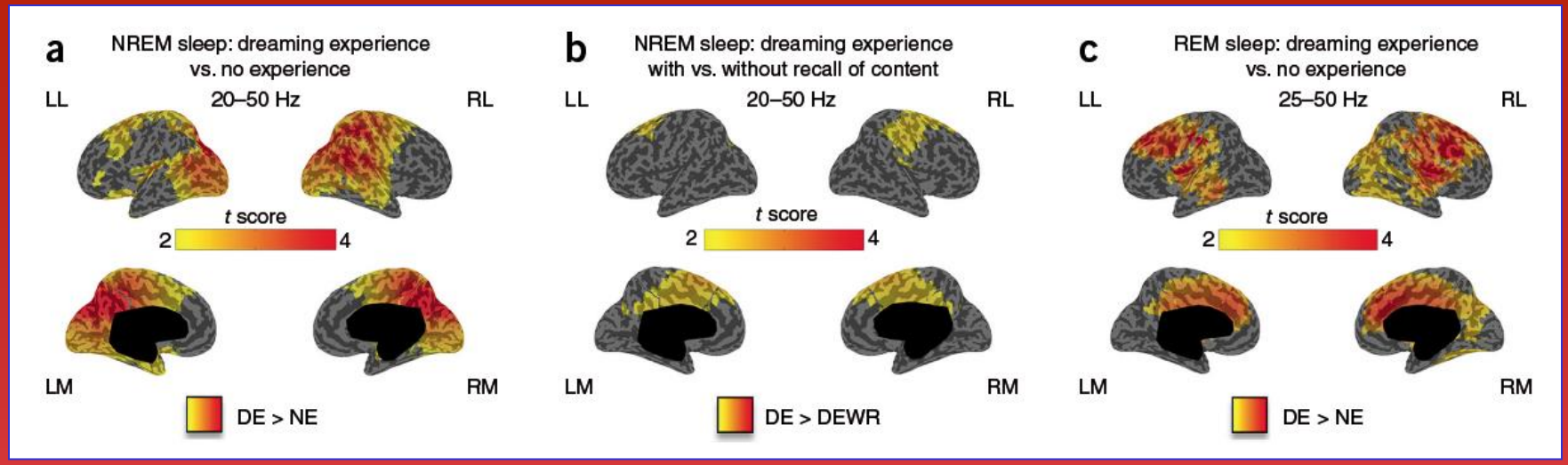


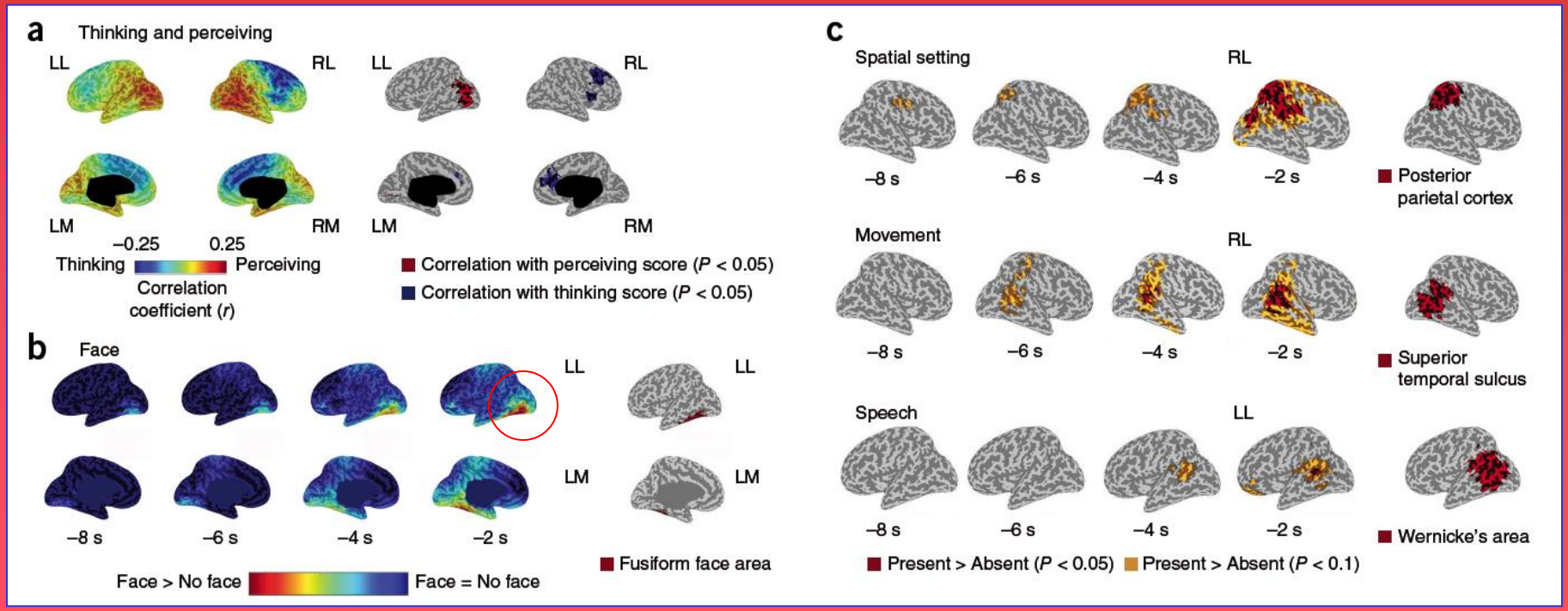


nature neuroscience

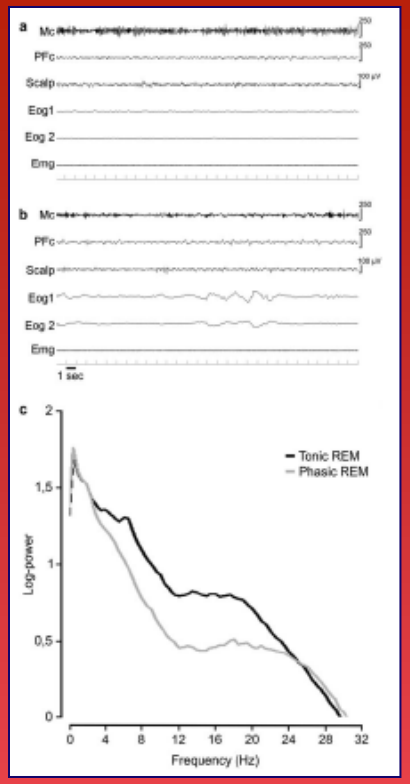
The neural correlates of dreaming

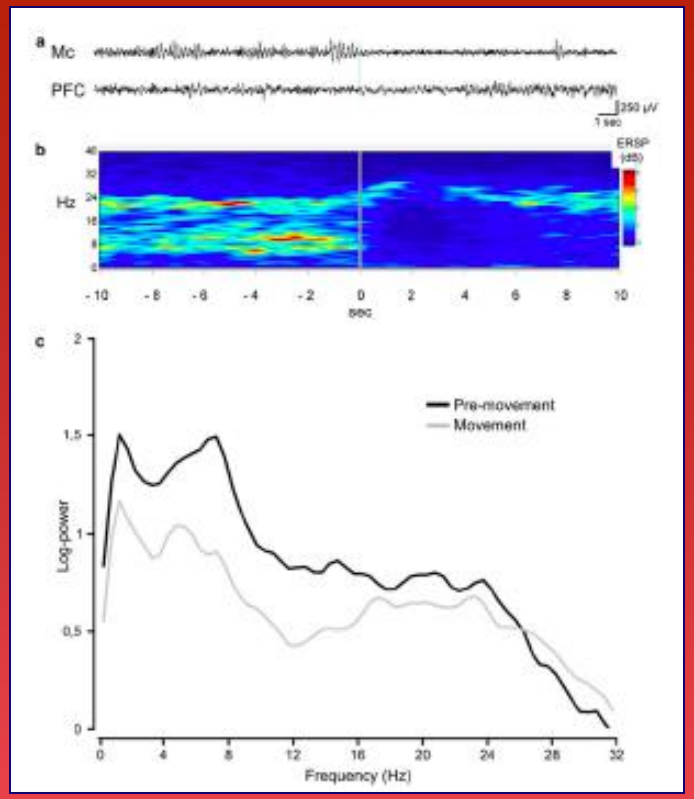
F Siclari[1,2,9], B Baird[1,9], L Perogamvros[1,3,4,9], G Bernardi[1,2,5], J J LaRocque[6], B Riedner[1], M Boly[1,7], B R Postle[1,8] & G Tononi[1]


a
NREM sleep: dreaming experience vs. no experience
LL
20–50 Hz
RL
t score
2
4
LM
RM
DE > NE
b
NREM sleep: dreaming experience with vs. without recall of content
LL
20–50 Hz
RL
t score
2
4
LM
RM
DE > DEWR
c
REM sleep: dreaming experience vs. no experience
LL
25–50 Hz
RL
t score
2
4
LM
RM
DE > NE

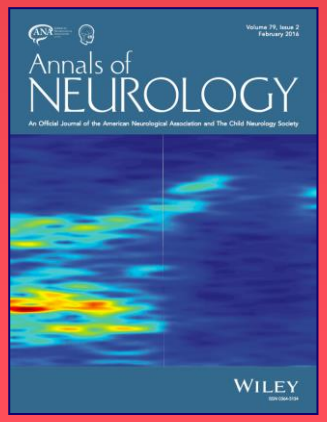

a
Thinking and perceiving
LL
RL
LM
RM
–0.25
0.25
Thinking
Perceiving
Correlation coefficient (r)
Correlation with perceiving score (P < 0.05)
Correlation with thinking score (P < 0.05)
b
Face
–8 s
–6 s
–4 s
–2 s
Face > No face
Face = No face
Fusiform face area
c
Spatial setting
Posterior parietal cortex
Movement
Superior temporal sulcus
Speech
Wernicke's area
Present > Absent (P < 0.05)
Present > Absent (P < 0.1)

ACCESSO PIU' DIRETTO ALL'ESPERIENZA ONIRICA





L'attività della corteccia motoria durante il REM con movimenti oculari è simile a quella espressa prima di un movimento volontario durante la veglia



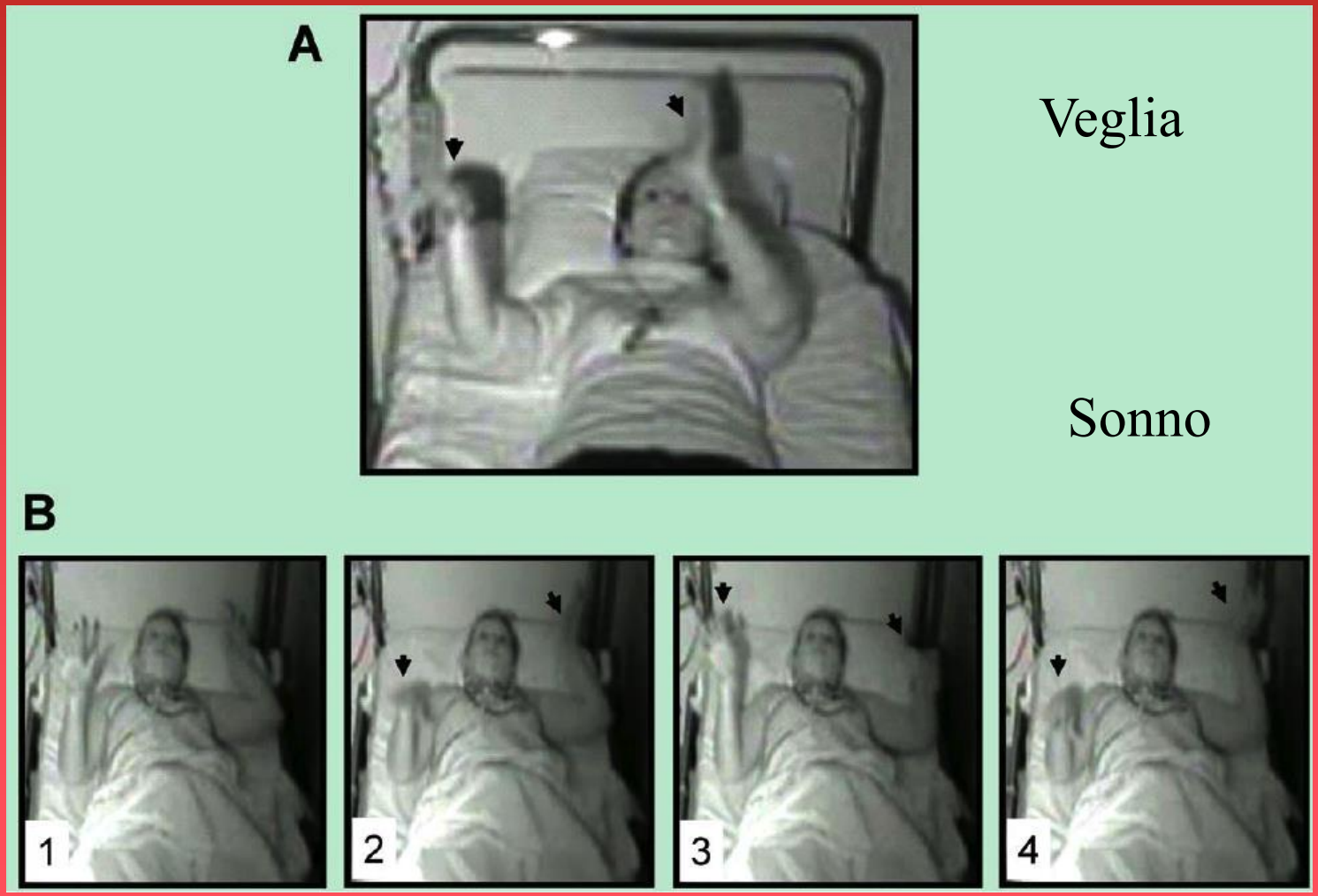
Activation of the Motor Cortex during Phasic Rapid Eye Movement Sleep

Fabrizio De Carli, MSc,[1]
Paola Proserpio, MD,[2]
Elisa Morrone, PhD,[3] Ivana Sartori, MD,[2]
Michele Ferrara, PhD,[4]
Steve Alex Gibbs, MD, PhD,[2]
Luigi De Gennaro, PhD,[5]
Giorgio Lo Russo, MD,[2] and
Lino Nobili MD, PhD[1,2]

OPEN ACCESS Freely available online PLoS one

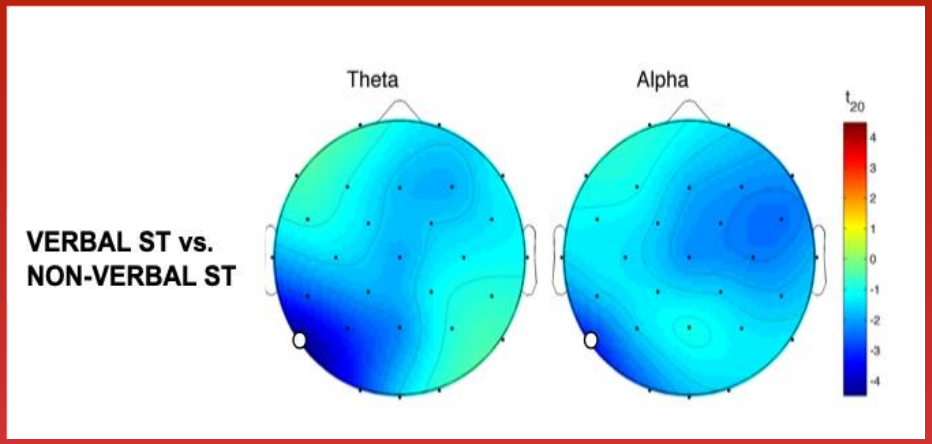
Evidence for the Re-Enactment of a Recently Learned Behavior during Sleepwalking

Delphine Oudiette[1,3*], Irina Constantinescu[4,5], Laurène Leclair-Visonneau[1,3], Marie Vidailhet[2,3], Sophie Schwartz[4,5], Isabelle Arnulf[1,2,3]

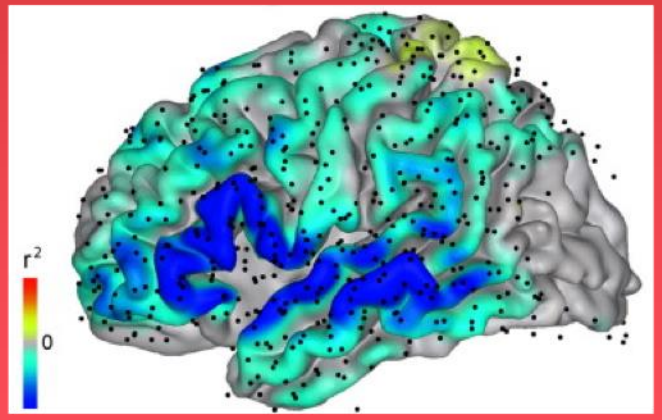


Part 1: Execution of the structured sequence by a waking control

Sleeptalking



The decreased theta and alpha activity localized on the left hemisphere, over posterior regions, suggests a functional parallelism between sleep and wakefulness verbal production (i.e., a continuity of neural mechanisms subsiding language programming across wake and sleep).



Selective decrease of the theta activity over left temporo-parietal electrodes by comparing covert speech e overt speech in wakefulness *(Hermes e coll., 2014).*

Left hemisphere			Right hemisphere		
Lead	Mean	SD	Lead	Mean	SD
Fp1	9.0	7.5	Fp2	8.6	6.2
F3	11.5	8.8	F4	11.0	8.3
F7	6.3	4.5	F8	5.8	4.2
C3	13.4***	10.8	C4	17.9	17.7
P3	18.3***	16.4	P4	25.7	26.6
T3	7.0*	5.2	T4	9.7	9.7
T5	7.5**	6.2	T6	12.1	13.2
O1	13.3	12.3	O2	16.2	16.2

[a] The unit of EEG alpha power is square of microvoltage (μV). Wilcoxon signed rank test was used to compare left and right. The significance level is indicated by asterisks: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.005$.

Selective decrease of the alpha activity over left temporo-parietal and central electrodes during dream speech in Stage REM *(Hong e coll.,1996).*

Sciencexpress

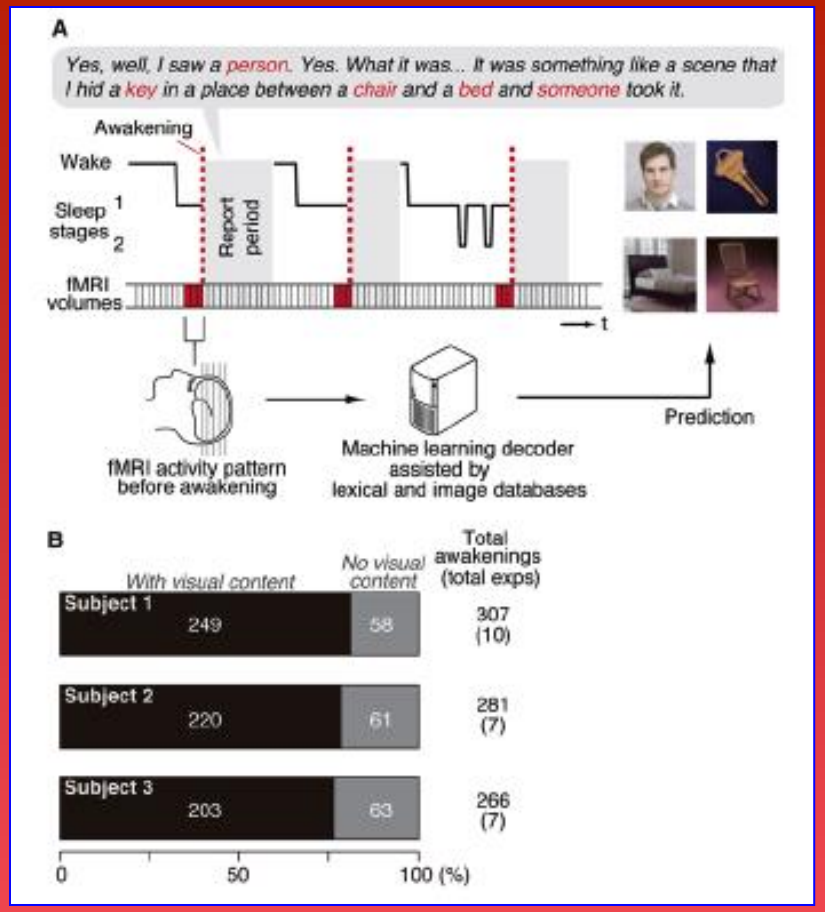
Neural Decoding of Visual Imagery During Sleep

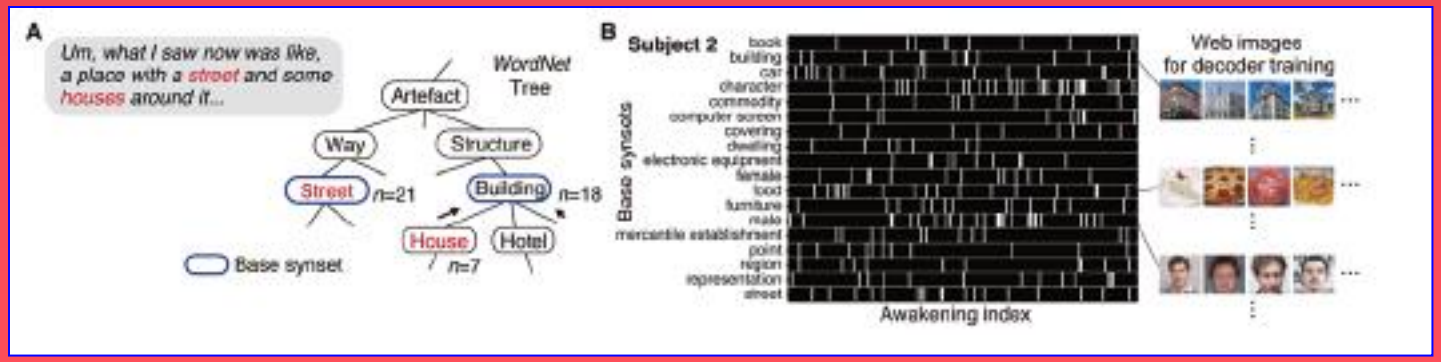
T. Horikawa,[1,2] M. Tamaki,[1*] Y. Miyawaki,[3,1†] Y. Kamitani,[1,2‡]

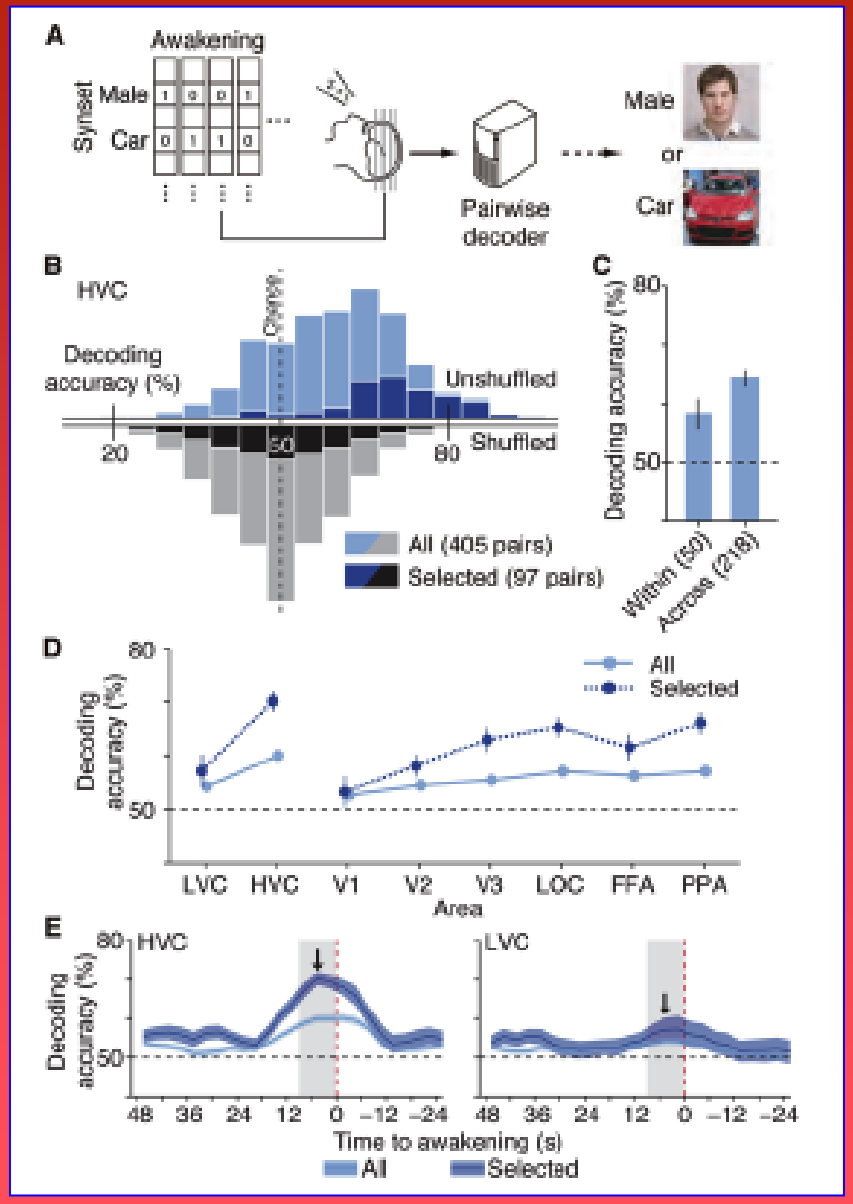
NEUROSCIENCE

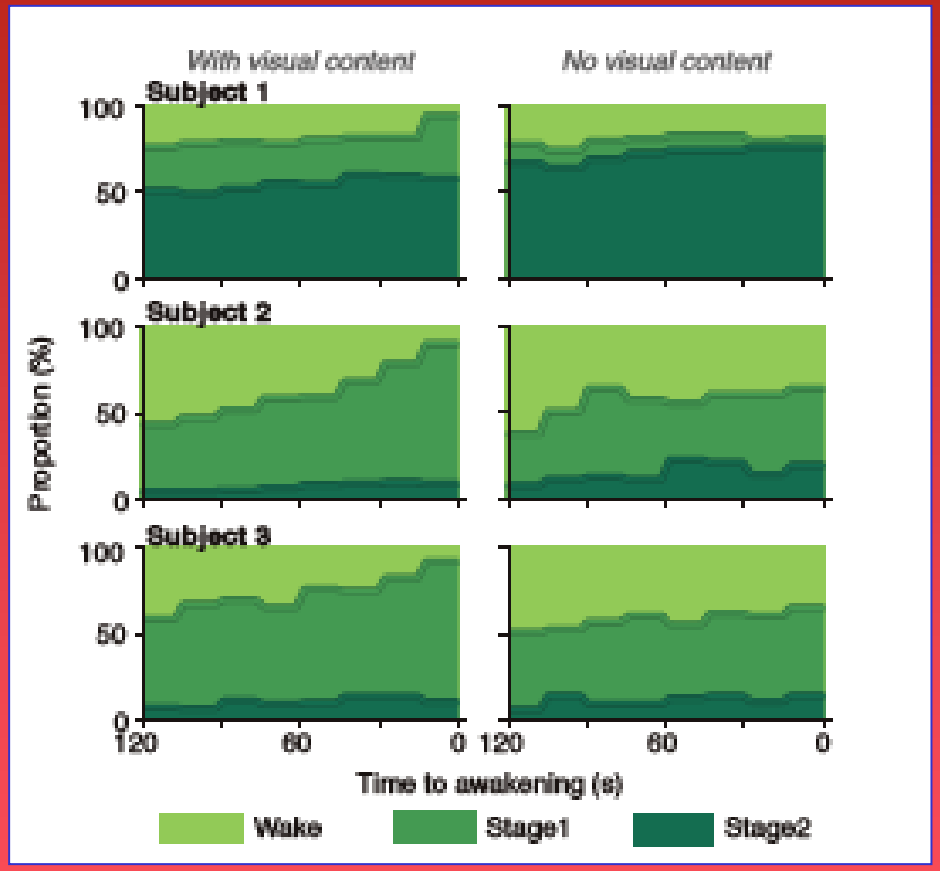
How to Build a Dream-Reading Machine

Dream reading?






A
Awakening
Synset
Male
Car
Pairwise decoder
Male
or
Car
B
HVC
Decoding accuracy (%)
Onset
Unshuffled
Shuffled
20
80
All (405 pairs)
Selected (97 pairs)
C
Decoding accuracy (%)
80
50
Within (50)
Across (218)
D
Decoding accuracy (%)
80
50
All
Selected
LVC
HVC
V1
V2
V3
LOC
FFA
PPA
Area
E
HVC
LVC
Decoding accuracy (%)
80
50
48
36
24
12
0
−12
−24
Time to awakening (s)
All
Selected

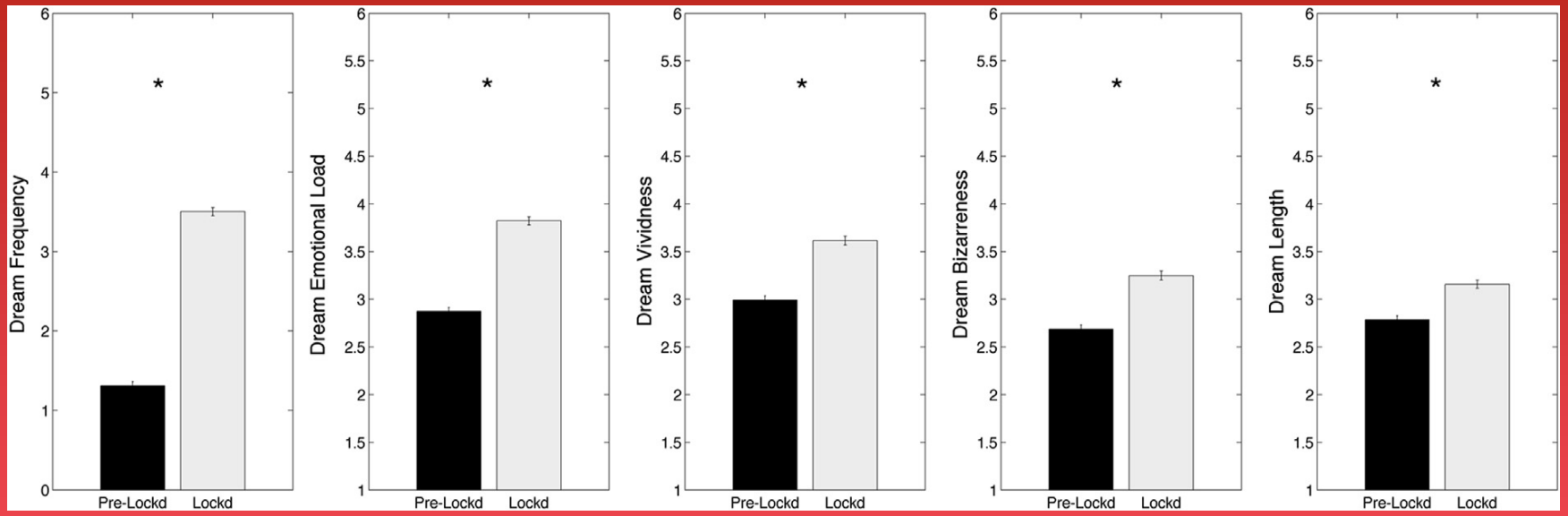

With visual content
No visual content
Subject 1
Subject 2
Subject 3
Proportion (%)
100
50
0
120
60
0
Time to awakening (s)
Wake
Stage1
Stage2

DIMENSIONI CAMPIONARIE MOLTO PIU' AMPIE

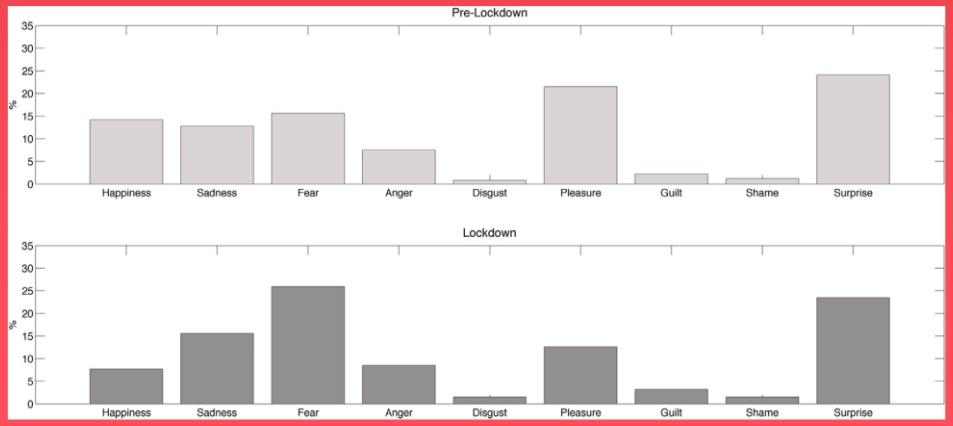
Dream EEG and Mentation (DREAM) database

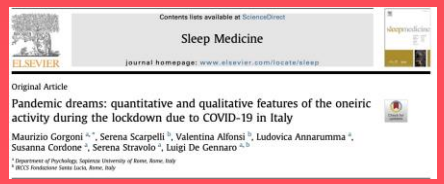
E' vero, io parlo dei sogni, che NON sono figli di un cervello ozioso ...

Il sogno al tempo del COVID:
#PandemicDreams



Queste differenze associate a genere femminile, sintomi depressivi e impoverita qualità del sonno




Contents lists available at ScienceDirect
Sleep Medicine
journal homepage: www.elsevier.com/locate/sleep
Original Article
Pandemic dreams: quantitative and qualitative features of the oneiric activity during the lockdown due to COVID-19 in Italy

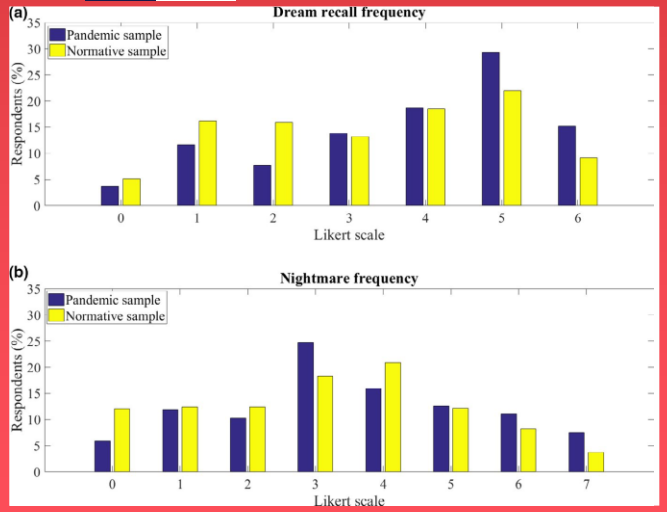
Il sogno al tempo del COVID:
#PandemicNightmares

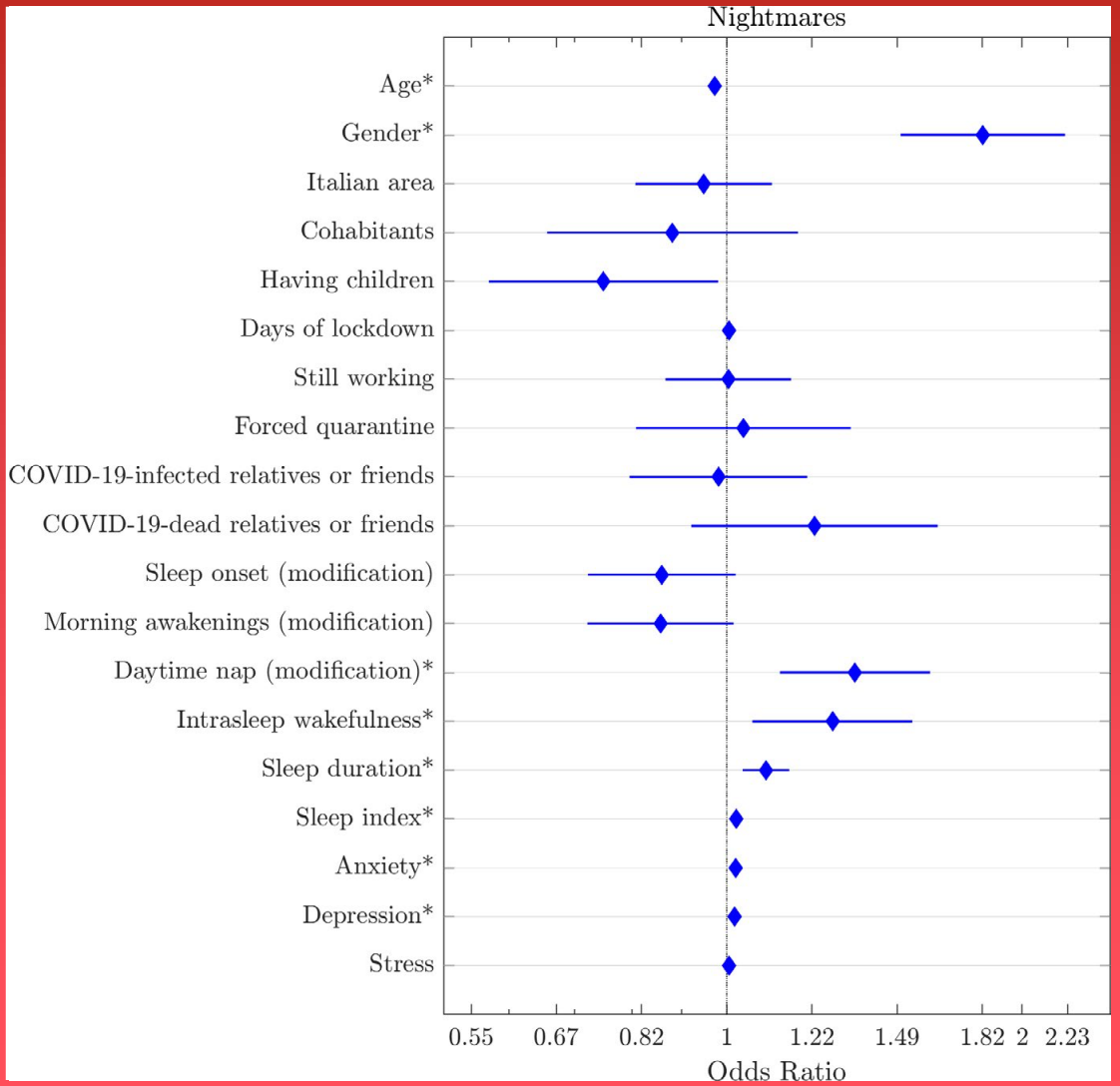
DOI: 10.1111/jsr.13300

REGULAR RESEARCH PAPER

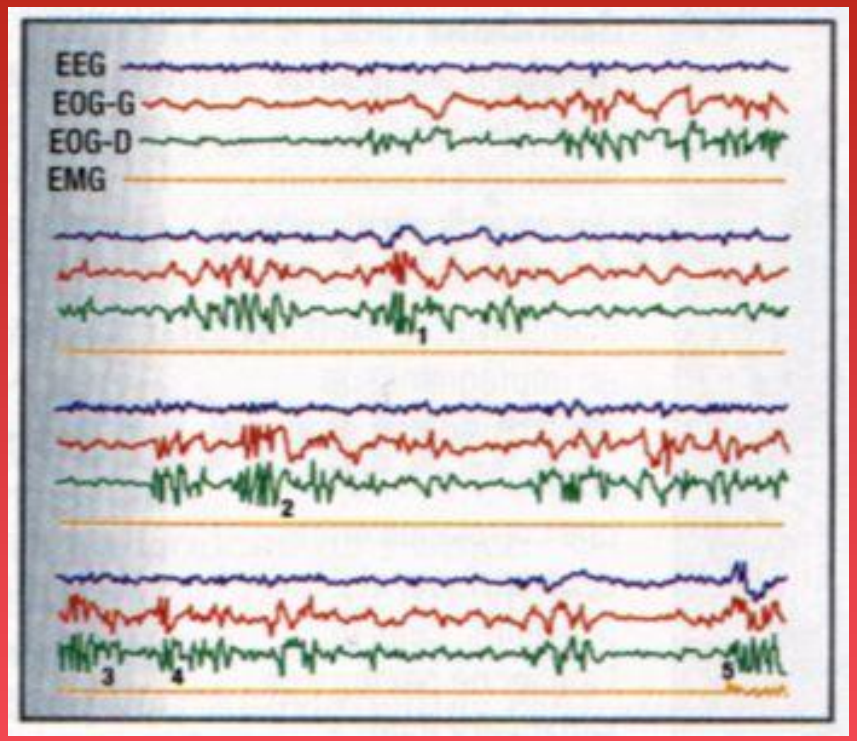
Pandemic nightmares: Effects on dream activity of the COVID-19 lockdown in Italy

Serena Scarpelli[1,2] | Valentina Alfonsi[2] | Anastasia Mangiaruga[3] | Alessandro Musetti[4] | Maria Catena Quattropani[5] | Vittorio Lenzo[5] | Maria Francesca Freda[6] | Daniela Lemmo[6] | Elena Vegni[7] | Lidia Borghi[7] | Emanuela Saita[8] | Roberto Cattivelli[8,9] | Gianluca Castelnuovo[8,9] | Giuseppe Plazzi[10,11] | Luigi De Gennaro[1,2] | Christian Franceschini[12]

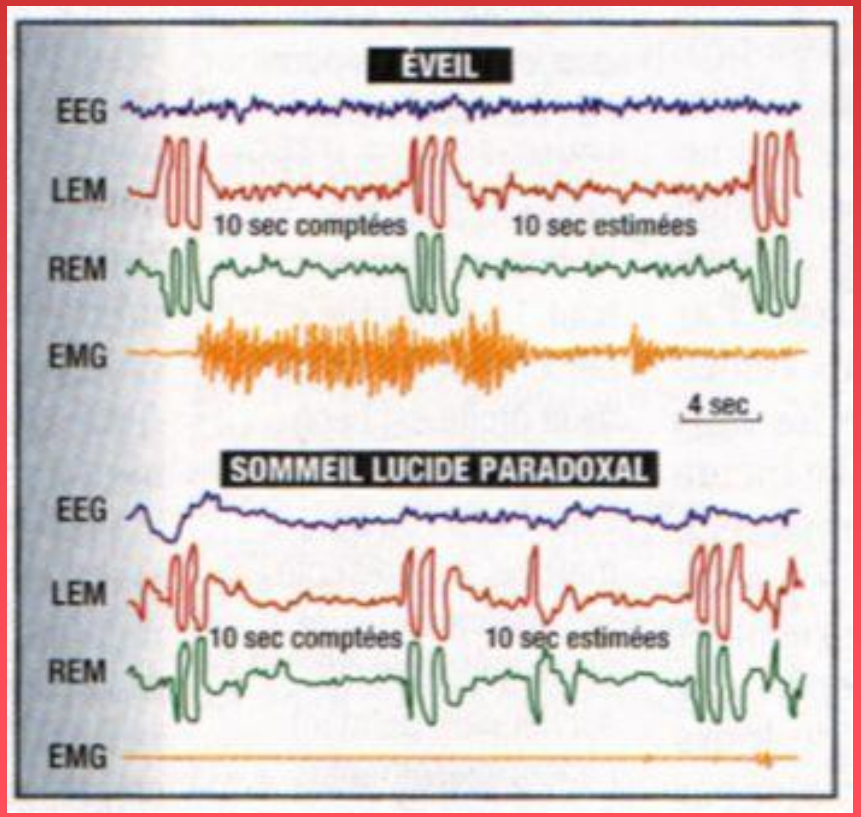




E' possibile controllare i propri sogni?



Sogni lucidi (Laberge, Stanford University)



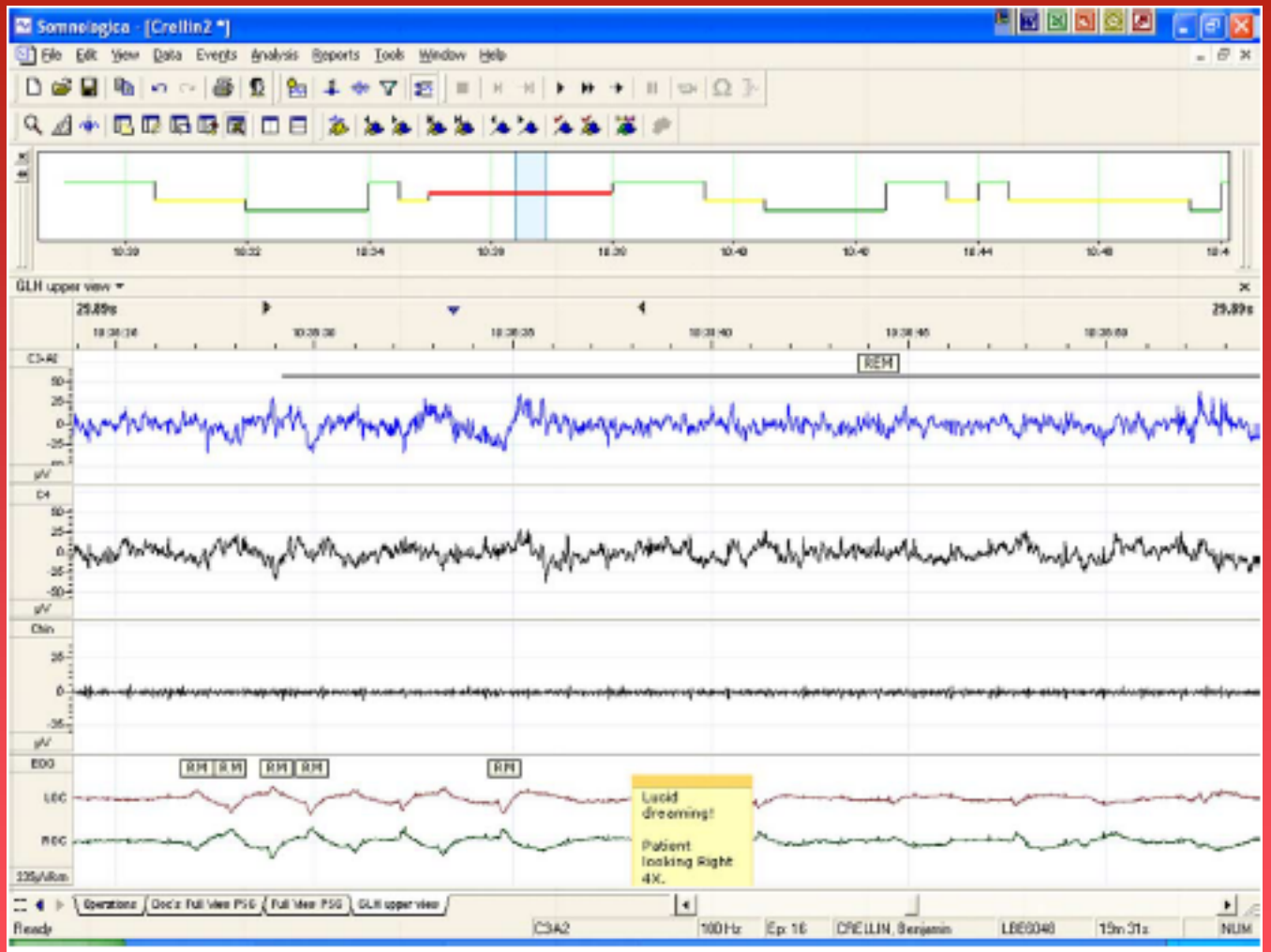
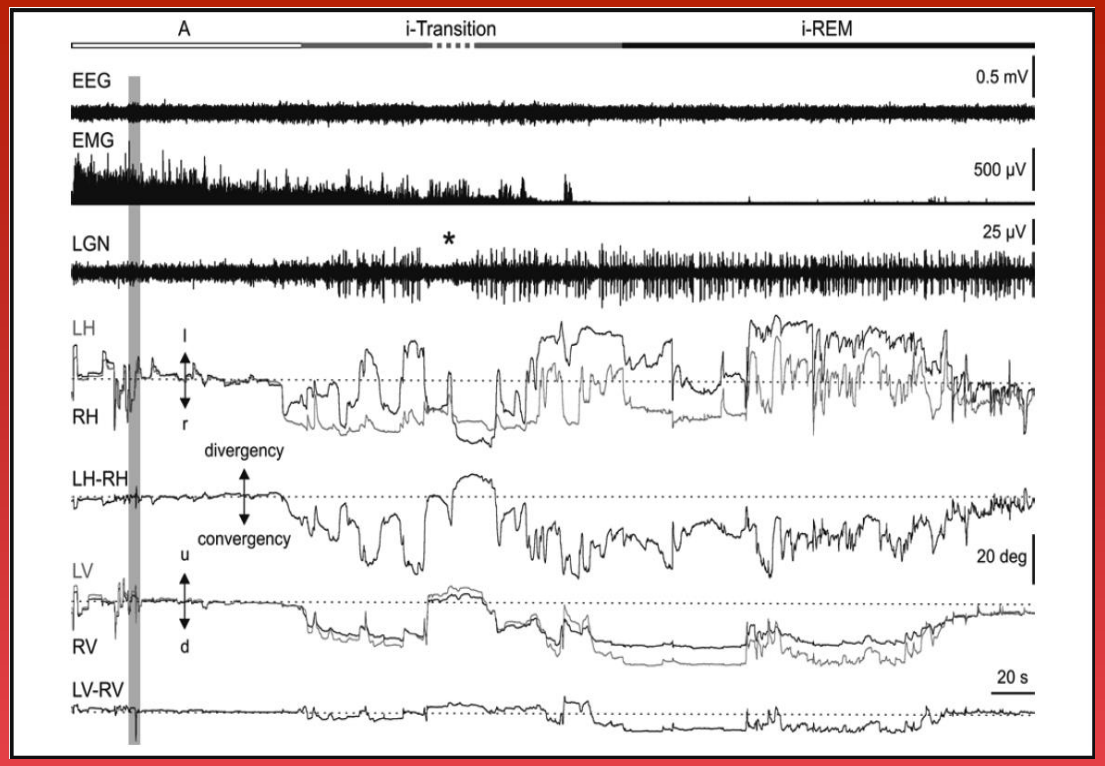
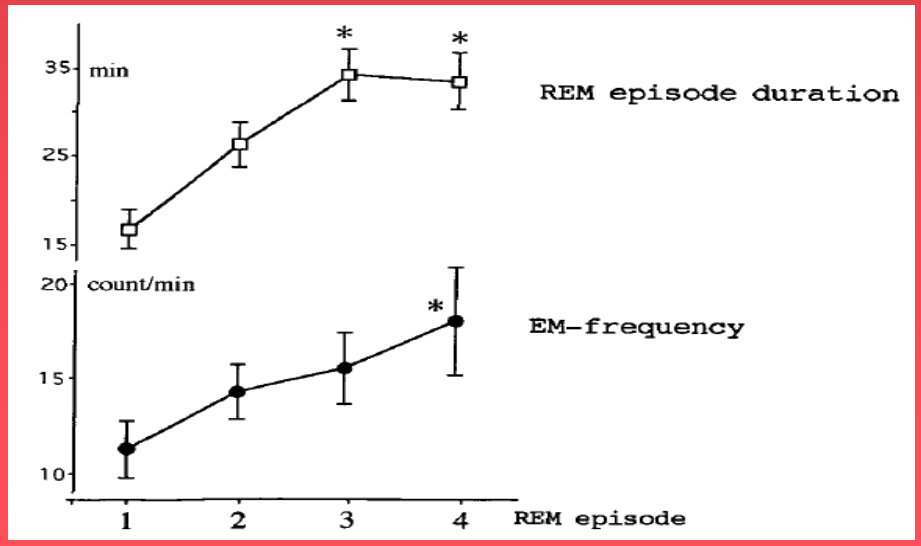
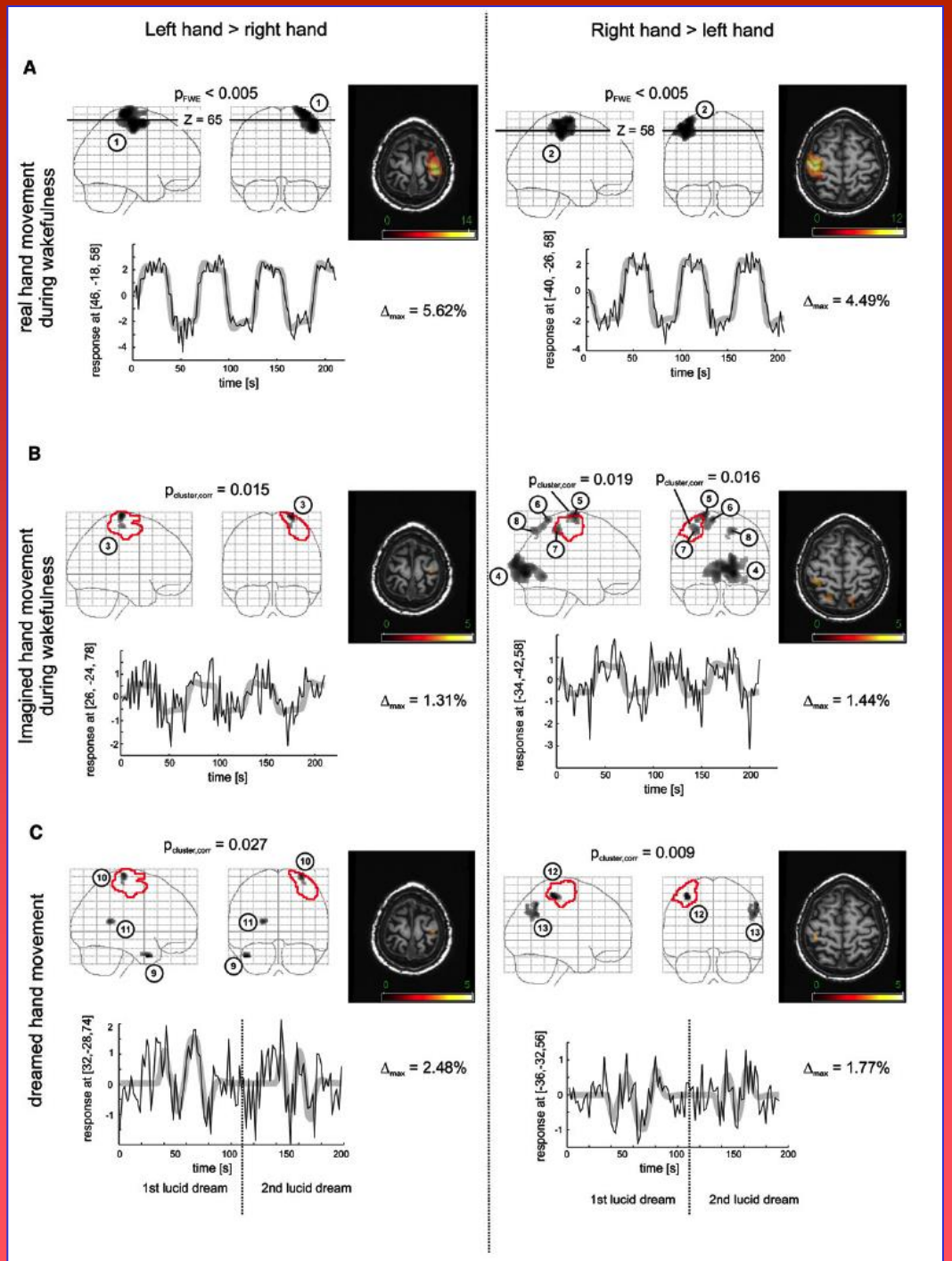


Fig. 2. Thirty-second epoch of REM sleep with four rightward movements as the pre-arranged signal to signify awareness.





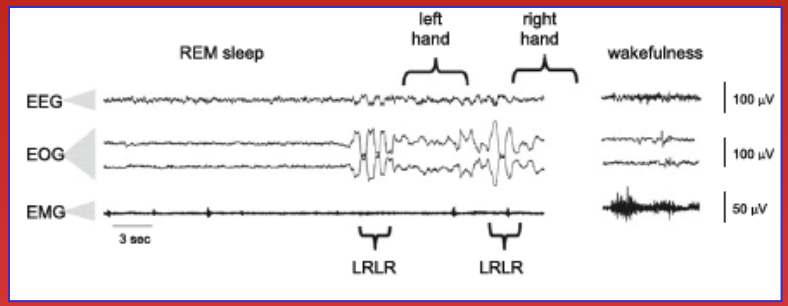
In una notte di sonno, durante le fasi REM ogni individuo produce migliaia di movimenti oculari. Pertanto, esiste una probabilità elevata di produrre casualmente una sequenza di 3 movimenti verso una specifica direzione



Current Biology 21, 1833–1837, November 8, 2011 ©2011 Elsevier Ltd All rights reserved DOI 10.1016/j.cub.2011.09.029

Report

Dreamed Movement Elicits Activation in the Sensorimotor Cortex



fMRI (N=2)

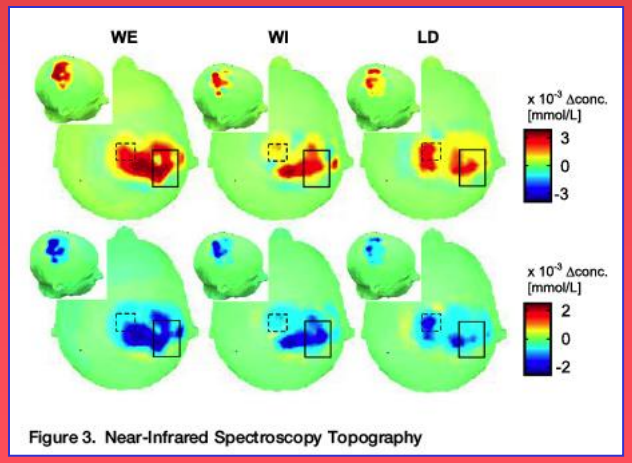
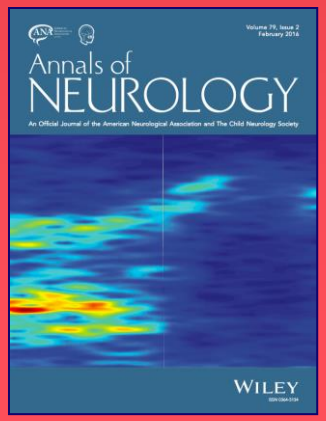


Figure 3. Near-Infrared Spectroscopy Topography

NIRS (N=2)

La sovrapponibilità delle aree attivate durante la chiusura del pugno all'interno di un sogno con le corrispondenti aree attivate durante la veglia si colloca nella stessa direzione indicata dalla corrispondenza tra attività elettrica della corteccia motoria in REM fasico (con movimenti oculari) e quella associata all'inizio di un movimento intenzionale durante la veglia



Activation of the Motor Cortex during Phasic Rapid Eye Movement Sleep

Fabrizio De Carli, MSc,[1]
Paola Proserpio, MD,[2]
Elisa Morrone, PhD,[3] Ivana Sartori, MD,[2]
Michele Ferrara, PhD,[4]
Steve Alex Gibbs, MD, PhD,[2]
Luigi De Gennaro, PhD,[5]
Giorgio Lo Russo, MD,[2] and
Lino Nobili MD, PhD[1,2]

Sciencexpress

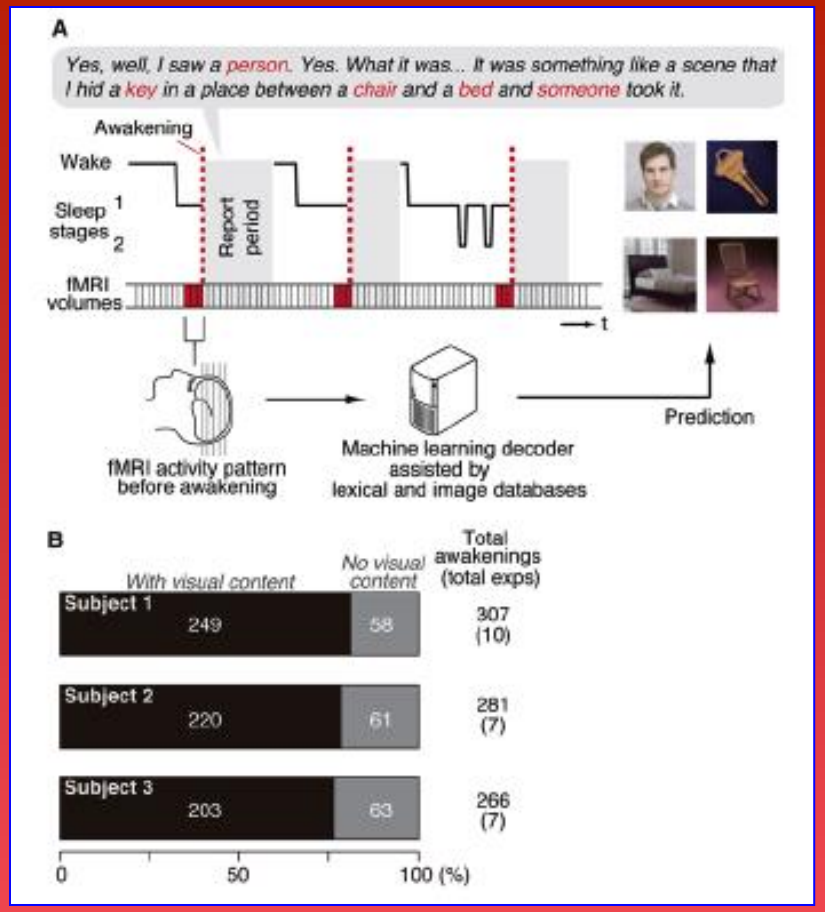
Neural Decoding of Visual Imagery During Sleep

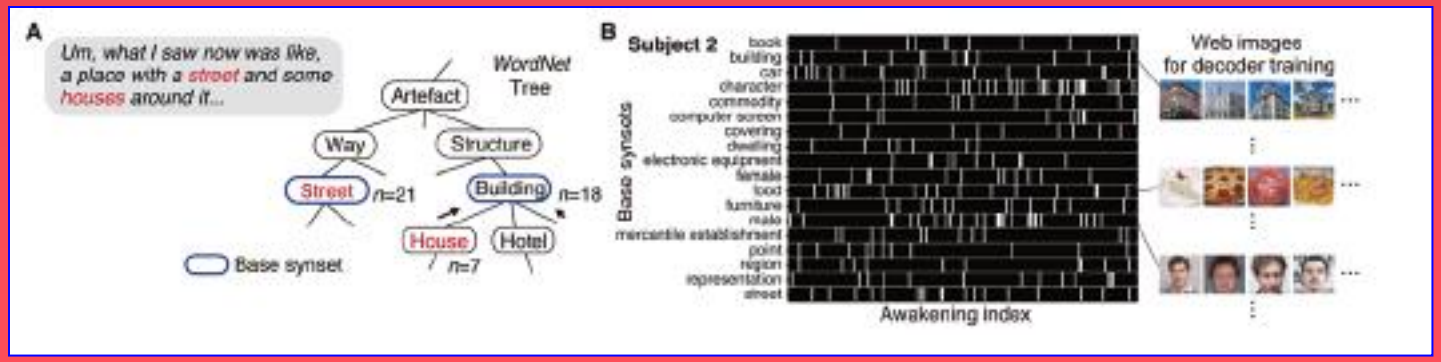
T. Horikawa,[1,2] M. Tamaki,[1*] Y. Miyawaki,[3,1†] Y. Kamitani,[1,2‡]

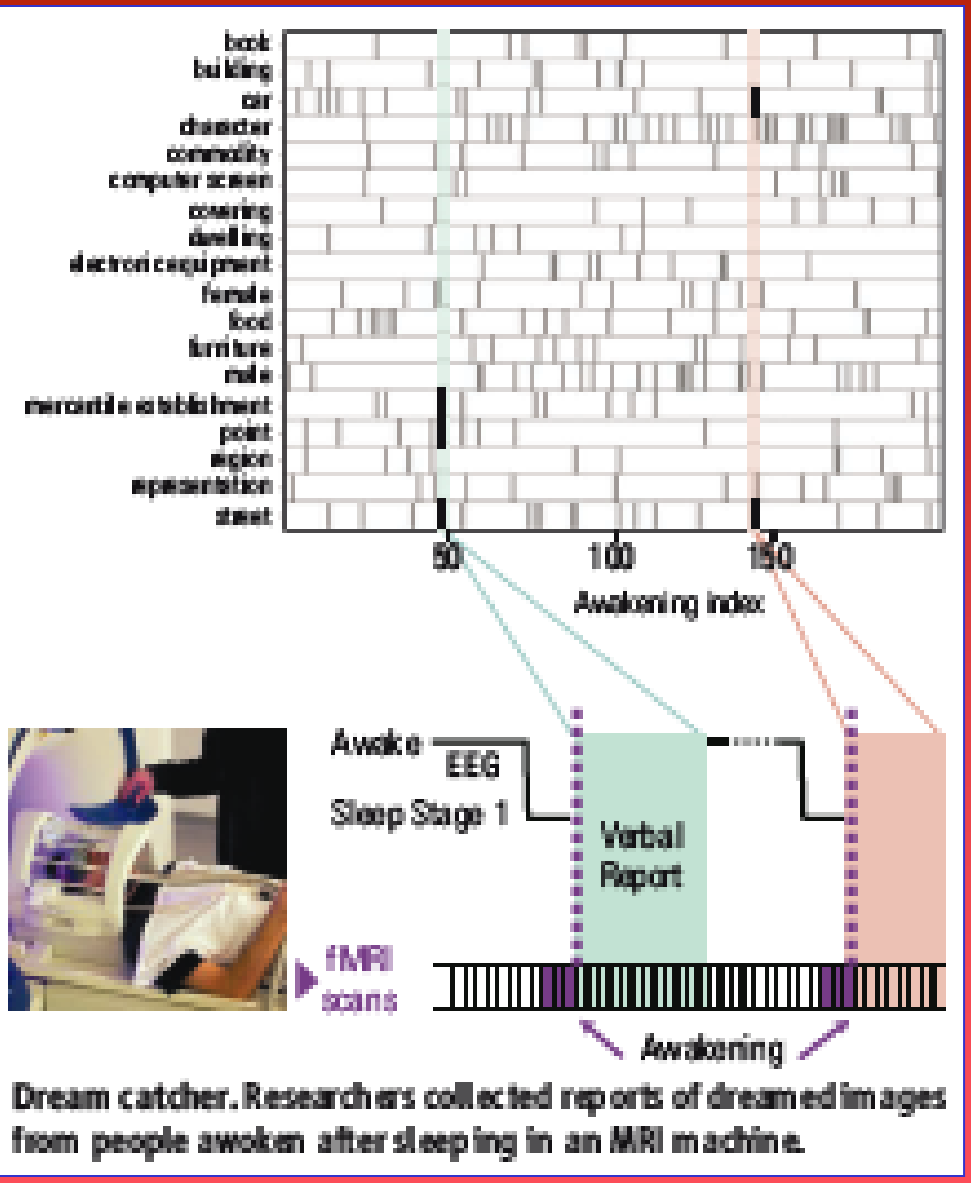
NEUROSCIENCE

How to Build a Dream-Reading Machine

Dream reading?

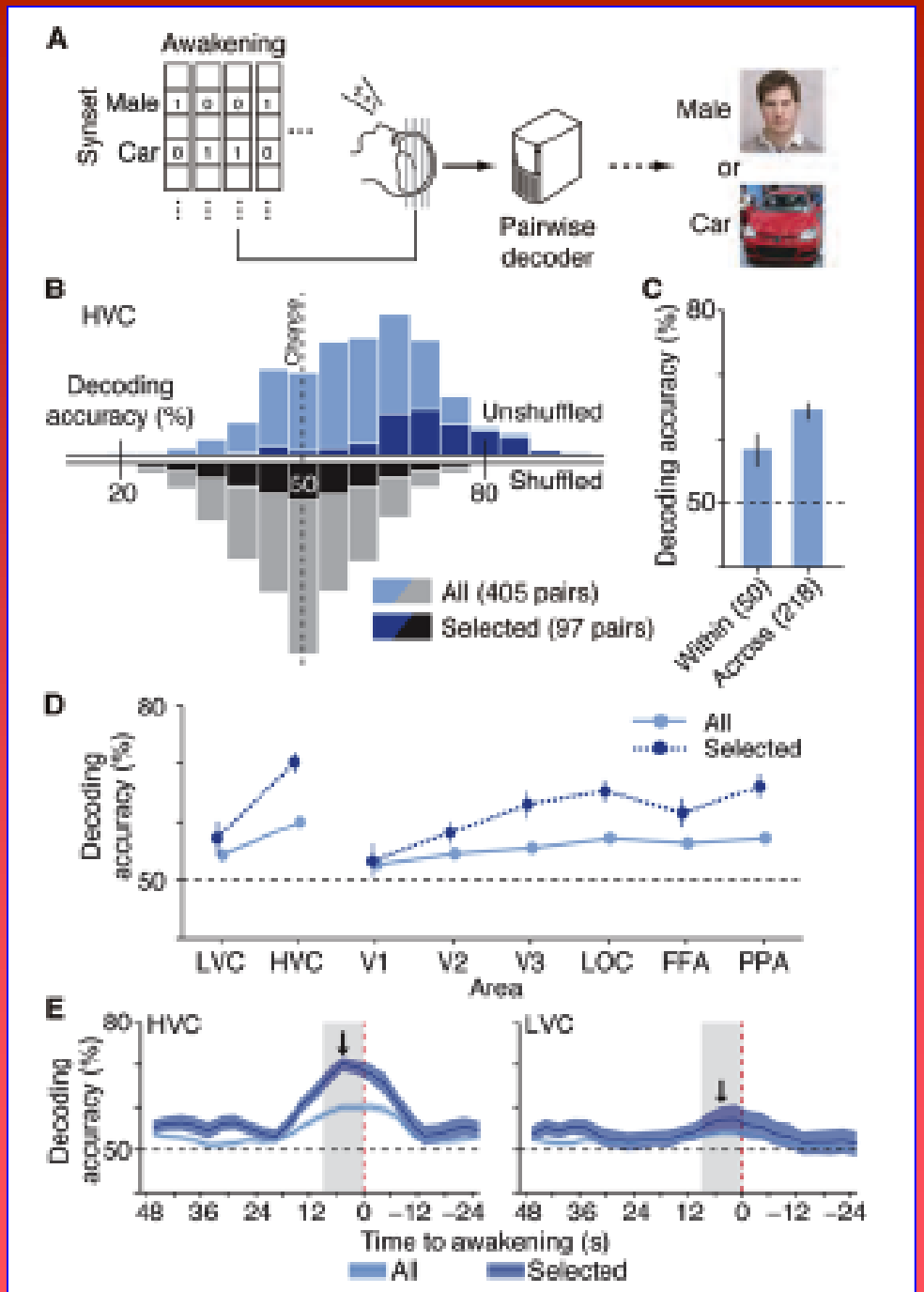






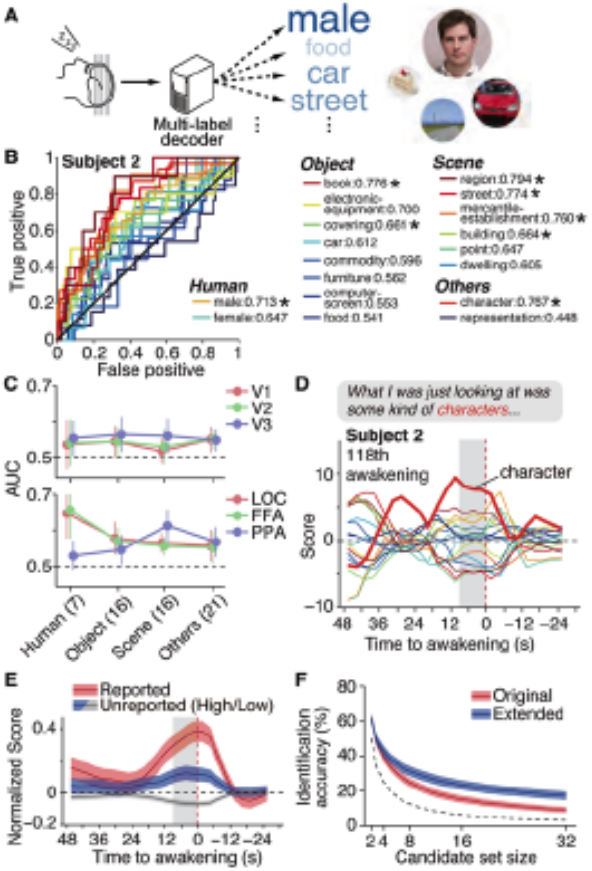
Dream catcher. Researchers collected reports of dreamed images from people awoken after sleeping in an MRI machine.

Dream catcher?

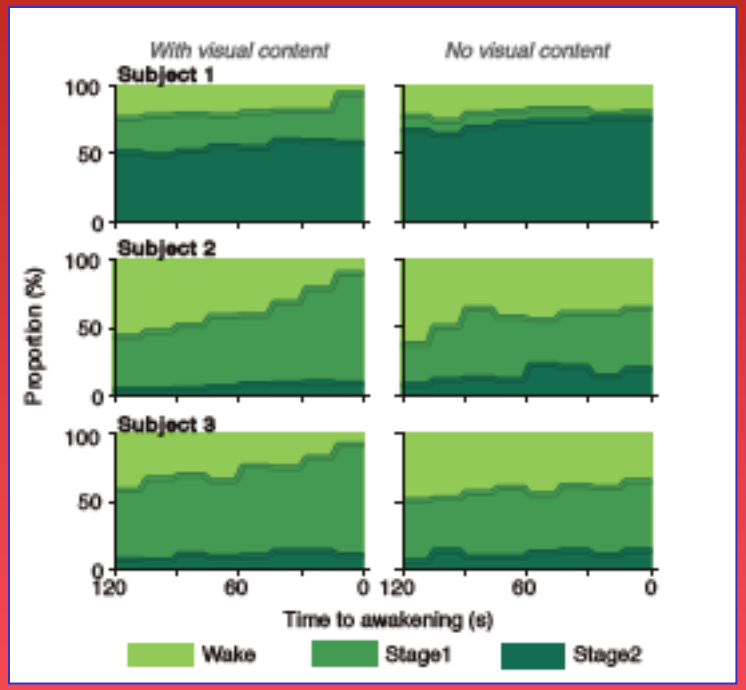


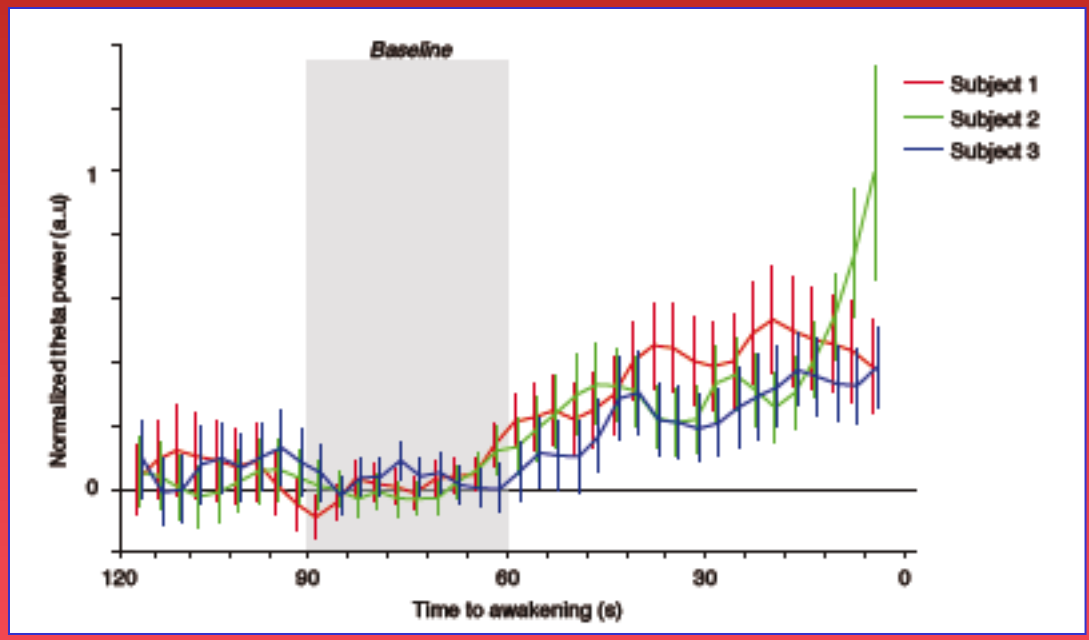
Elevata accuratezza nella predizione sulle caratteristiche del “sogno” sulla base dei pattern di attività metabolica rilevati

Fig. 4. Multilabel decoding. (**A**) Schematic overview. (**B**) ROC curves (left) and AUCs (right) are shown for each synset (subject 2; asterisks, Wilcoxon rank-sum test, $P < 0.05$). (**C**) AUC averaged within meta-categories for different visual areas (three subjects pooled; numbers of synsets in parentheses). (**D**) Example time course of synset scores for a single sleep sample (subject 2, 118th; color legend as in (B); reported synset, *character*, in bold). (**E**) Time course of averaged synset scores for reported synsets (red) and unreported synsets with high/low (blue/gray) co-occurrence with reported synsets (averaged across awakenings and subjects). Scores are normalized by the mean magnitude in each subject. (**F**) Identification analysis. Accuracies are plotted against candidate set size for original and extended visual content vectors (averaged across awakenings and subjects). Because Pearson's correlation coefficient could not be calculated for vectors with identical elements, such samples were excluded. For all results, error bars or shades indicate 95% CI, and dashed lines denote chance level.



Specificità metabolica di alcune aree per categorie di immagini o parole





Ma si tratta davvero di "sogno"?

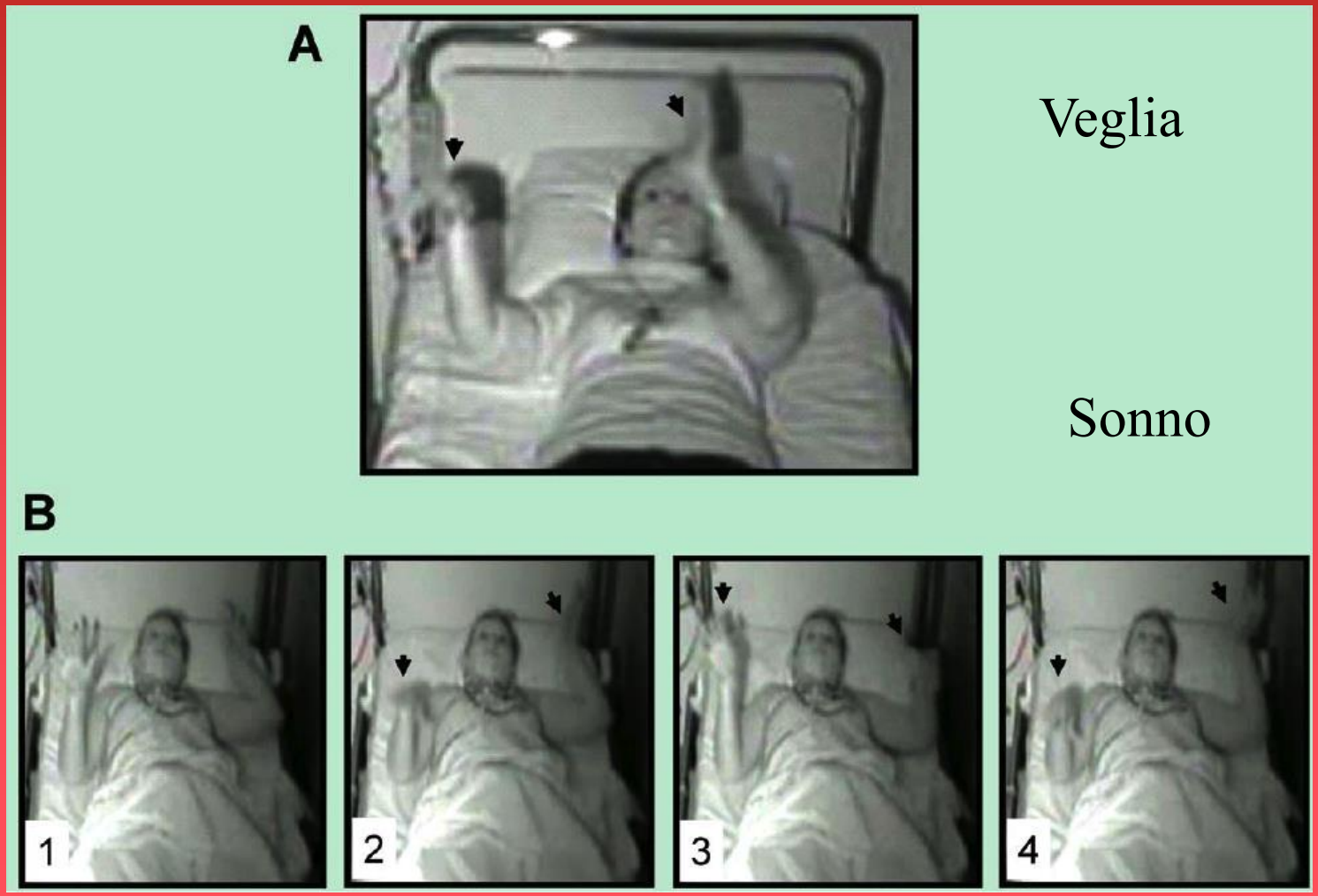
Una strategia diversa per risolvere il dilemma del gatto di Schroedinger


23- 8-96 L24H
2:26:17

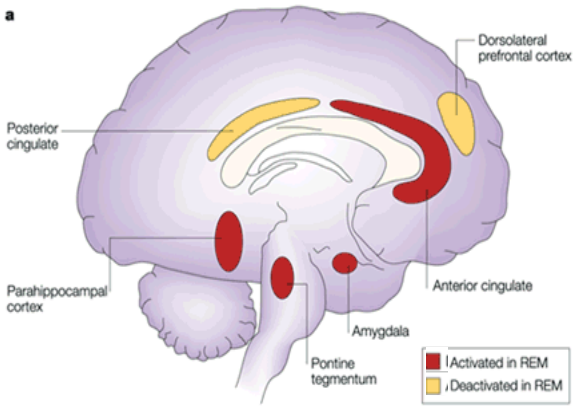
OPEN ACCESS Freely available online PLoS one

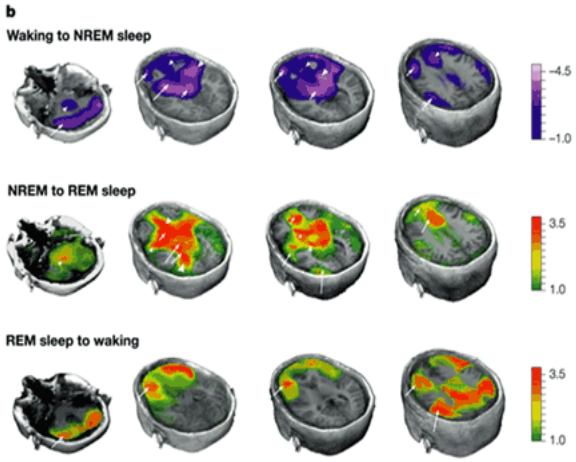
Evidence for the Re-Enactment of a Recently Learned Behavior during Sleepwalking

Delphine Oudiette[1,3*], Irina Constantinescu[4,5], Laurène Leclair-Visonneau[1,3], Marie Vidailhet[2,3], Sophie Schwartz[4,5], Isabelle Arnulf[1,2,3]

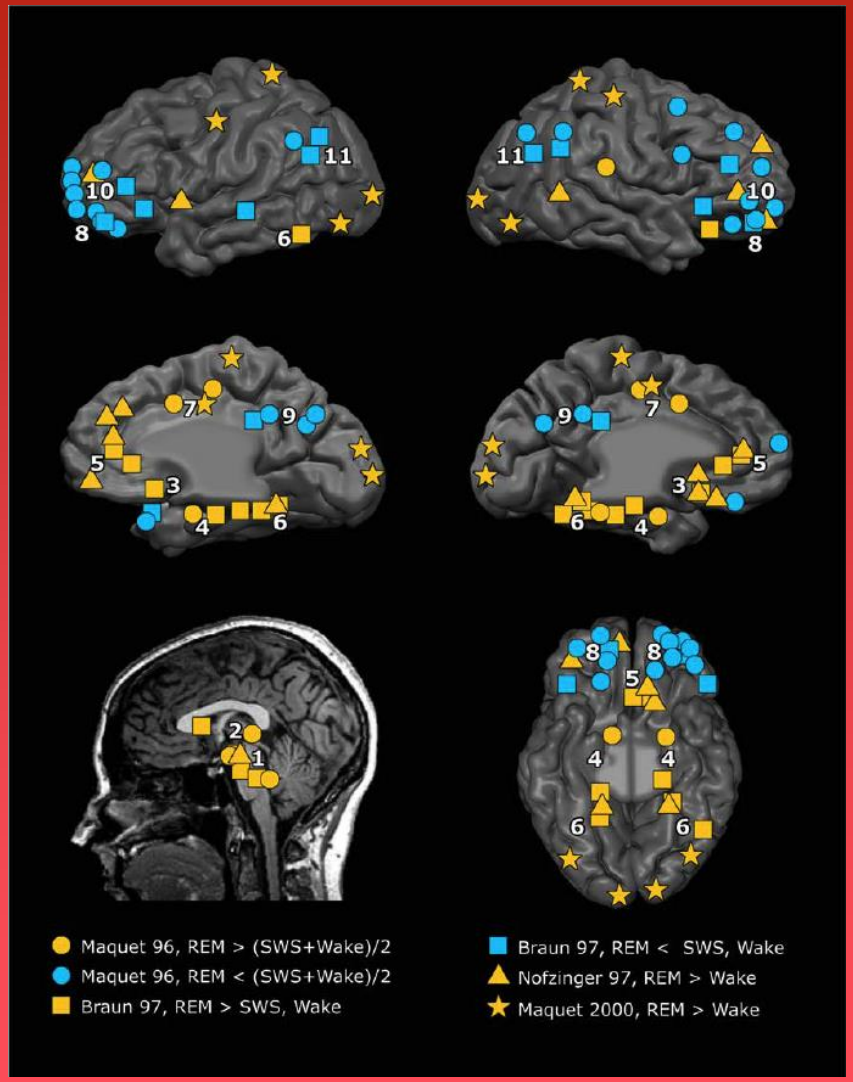


Part 1: Execution of the structured sequence by a waking control





Nature Reviews | Neuroscience



QUALI SONO GLI ARGOMENTI NON COERENTI CON L'IPOTESI DI UNA STRETTA SOVRAPPONIBILITÀ/COINCIDENZA TRA FASI REM DEL SONNO E ESPERIENZA ONIRICA?

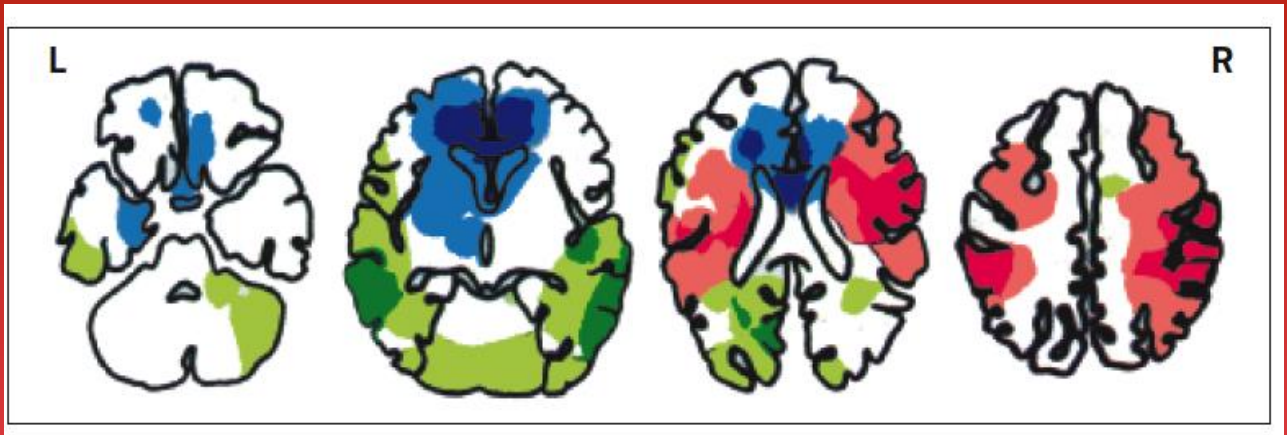
- Si ottengono **resoconti di sogno** (seppur con diversa frequenza), **al risveglio da qualsiasi fase del sonno**, in addormentamento, in stadio 2, in *Slow-Wave-Sleep* (SWS); oltre alle differenze quantitative (di frequenza di resoconti di sogno) ci sono una serie di differenze anche qualitative, cioè relative alle caratteristiche dei resoconti NREM (più brevi, più *thought-like*, meno bizzarri, a minor carico visivo)

- Almeno un **caso di una lesione pontina** da proiettile documenta la totale assenza di REM da circa 20 anni con preservata attività onirica

- Pazienti **depressi in trattamento** con diverse classi farmacologiche REM-depressive o REM-soppressive non eliminano/riducono l'attività onirica (anche per i normali, Landolt et al. *Arch Gen Psychiat* 2001)

- La maggior parte dei casi di **scomparsa totale di attività onirica** non é associata a riduzione/scomparsa di REM

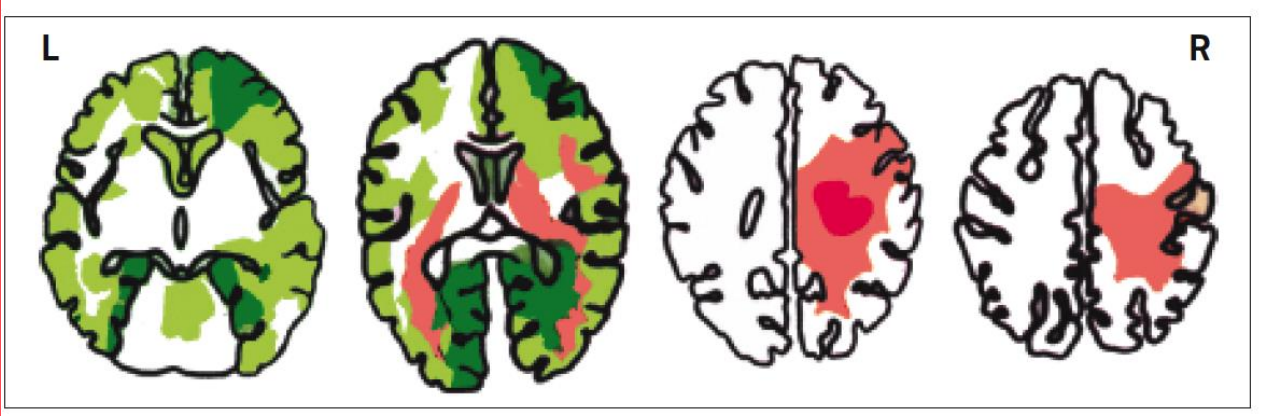
- Le variazioni quantitative di **REM non correlano con la frequenza di *dream recall***



Anoneria globale:

cessazione completa dell'esperienza onirica

- 6 cases with parietal lobe lesions (inferior lobule and supramarginal gyrus; red),
- 9 cases with deep frontal lesions (blue),
- 8 cases with posterior lesions, close to parietal lobes (green)



Anoneria visiva:

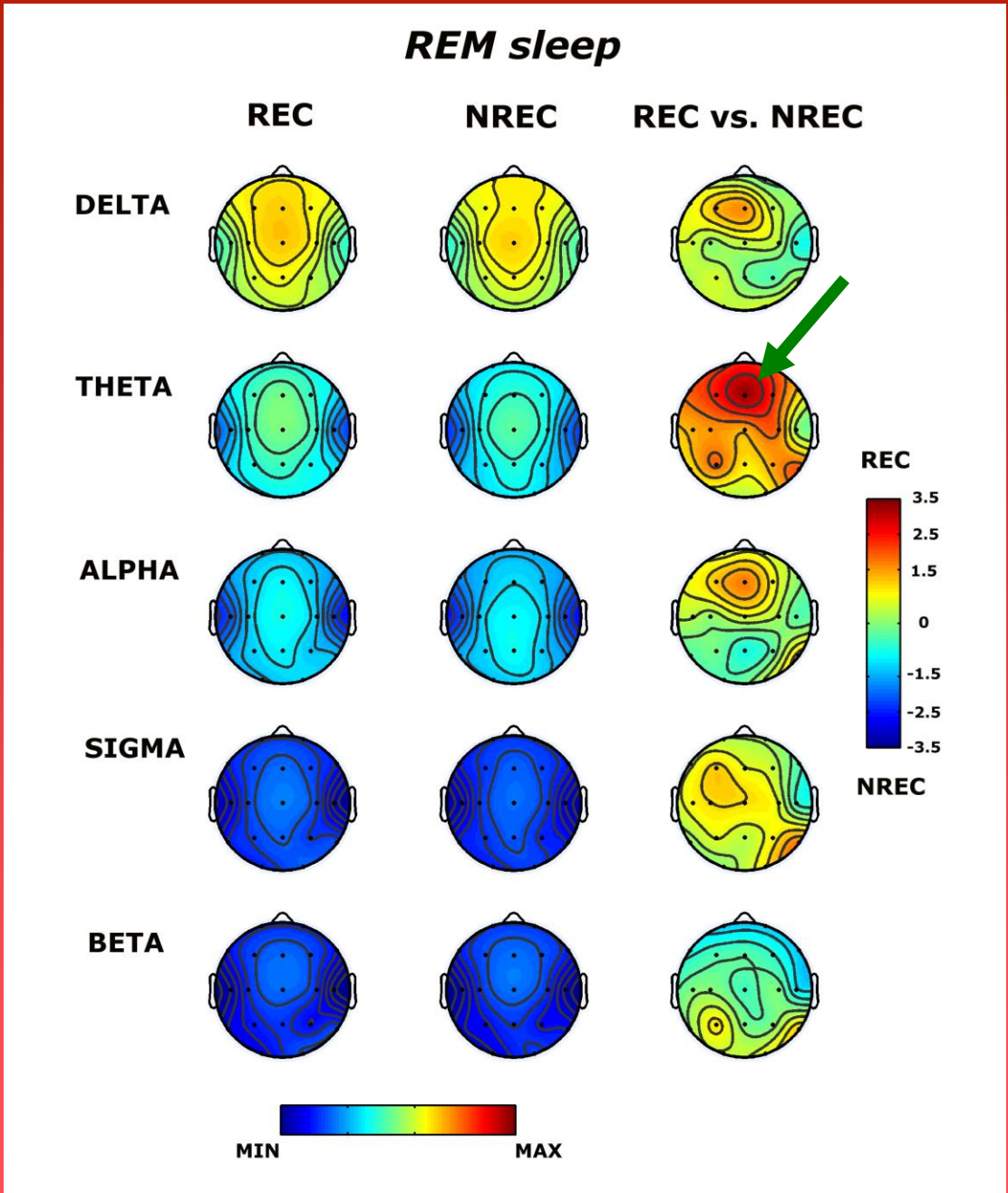
riduzione o cessazione dei sogni visivi

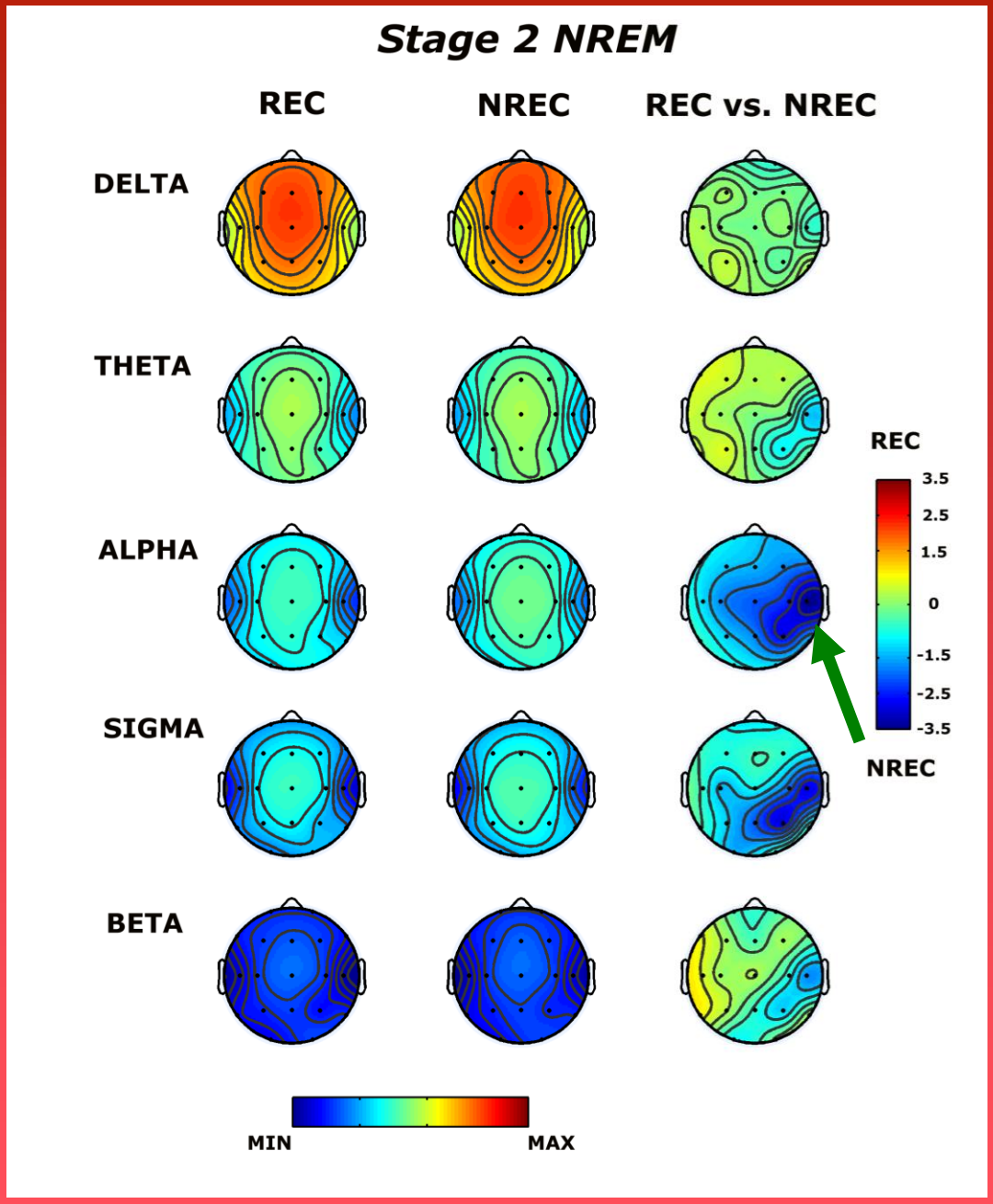
- Reduction of dream-imagery vividness occurred in 21 cases with preponderant medial occipito-temporal-limbic lesions (green)

- Cessation of visual dreaming was found in one case with right parietal arterio-venous malformation and bilateral oedema (red)

Solms 1997

L'attività elettrica cerebrale (EEG) ci permette di spiegare il ricordo e l'oblio dei sogni? Ricordo e oblio del sogno sono simili a ricordo e oblio della veglia?




Stage 2 NREM
REC
NREC
REC vs. NREC
DELTA
THETA
ALPHA
SIGMA
BETA
REC
3.5
2.5
1.5
0
-1.5
-2.5
-3.5
NREC
MIN
MAX