Journées Lilloises d'Anesthésie-Réanimation et Médecine d'Urgence

JLARMU

Jeudi 3 avril 2014

Lille

Vincent Bonhomme

CHU de Liège et CHR de la Citadelle, Belgique

MONITORAGE DE LA PROFONDEUR DE L'ANESTHÉSIE

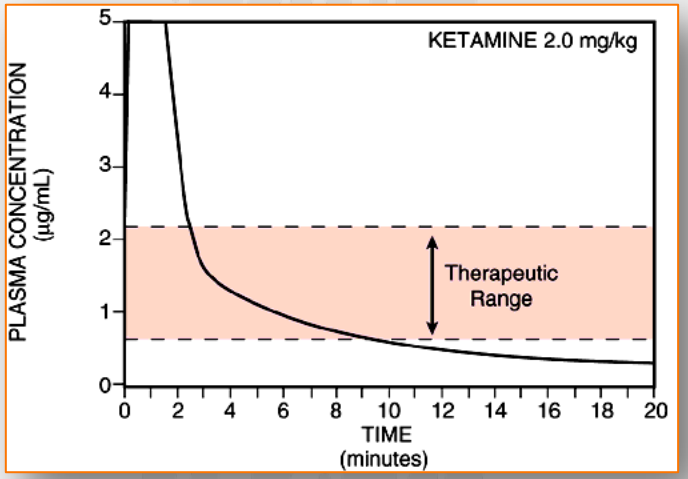
POURQUOI?

1. Ajustement individuel de l’anesthésie
2. Prévention d’un défaut

POURQUOI?

1. Ajustement individuel

Dose ⇔ Concentration ⇔ Réponse



Effets pharmacodynamiques

Modulation de la conscience

Relaxation musculaire

Anti-nociception

…

Variabilité interindividuelle

Pharmacocinétique

Pharmacodynamique

Interactions

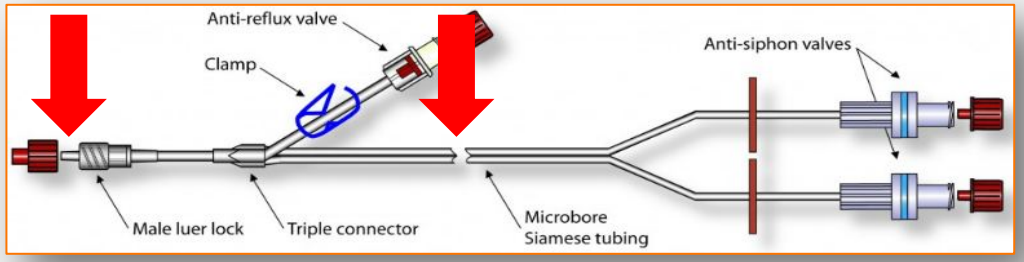
POURQUOI?

http://web.squ.edu.om/med-Lib/MED_CD/E_CDs/anesthesia/site/content/v02/020258r00.htm

2. Prévention d'un défaut

- **Déconnexions**
- **Vaporisateur vide**
- **Défaut de pompe**
- **Surdosage**
- **…**

POURQUOI?

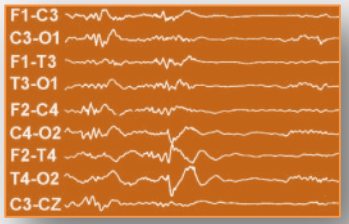


Mesurer quelque-chose …

- **Alarmes**
- **Balance individuelle**

Trop léger

Trop profond



POURQUOI?

Cela en vaut-il la peine?

- **Anti-nociception**
  - **Trop légère**
    - **Répercutions hémodynamiques**
    - **Augmentation du stress chirurgical**
    - **Mouvements**
  - **Trop profonde**
    - **Réveil retardé**
    - **Tolérance aigüe**
    - **Effets à long terme (immunité?)**

POURQUOI?

Cela en vaut-il la peine?

- **Modulation de la conscience**
  - **Trop légère = éveil accidentel**

Type de chirurgie	Incidence
Toutes	0.2 %
Haut risque	
Fragile	Césarienne
Trauma	Instabilité hémodynamique

POURQUOI?

Cela en vaut-il la peine?

- **Modulation de la conscience**
  - **Trop légère = éveil accidentel**

Conséquences	
Mouvements	Réponse hémodynamique
Psychologique	DSPT (PTSD)

POURQUOI?

Cela en vaut-il la peine?

- **Modulation de la conscience**
  - **Trop profonde ?**
    - **Durée cumulée trop profonde (BIS < 45)**
      - **Morbidité – mortalité à 1 ou 2 ans**
        - **IM – accident cérébrovasculaire**
        - **Independent de l'hypotension**
        - **Non lié à une dose plus importante**

Anesthetic Management and One-Year Mortality After Noncardiac Surgery

Terri G. Monk, MD, MS*, Vikas Saini, MD, FACC†, B. Craig Weldon, MD*, and Jeffrey C. Sigl, PhD‡

*Department of Anesthesiology, Duke University Medical Center, Durham, North Carolina, †The Cardiovascular Specialists LLC, Hyannis, Massachusetts, ‡Aspect Medical Systems, Newton, Massachusetts

Little is known about the effect of anesthetic management on long-term outcomes. We designed a prospective observational study of adult patients undergoing major noncardiac surgery with general anesthesia to determine if mortality in the first year after surgery is associated with demographic, preoperative clinical, surgical, or intraoperative variables. One-year mortality was 5.5% in all patients ($n = 1064$) and 10.3% in patients ≥65 yr old ($n = 243$). Multivariate Cox Proportional Hazards modeling identified three variables as significant independent predictors of mortality: patient comorbidity (relative risk, 16.116; $P < 0.0001$), cumulative deep hypnotic time (Bispectral Index® <45) (relative risk = 1.244/h; $P = 0.0121$) and intraoperative systolic hypotension (relative risk = 1.036/min; $P = 0.0125$). Death during the first year after surgery is primarily associated with the natural history of preexisting conditions. However, cumulative deep hypnotic time and intraoperative hypotension were also significant, independent predictors of increased mortality. These associations suggest that intraoperative anesthetic management may affect outcomes over longer time periods than previously appreciated.

(Anesth Analg 2005;100:4–10)

Anesthesiology 2010; 112:1116–27
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Association of Perioperative Risk Factors and Cumulative Duration of Low Bispectral Index with Intermediate-term Mortality after Cardiac Surgery in the B-Unaware Trial

Miklos D. Kertai, M.D., Ph.D.,* Nirvik Pal, M.D.,* Ben J. A. Palanca, M.D., Ph.D.,† Nan Lin, Ph.D.,‡ Sylvia A. Searleman, B.S.,§ Lini Zhang, M.D.,§ Beth A. Burnside, B.A.,§ Kevin J. Finkel, M.D.,‖ Michael S. Avidan, M.B., B.Ch., F.C.A.S.A.#; on behalf of the B-Unaware Study Group**

The Effect of Bispectral Index Monitoring on Long-Term Survival in the B-Aware Trial

Kate Leslie, MBBS, MD, MEpi, FANZCA,*† Paul S. Myles, MBBS, MD, MPH, FANZCA, FCARSCI, FRCA,†§‖ Andrew Forbes, MSc, PhD,¶ Matthew T. V. Chan, MBBS, FANZCA#

BACKGROUND: When anesthesia is titrated using bispectral index (BIS) monitoring, patients generally receive lower doses of hypnotic drugs. Intraoperative hypotension and organ toxicity might be avoided if lower doses of anesthetics are administered, but whether this translates into a reduction in serious morbidity or mortality remains controversial. The B-Aware Trial randomly allocated 2463 patients at high risk of awareness to BIS-guided anesthesia or routine care. We tested the hypothesis that the risks of death, myocardial infarction (MI), and stroke would be lower in patients allocated to BIS-guided management than in those allocated to routine care.
METHODS: The medical records of all patients who had not died within 30 days of surgery were reviewed. The date and cause of death and occurrence of MI or stroke were recorded. A telephone interview was then conducted with all surviving patients. The primary end point of the study was survival.
RESULTS: The median follow-up time was 4.1 (range: 0–6.5) years. Five hundred forty-eight patients (22.2%) had died since the index surgery, 220 patients (8.9%) had an MI, and 115 patients (4.7%) had a stroke. The risk of death in BIS patients was not significantly different than in routine care patients (hazard ratio = 0.86 [95% confidence interval (CI): 0.72–1.01]; $P = 0.07$). However, propensity score analysis indicated that the hazard ratio for death in patients who recorded BIS values <40 for >5 min compared with other BIS-monitored patients was 1.41 (95% CI: 1.02–1.95; $P = 0.039$). In addition, the odds ratios for MI in patients who recorded BIS values <40 for >5 min compared with other BIS-monitored patients was 1.94 (95% CI: 1.12–3.35; $P = 0.02$) and the odds ratio for stroke was 3.23 (95% CI: 1.29–8.07; $P = 0.01$).
CONCLUSIONS: Monitoring with BIS and absence of BIS values <40 for >5 min were associated with improved survival and reduced morbidity in patients enrolled in the B-Aware Trial. (Anesth Analg 2010;110:918–22)

Mortality Within 2 Years After Surgery in Relation to Low Intraoperative Bispectral Index Values and Preexisting Malignant Disease

Maj-Lis Lindholm, PhD, RN*
Stefan Traff, MD†
Fredrik Granath, PhD‡
Scott D. Greenwald, PhD§
Anders Ekbom, MD, PhD‖
Claes Lennmarken, MD, PhD#
Rolf H. Sandin, MD, PhD*

BACKGROUND: A correlation between deep anesthesia (defined as time with Bispectral Index (BIS) <45; $T_{BIS<45}$) and death within 1 yr after surgery has previously been reported. In order to confirm or refute these findings, we evaluated $T_{BIS<45}$ as an independent risk factor for death within 1 and 2 yr after surgery and also the impact of malignancy, the predominant cause of death in the previous report.
METHODS: Mortality within 2 yr after surgery, causes of death and the occurrence of malignant disease at the time of surgery were identified in a cohort of 4087 BIS-monitored patients. Statistically significant univariate predictors of mortality were identified. In order to allow for comparison with previous data, the following multivariate analysis was first done without, and thereafter with, preexisting malignancy status, the predominant cause of death.
RESULTS: One-hundred-seventy-four (4.3%) patients died within 1 yr and another 92 during the second year (totaling 6.5% in 2 yr). $T_{BIS<45}$ was a significant predictor of 1- and 2-yr mortality when preexisting malignant disease was not among the co-variates (hazard ratio [HR] 1.33 [1.05–1.27] and 1.28 [1.08–1.26], respectively). Further exploration confined the significant relation between postoperative mortality and $T_{BIS<45}$ to patients with preexisting malignant diagnoses associated with extensive surgery and less favorable prognosis. The most powerful predictors of 2-yr mortality in the model, including preexisting malignancy, were ASA physical score class IV (HR 30.3 [7.31–51.1]), age >80 yr (HR 2.93 [1.79–4.79]), and preexisting malignancy associated with less favorable prognosis (HR 9.38 [6.60–13.1]). When the initial multivariate regression was repeated using preexisting malignancy status among the co-variates in the model, the previously significant relation between 1, and 2-yr mortality and $T_{BIS<45}$ did not reach statistical significance.
CONCLUSION: Using a similar set of co-variates as in previous work, we confirmed the statistical relation between 1-yr mortality and $T_{BIS<45}$ and we extended this observation to 2-yr mortality. However, this relation is sensitive to the selection of co-variates in the statistical model, and a randomized study is required to demonstrate that there really is a causal impact from and $T_{BIS<45}$ on postoperative mortality and, if it does, the effect is probably very weak in comparison with co-morbidity as assessed by ASA physical score, the preexisting malignancy status at surgery and age.
(Anesth Analg 2008;106:848–55)

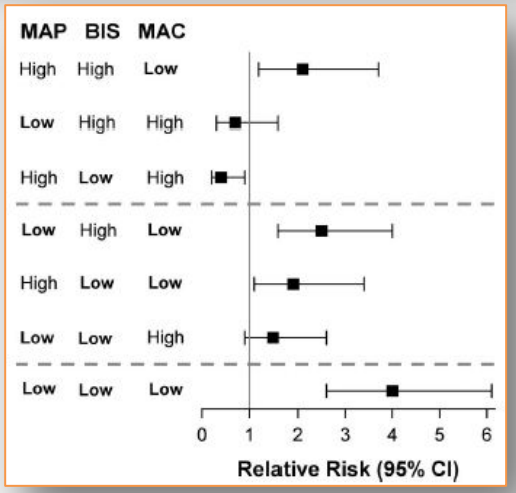
POURQUOI?

Cela en vaut-il la peine?

- **Modulation de la conscience**
  - **Trop profonde ?**
    - **Concept du 'Tripple Low'**
      - **'Low BIS'**
      - **'Low blood pressure'**
      - **'Low ETAC'**

Hospital Stay and Mortality Are Increased in Patients Having a "Triple Low" of Low Blood Pressure, Low Bispectral Index, and Low Minimum Alveolar Concentration of Volatile Anesthesia

Daniel I. Sessler, M.D.,* Jeffrey C. Sigl, Ph.D.,† Scott D. Kelley, M.D.,‡ Nassib G. Chamoun, M.S.,§ Paul J. Manberg, Ph.D.,‖ Leif Saager, M.D.,# Andrea Kurz, M.D.,** Scott Greenwald, Ph.D.††



POURQUOI?

Sessler et al. Anesthesiology 2012

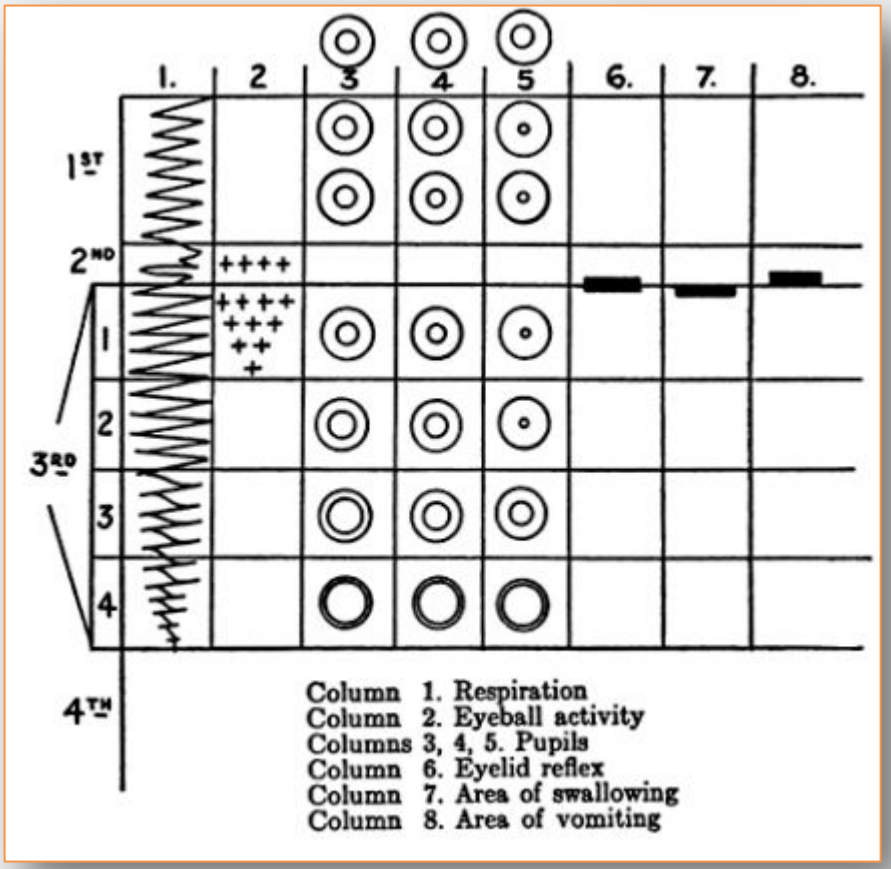
COMMENT?

1. Passé
2. Présent
3. Futur

COMMENT?

1. Passé

Evaluation clinique



Guedel 1937

COMMENT?

1. Passé

Evaluation clinique

- Faible sensibilité
- Faible spécificité

COMMENT?

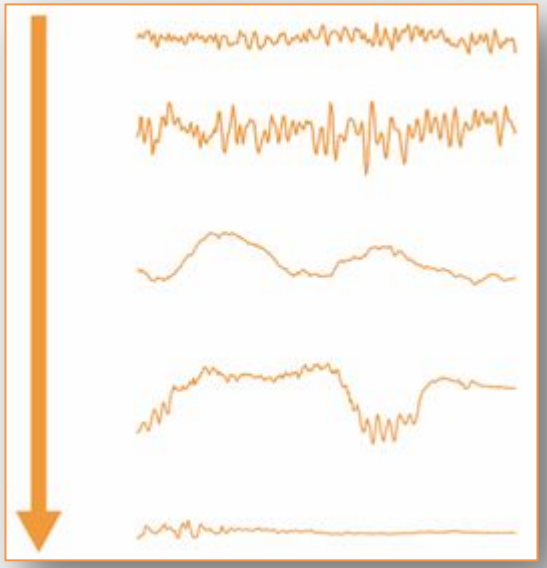
2. Présent

- **Composante hypnotique**

COMMENT?

EEG

Profondeur de la sédation



Eveil

Activation beta

Ralentissement delta

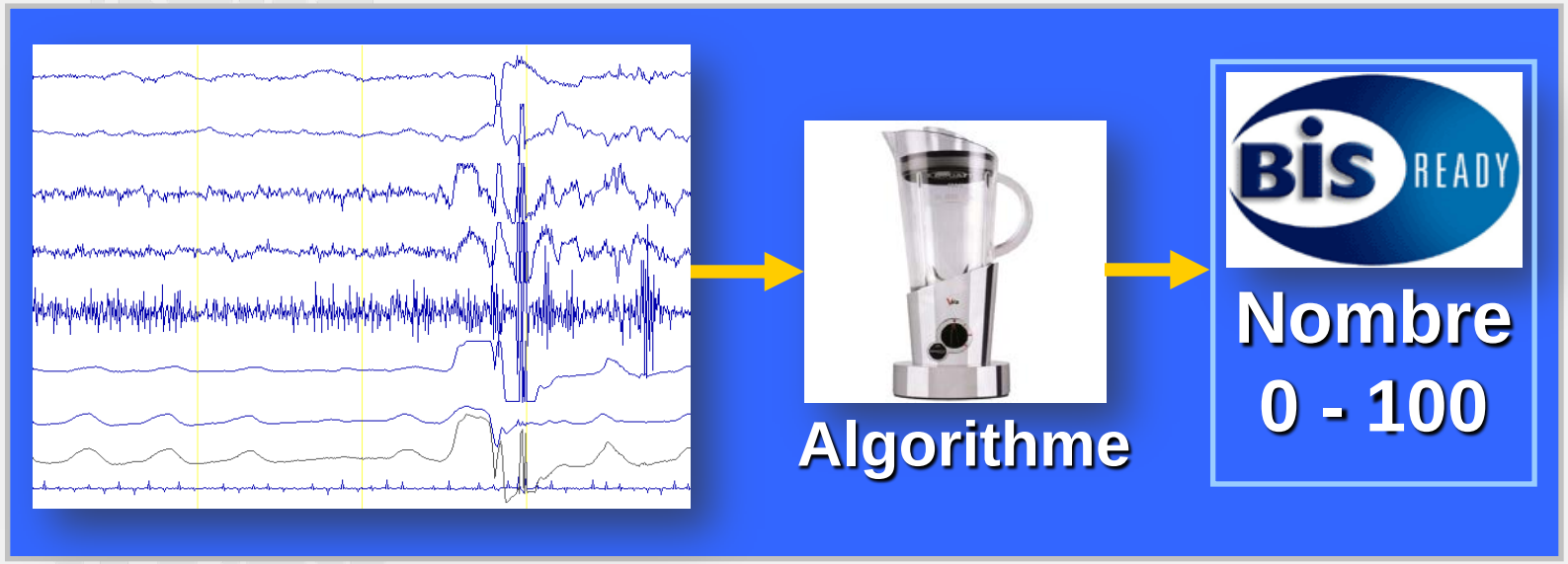
Burst-suppression

Plat

Tonner et Bein Best Pract Res Clin Anaesthesiol 2006

2. Présent

- Composante hypnotique

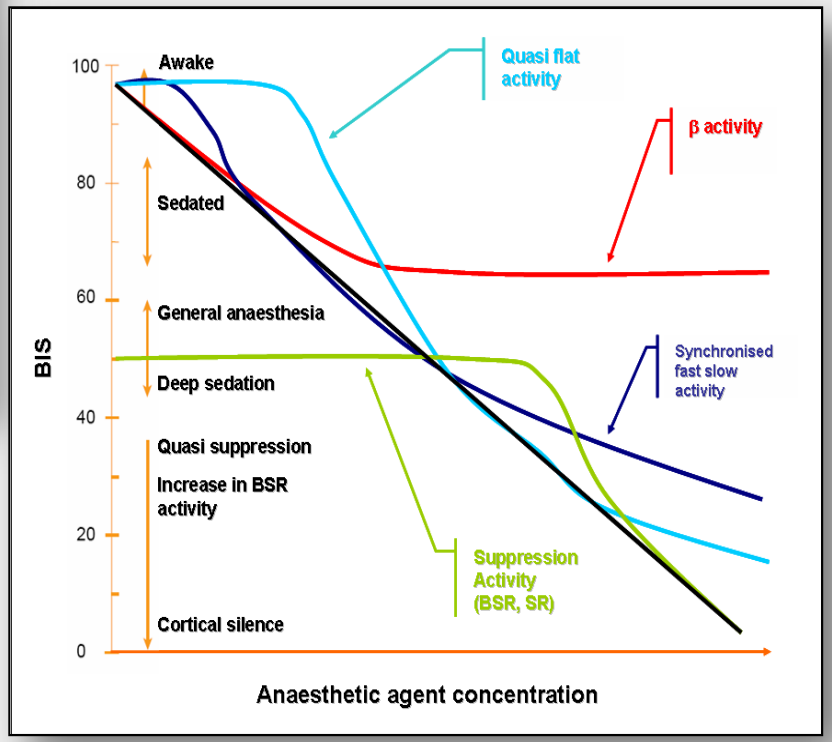


COMMENT?

2. Présent

- Composante hypnotique

Index Bispectral



COMMENT?

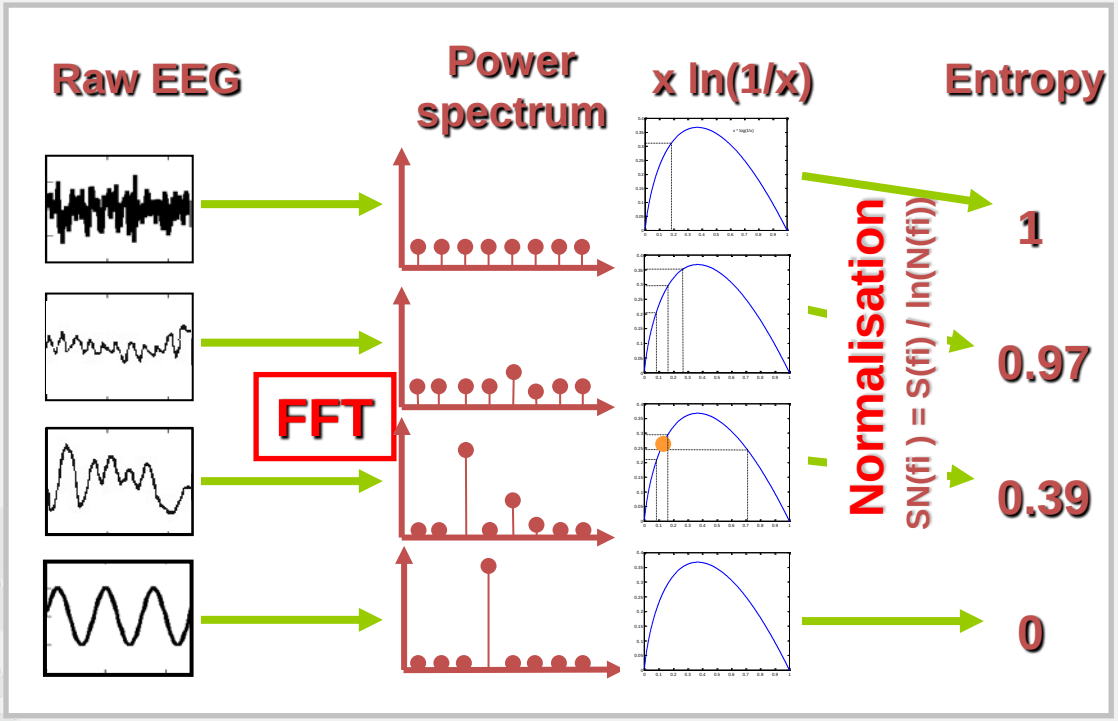
2. Présent

- **Composante hypnotique**

'M-Entropy' – Entropie Spectrale de l'EEG

'State Entropy' (SE) – 'Response Entropy' (RE)

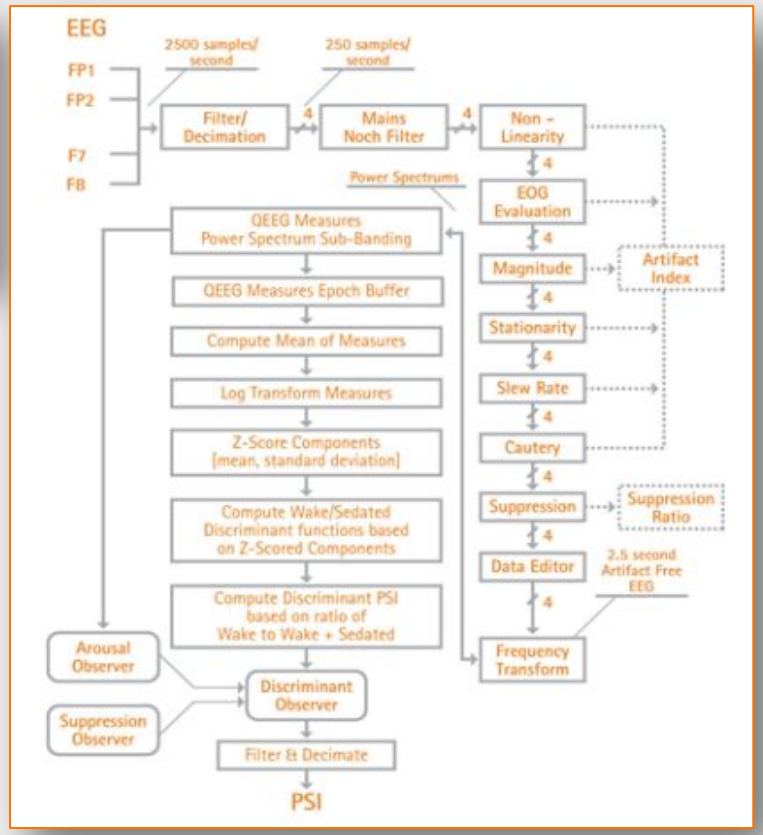
COMMENT?



2. Présent

- Composante hypnotique

SedLine – Patient State Index (PSI)



COMMENT?

2. Présent

- **Composante hypnotique**

Cerebral State Monitor (CSM)

Cerebral State Index (CSI)

1. β ratio $= \log \frac{E_{30\text{–}42.5\ Hz}}{E_{11\text{–}21\ Hz}}$
2. α ratio $= \log \frac{E_{30\text{–}42.5\ Hz}}{E_{6\text{–}12\ Hz}}$
3. β-α ratio $= \log \frac{E_{6\text{–}12\ Hz}}{E_{11\text{–}21\ Hz}}$
4. Burst suppression ratio (percentage of time in a 30-second window where the EEG amplitude is $<3.5\ \mu V$).

COMMENT?

Pilge et al Anesth Analg 2011

2. Présent

- **Composante hypnotique**

Narcotrend

COMMENT?

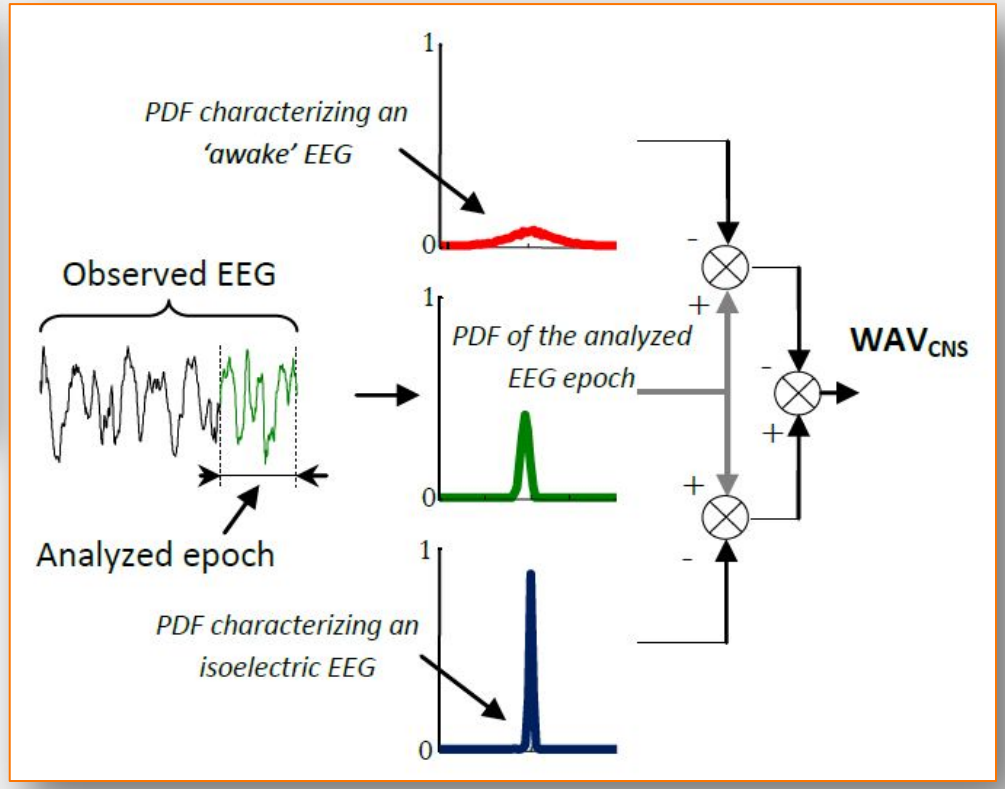
Depth of hypnosis	Leading EEG features	EEG stage	Range of Narcotrend Index
Awake	Alpha waves, typical artefacts	A	100–95
		B_0	94–90
	Beta waves, theta waves	B_1	89–85
		B_2	84–80
Light		C_0	79–75
	Increasing amount of theta waves	C_1	74–70
		C_2	69–65
		D_0	64–57
	Increasing amount of delta waves	D_1	56–47
		D_2	46–37
Deep	Continuous high delta activity	E_0	36–27
		E_1	26–20
	Transition to burst suppression	E_2	19–13
	Burst suppression activity	F_0	12–5
Very deep	Continuous EEG suppression	F_1	4–0

Schultz et al J Clin Monit Comp 2008

2. Présent

- **Composante hypnotique**

NeuroSense - WAV_{CNS}



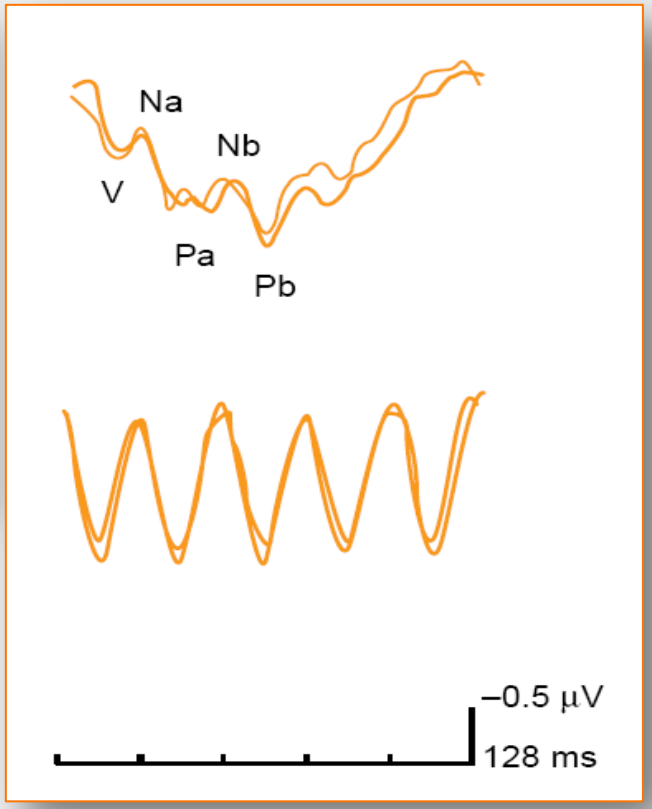
COMMENT?

http://www.neurowavesystems.com/pdfs/NeuroSENSE_WhitePaper_July2013.pdf

2. Présent

- Composante hypnotique

aepEX

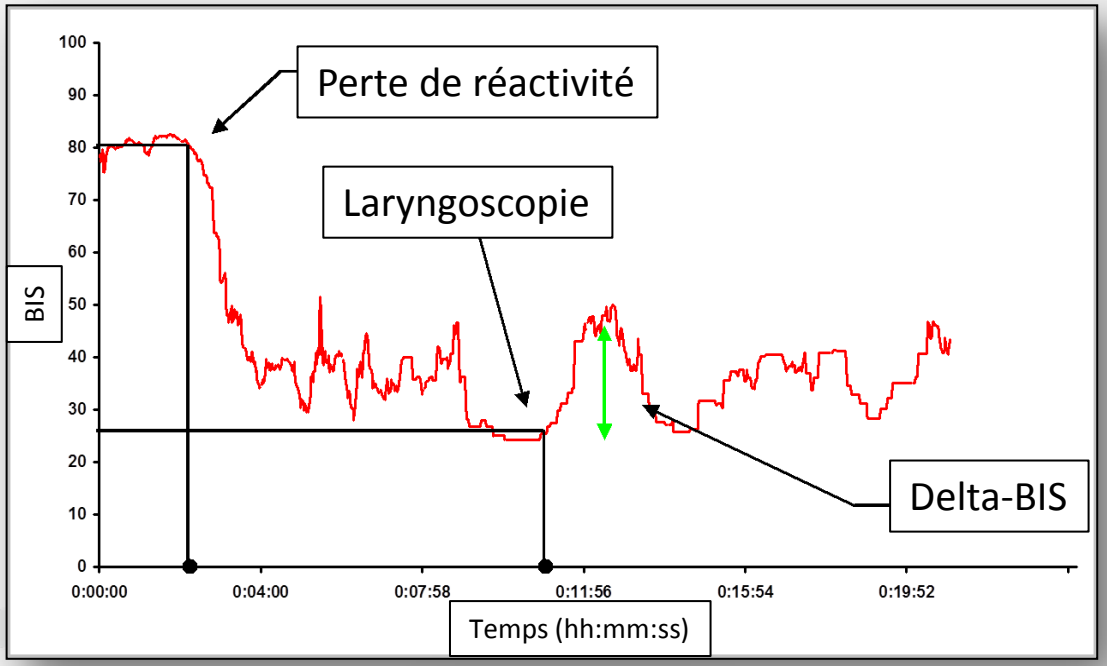


COMMENT?

2. Présent

- Composante hypnotique

Mode d'utilisation



COMMENT?

2. Présent

- Composante hypnotique

Arrive-t-on à nos fins?

Prévention du réveil accidentel avec mémorisation

Pas évident

COMMENT?

Table 1. Definite Awareness Events in Prospective Clinical Trials

Study	Design	Comparison Groups	Estimated Definite AWR Reduction or Increase with BIS Protocol	Precision (95% CI)	Comments
Ekman *et al.* 2004[13]	Prospective Cohort	Initial control cohort treated with routine care. Subsequent intervention cohort treated with BIS-guided protocol	ARR = 0.14% NNTB = 722 • 14/7826 (0.18%) in control group • 2/4945 (0.04%) in BIS group	ARR = 0.01% to 0.26% NNTB = 10657 to 380	• Cohorts not concurrent • Only 80% of control cohort had ETAC monitoring • BIS superior
B-Aware Trial 2004[14]	Multicenter RCT	BIS-guided protocol *versus* routine anesthetic care	ARR = 0.73% NNTB = 138 • 11/1238 (0.89%) in control group • 2/1225 (0.16%) in BIS group	ARR = 0.14% to 1.4% NNTB = 697 to 70	• Patients at high risk for AWR • 43% of patients received TIVA • BIS superior
B-Unaware Trial 2008[17]	Single center RCT	BIS-guided protocol *versus* ETAC-guided protocol	ARR = 0% NNTB = ∞ • 2/974 (0.21%) in ETAC group • 2/967 (0.21%) in BIS group	ARR = −0.57% to 0.56% NNTH = 177 to ∞ NNTB = ∞ to 179	• Patients at high risk for AWR • All patients received potent inhaled agent • BIS superiority not demonstrated
BAG-RECALL Trial 2011[20]	Multicenter RCT	BIS-guided protocol *versus* ETAC-guided protocol	ARI = 0.21% NNTH = 477 • 2/2852 (0.07%) in ETAC group • 8/2861 (0.28%) in BIS group	ARR = −0.49% to 0.02% NNTH = 206 to ∞ NNTB = ∞ to 4673	• Patients at high risk for AWR • All patients received potent inhaled agent • Trial was designed to evaluate superiority of BIS protocol; superiority of ETAC protocol was not considered • One patient in the BIS group spontaneously reported AWR 1 yr postoperatively • BIS superiority not demonstrated
Zhang *et al.* 2011[22]	Multicenter RCT	BIS-guided protocol *versus* routine anesthetic care	ARR = 0.51% NNTB = 195 • 15/2309 (0.65%) in routine care group • 4/2919 (0.14%) in BIS group	ARR = 0.18% to 0.94% NNTB = 559 to 106	• All patients received TIVA • BIS superior
Michigan Awareness Control Study 2012[11]	Effectiveness RCT	BIS-guided protocol *versus* anesthetic concentration-guided protocol	ARR = 0.07% NNTB = 1472 • 11/9376 (0.12%) in anesthetic concentration group • 3/6076 (0.05%) in BIS group	ARR = −0.04% to 0.17% NNTH = 2447 to ∞ NNTB = ∞ to 602	• Unselected surgical patients • Per protocol analysis (patients are analyzed according to the treatment they received) • BIS superiority not demonstrated
Michigan Awareness Control Study 2012[11]	Effectiveness RCT	BIS-guided protocol *versus* routine anesthetic care	ARR = 0.1% NNTB = 1017 • 5/3384 (0.15%) in routine care group • 3/6076 (0.05%) in BIS group	ARR = −0.03% to 0.3% NNTH = 3405 to ∞ NNTB = ∞ to 335	• Per protocol analysis (patients are analyzed according to the treatment they received) • Patients received routine care when there was a technical problem with the BIS monitor • BIS superiority not demonstrated

ARI = absolute risk increase; ARR = absolute risk reduction; AWR = awareness with recall; BIS = bispectral index; ETAC = end tidal anesthetic concentration; NNTB = number needed to treat to benefit; NNTH = number needed to treat to harm; RCT = randomized controlled trial; TIVA = total intravenous anesthesia.

Avidan et al Anesthesiology 2013

2. Présent

- Composante hypnotique

Arrive-t-on à nos fins?

Prévention du réveil accidentel avec mémorisation

Pas évident

COMMENT?

Table 2. Definite and Possible Awareness Events in Prospective Clinical Trials

Study	Design	Comparison Groups	Estimated Definite or Possible AWR Reduction or Increase with BIS Protocol	Precision (95% CI)	Comments
B-Aware Trial 2004[14]	Multicenter RCT	BIS-guided protocol *versus* routine anesthetic care	ARR = 0.39% NNTB = 260 • 27/1238 (2.18%) in control group • 22/1225 (1.8%) in BIS group	ARR = −0.75% to 1.53% NNTH = 134 to ∞ NNTB = ∞ to 65	• Possible AWR events included reports of dreaming as well as credible awareness experiences • BIS superiority not demonstrated
B-Unaware Trial 2008[17]	Single Center RCT	BIS-guided protocol *versus* ETAC-guided protocol	ARI = 0.31% NNTH = 320 • 3/974 (0.31%) in ETAC group • 6/967 (0.62%) in BIS group	ARR = −1.07% to 0.37% NNTH = 94 to ∞ NNTB = ∞ to 271	• Possible AWR events were credible awareness experiences • BIS superiority not demonstrated
BAG-RECALL Trial 2011[20]	Multicenter RCT	BIS-guided protocol *versus* ETAC-guided protocol	ARI = 0.42% NNTH = 239 • 8/2852 (0.28%) in ETAC group • 20/2861 (0.7%) in BIS group	ARI = 0.05% to 0.8% NNTH = 1933 to 122	• Possible AWR events were credible awareness experiences • Trial was designed to evaluate superiority of BIS protocol; superiority of ETAC protocol was not considered • One patient in the BIS group spontaneously reported AWR 1 yr postoperatively • BIS superiority not demonstrated
Zhang *et al.* 2011[22]	Multicenter RCT	BIS-guided protocol *versus* routine anesthetic care	ARR = 0.64% NNTB = 157 • 21/2309 (0.91%) in routine care group • 8/2919 (0.27%) in BIS group	ARR = 0.22% to 1.13% NNTB = 446 to 88	• All patients received TIVA • Possible AWR events were credible awareness experiences • BIS superior
Michigan Awareness Control Study 2012[11]	Effectiveness RCT	BIS-guided protocol *versus* anesthetic concentration-guided protocol	ARR = 0.12% NNTB = 831 • 19/9376 (0.2%) in anesthetic concentration group • 5/6076 (0.08%) in BIS group	ARR = −0.01% to 0.24% NNTH = 8494 to ∞ NNTB = ∞ to 411	• Per protocol analysis (patients are analyzed according to the treatment they received) • Possible AWR events were credible awareness experiences • BIS superiority not demonstrated
Michigan Awareness Control Study 2012[11]	Effectiveness RCT	BIS-guided protocol *versus* routine anesthetic care	ARR = 0.3% NNTB = 331 • 13/3384 (0.38%) in routine care group • 5/6076 (0.08%) in BIS group	ARR = 0.11% to 0.58% NNTB = 926 to 173	• Per protocol analysis (patients are analyzed according to the treatment they received) • Patients received routine care when there was a technical problem with the BIS monitor • Possible AWR events were credible awareness experiences • BIS superior

ARI = absolute risk increase; ARR = absolute risk reduction; AWR = awareness with recall; BIS = bispectral index; ETAC = end tidal anesthetic concentration; NNTB = number needed to treat to benefit; NNTH = number needed to treat to harm; RCT = randomized controlled trial; TIVA = total intravenous anesthesia.

Avidan et al Anesthesiology 2013

2. Présent

- Composante hypnotique

Arrive-t-on à nos fins?

Prévention du réveil accidentel avec mémorisation

Raisons

- Incidence relativement faible
- Nombreux facteurs confondants

  Artéfacts électriques, variabilité interindividuelle, site d'enregistrement, particularités cliniques, **interactions médicamenteuses …**

- Définition des objectifs

  Conscience

  Connexité

  Réactivité

COMMENT?

2. Présent

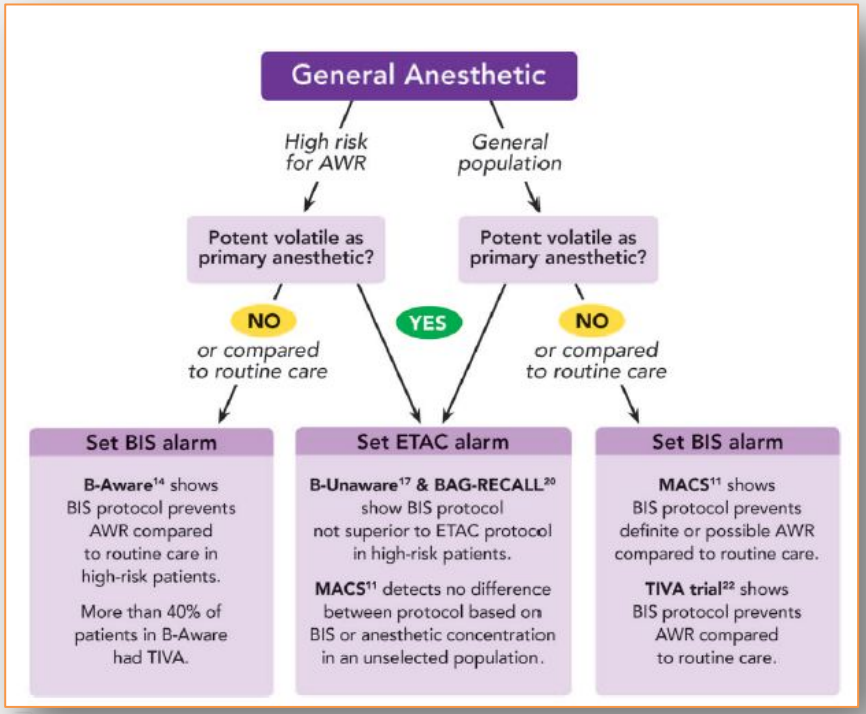
- Composante hypnotique

Arrive-t-on à nos fins?

Prévention du réveil accidentel avec mémorisation

Recommandations actuelles

COMMENT?



Avidan et al Anesthesiology 2013

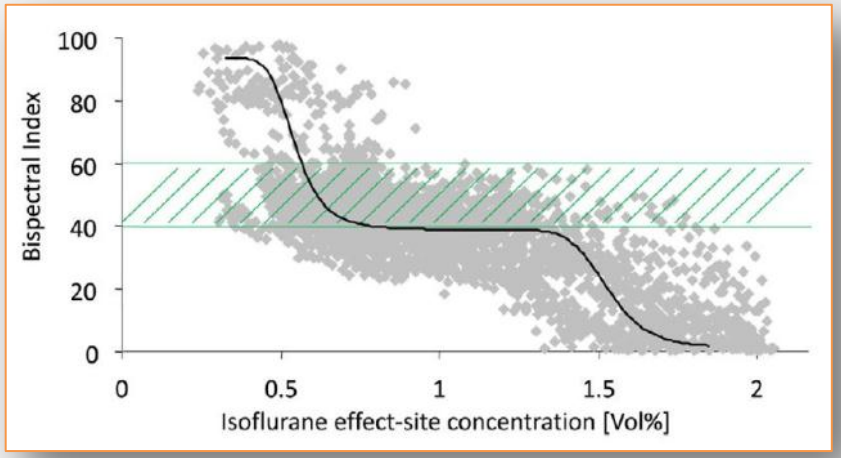
2. Présent

- Composante hypnotique

Arrive-t-on à nos fins?

Ajustement individuel

Etudes randomisées à large échelle peu convaincantes, mais …



COMMENT?

✓ Limitation de la variabilité inter-individuelle

Ellerkmann et al. Best Practice & Research Clinical Anaesthesiology 2013

2. Présent

- Composante hypnotique

Arrive-t-on à nos fins?

Ajustement individuel

Raccourcissement du délai de réveil

COMMENT?

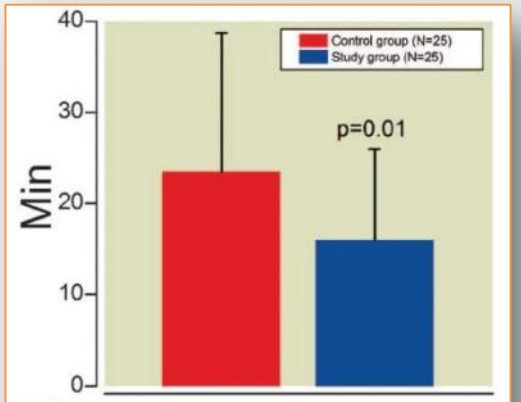


Fig. 3. Sevoflurane extubation time (min): time in minutes from the discontinuation of sevoflurane administration until extubation in the control group (CG) and study group (SG). Data are presented as median (25–75 interquartiles).

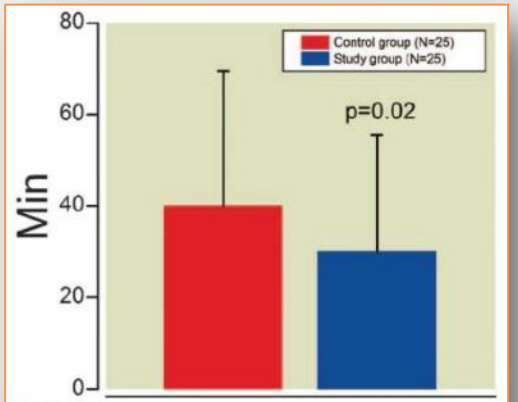


Fig. 4. Sufentanil extubation time (min): time in minutes from the discontinuation of sufentanil infusion until extubation in the control group (CG) and study group (SG). Data are presented as median (25–75 interquartiles).

El Hor et al Anesthesiology 2013

2. Présent

- Composante hypnotique

Arrive-t-on à nos fins?

Ajustement individuel

Limitation du risque d'overdose

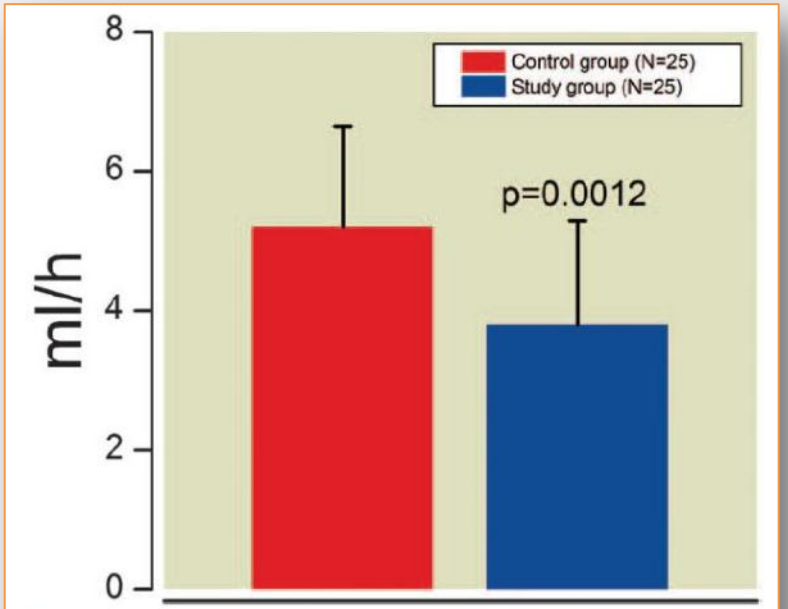


Fig. 2. Intraoperative sevoflurane uptake (ml/h) in the control group (CG) and study group (SG). Data are presented as mean ± SD.

COMMENT?

El Hor et al Anesthesiology 2013

2. Présent

- Composante hypnotique

Arrive-t-on à nos fins?

Ajustement individuel

Moins de nausées-vomissements

Table 2. Effects of Bispectral Index Monitoring on Ambulatory Surgical Patients

Outcome	n	No. of Trials	BIS,* Mean	Control,* Mean	OR or WMD† (95% Confidence Interval)	*P* Value
Anesthetic use ratio, BIS:control	1,380	11	0.81	1	0.81 (0.73 to 0.89)	0.0001
Bypass PACU, %	562	2	32	29	1.01 (0.65 to 1.57)	0.96
Time in PACU, min	851	5	45.2	49.1	−4 (−7.3 to −0.8)	0.01
Nausea/vomiting, %	870	6	31.5	37.5	0.77 (0.56 to 0.99)	0.04
Time in ASU, min	702	5	159	165	−13.4 (−34.3 to −7.6)	0.21

* Weighted by subject number. † Weighted by inverse variance.

ASU = ambulatory surgical unit; BIS = Bispectral Index; OR = odds ratio; PACU = postanesthesia care unit; WMD = weighted mean difference.

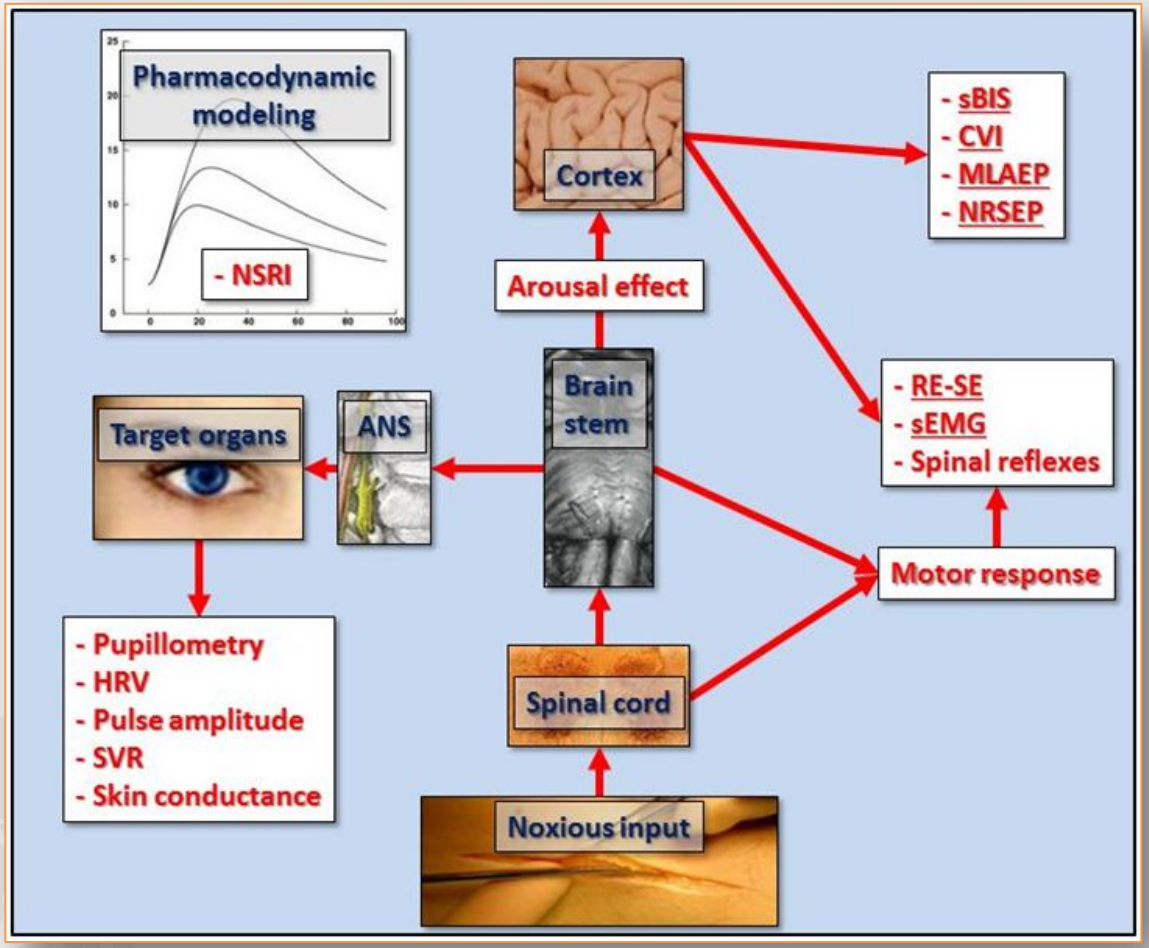
COMMENT?

Liu et al Anesthesiology 2004

2. Présent

- **Nociception**

COMMENT?



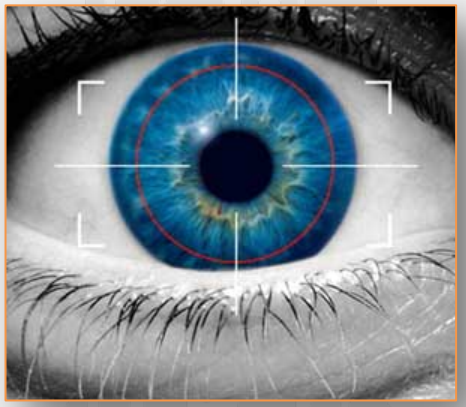
Marchant et al Clin EEG Neurosci 2014

2. Présent

- Nociception

Disponible commercialement

Algiscan



COMMENT?

2. Présent

- Nociception

Disponible commercialement

Surgical Pleth Index (SPI)

COMMENT?

2. Présent

- Nociception

Disponible commercialement

Analgesia Nociception Index (ANI)

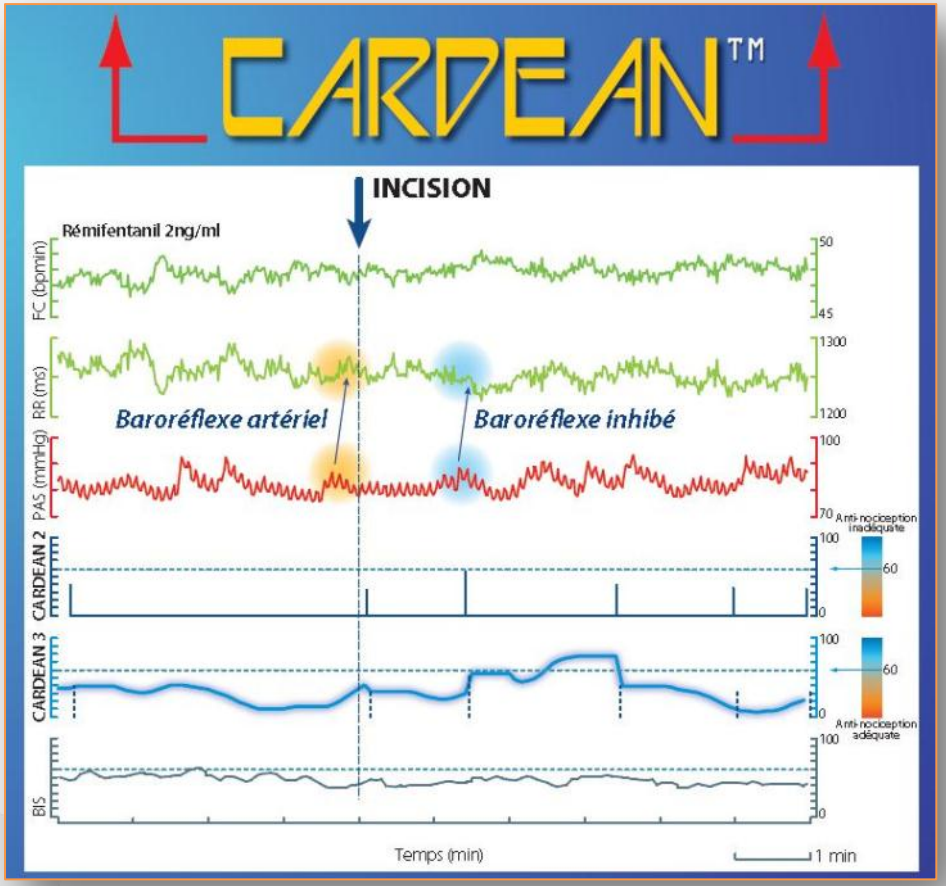
COMMENT?

2. Présent

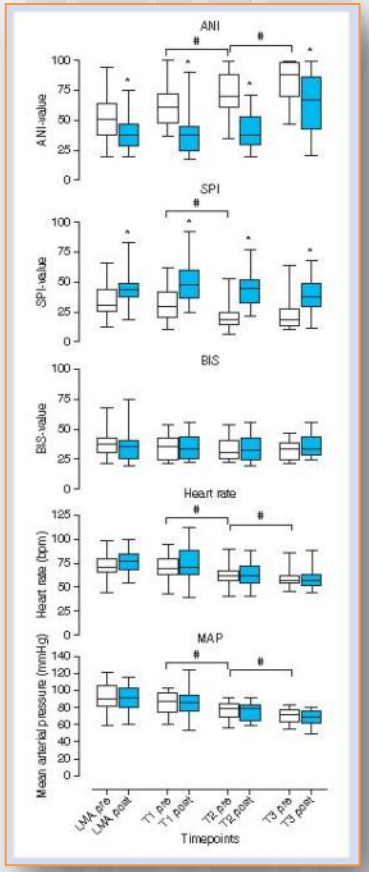
- Nociception

Disponible commercialement

CARDEAN



COMMENT?

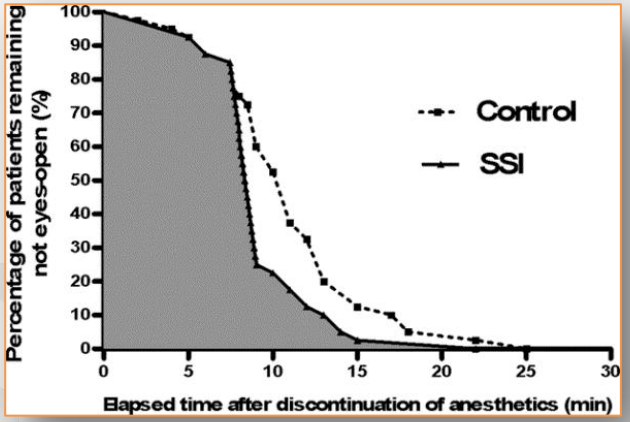


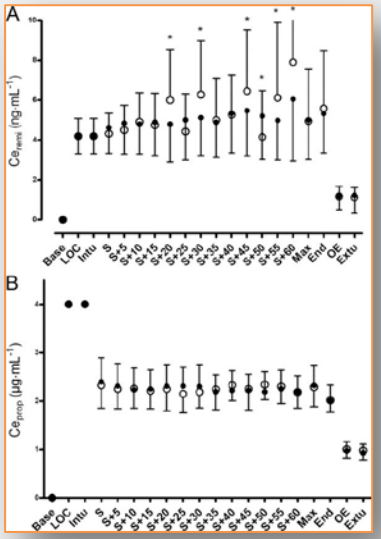
2. Présent

- Nociception

Bénéfices avérés

- Sensibles à la balance nociception-anti-nociception
- Prédiction mouvements (réponse à une stimulation)
- Diminution de la consommation de remifentanil
- Moins d'événements indésirables
- Meilleure prédiction du moment du réveil





COMMENT?

Table 5. Number of Unwanted Events during the Intraoperative Period

	SSI Group (n = 40)	Standard Practice (n = 40)
Hypertension	11 (0.28)*	84 (2.1)
Hypotension	5 (0.13)*	67 (1.68)
Tachycardia	0 (0)	2 (0.05)
Bradycardia	23 (0.57)*	111 (2.78)
Movements	3 (0.08)*	14 (0.35)
Total unwanted events	42 (1.05)*	278 (6.95)

Data are numbers of unwanted events during surgery. Data in parentheses are numbers of unwanted events per patient.
* $P < 0.01$ when compared with standard analgesia practice group.
SSI = surgical stress index.

Chen et al Anesthesiology 2010
Gruenewald BJA 2013

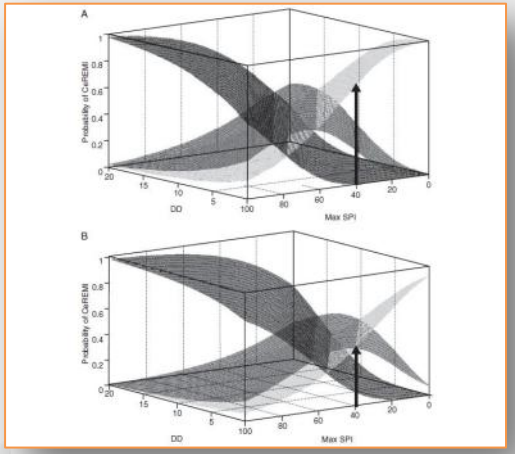
2. Présent

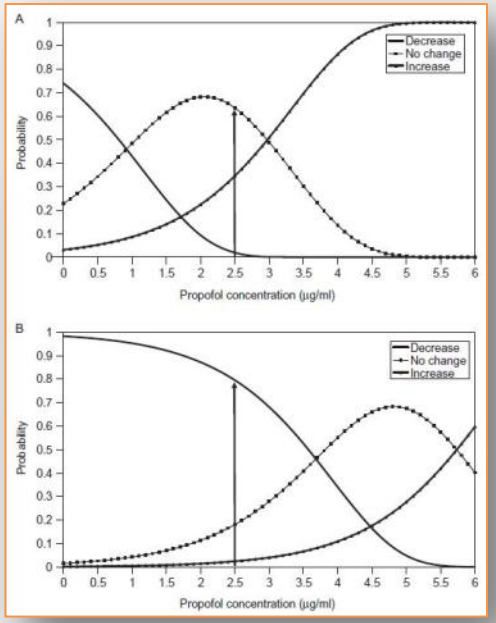
- Nociception

Facteurs confondants

- PCMK – rythme non sinusal
- Atropine – amines
- Position du senseur
- Mode ventilatoire
- Hypothermie
- Volémie
- Seuils ?

COMMENT?



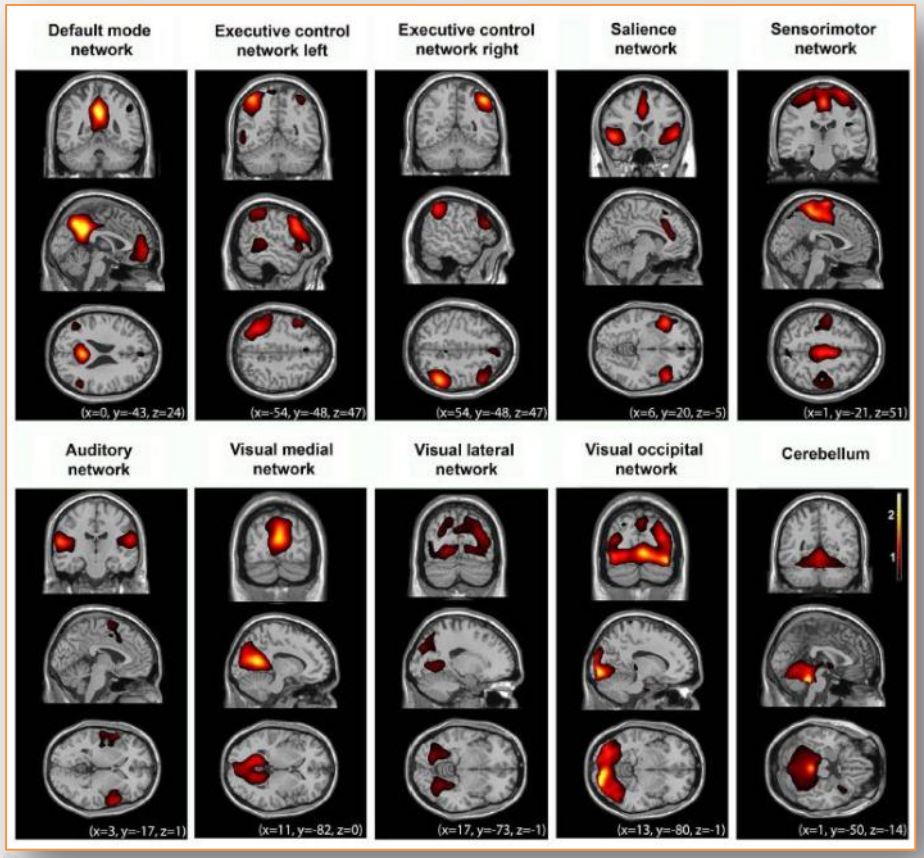


Hans et al Acta Anaesthesiol Scand 2012
Bonhomme et al BJA 2010

3. Futur

- Composante hypnotique

Réseaux de la conscience



COMMENT?

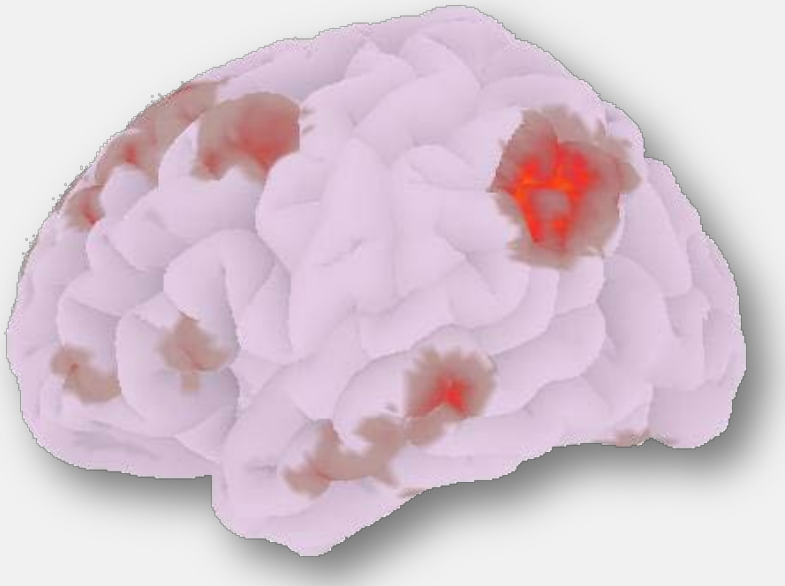
Heine et al Front Neurol 2012

3. Futur

- Composante hypnotique

Réseaux de la conscience

DMN



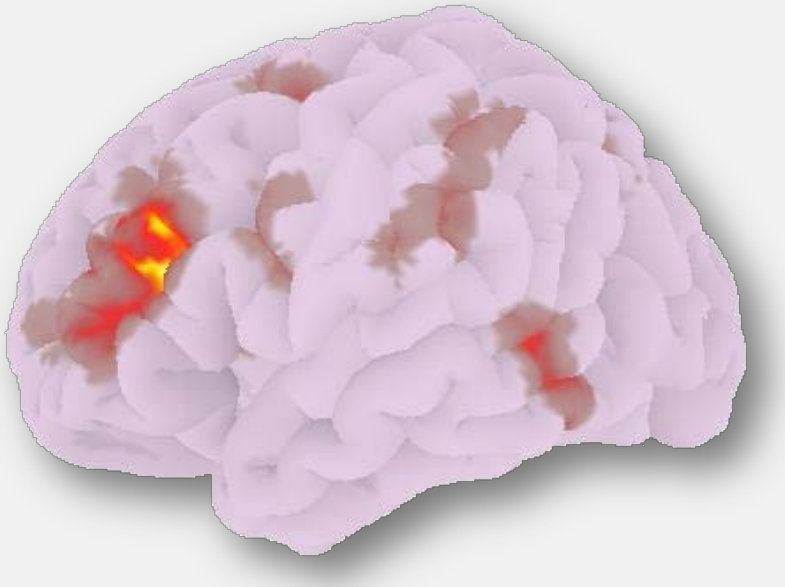
COMMENT?

3. Futur

- Composante hypnotique

Réseaux de la conscience

ECN



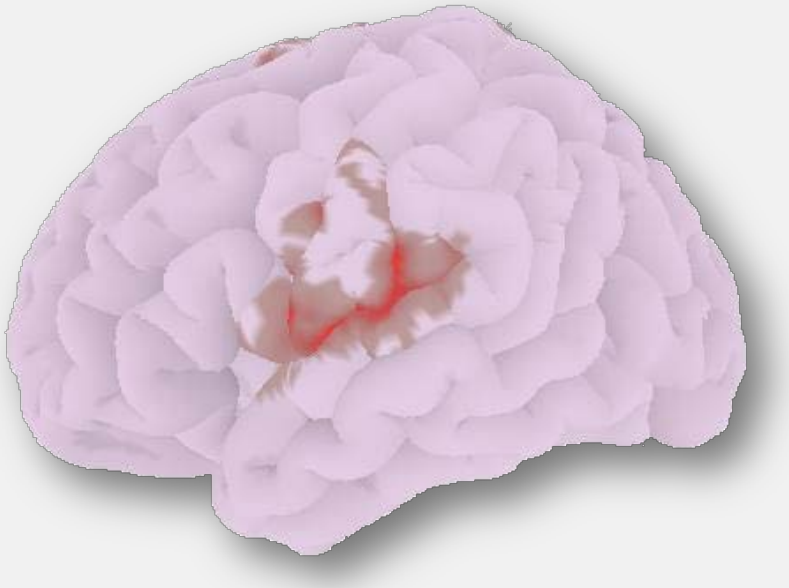
COMMENT?

3. Futur

- Composante hypnotique

Réseaux de la conscience

Auditif



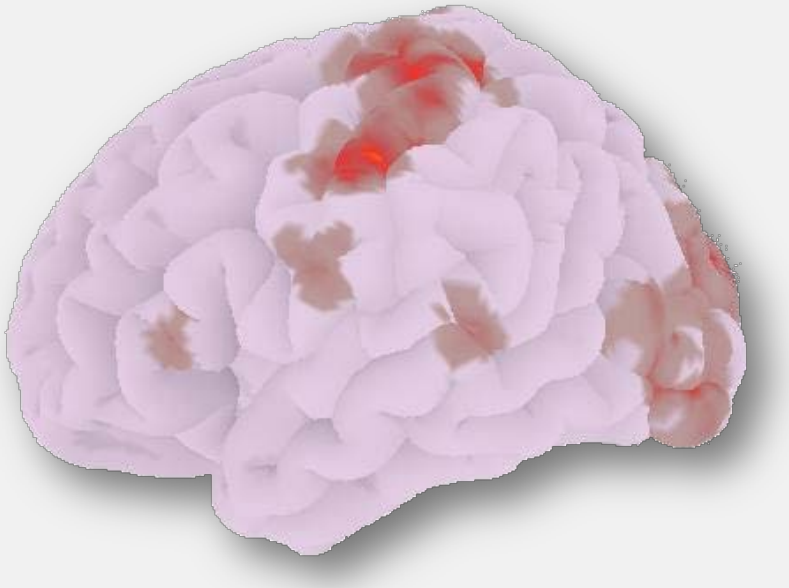
COMMENT?

3. Futur

- Composante hypnotique

Réseaux de la conscience

Visuel



COMMENT?

3. Futur

- Composante hypnotique

Précisions sémantiques

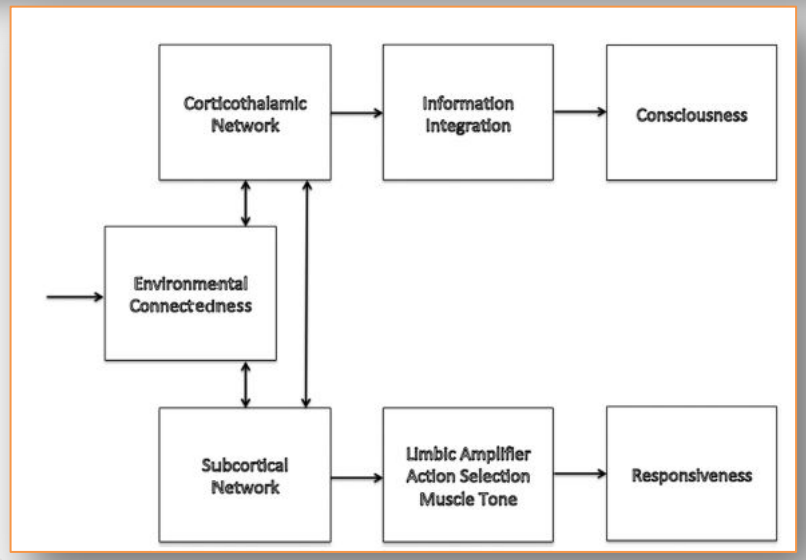
Conscience - Connexité – Réactivité ?

Table 1. Consciousness, Connectedness, and Responsiveness in Wake and Sleep States

	Consciousness	Connectedness	Responsiveness
Awake	Yes	Yes	Yes
NREM sleep	No	No	No
REM sleep	Yes	No	No

NREM = non-rapid eye movement sleep, or slow-wave sleep early in the night when subjects are often unconscious; REM = rapid eye movement sleep.

COMMENT?



Sanders et al Anesthesiology 2012

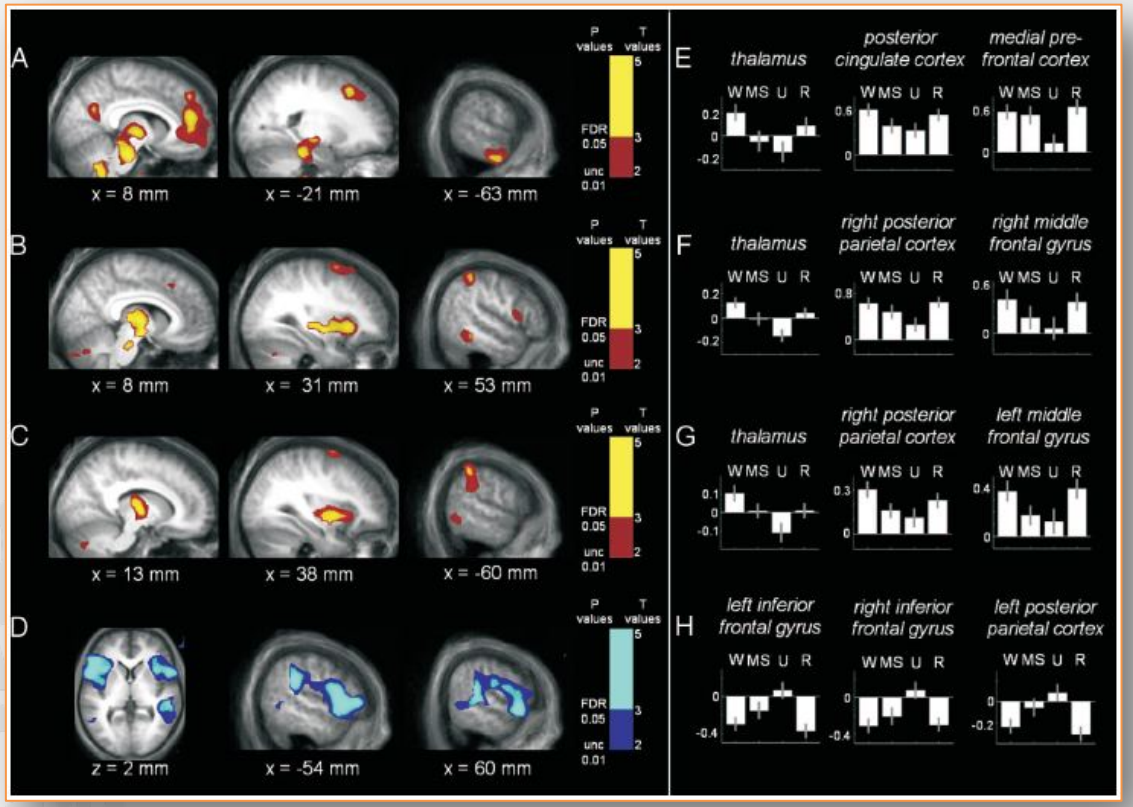
3. Futur

- Composante hypnotique

Réseaux de la conscience

Effets de l'anesthésie - propofol

COMMENT?



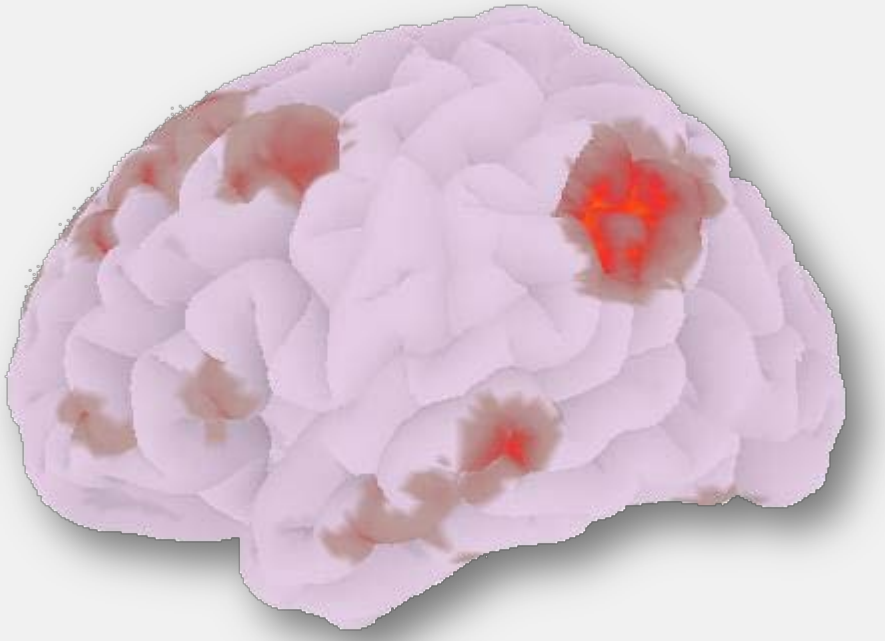
Boveroux et al Anesthesiology 2010

3. Futur

- Composante hypnotique

Réseaux de la conscience

Effets de l'anesthésie – kétamine



DMN

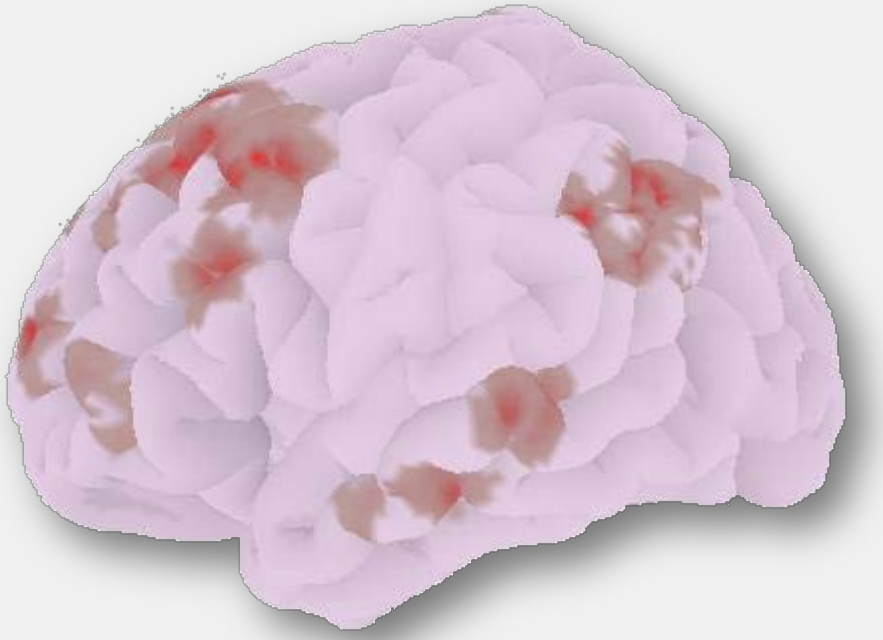
COMMENT?

3. Futur

- Composante hypnotique

Réseaux de la conscience

Effets de l'anesthésie – kétamine



DMN

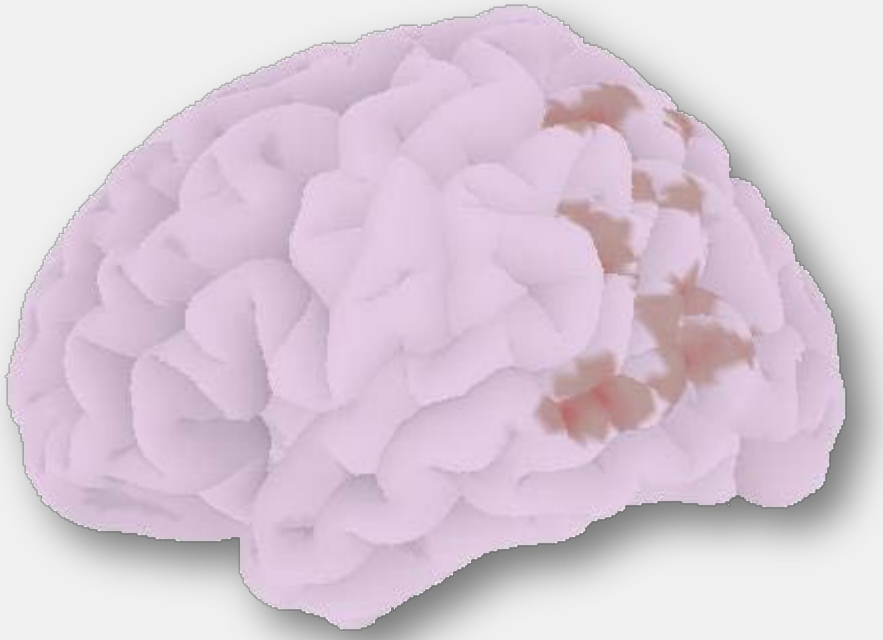
COMMENT?

3. Futur

- Composante hypnotique

Réseaux de la conscience

Effets de l'anesthésie – kétamine



DMN

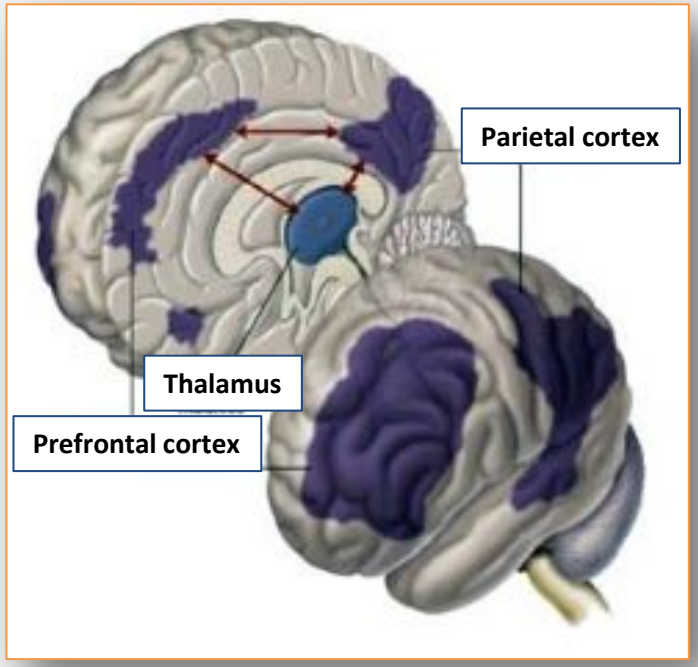
COMMENT?

3. Futur

- Composante hypnotique

Réseaux de la conscience

Connectivité fronto-pariétale



COMMENT?

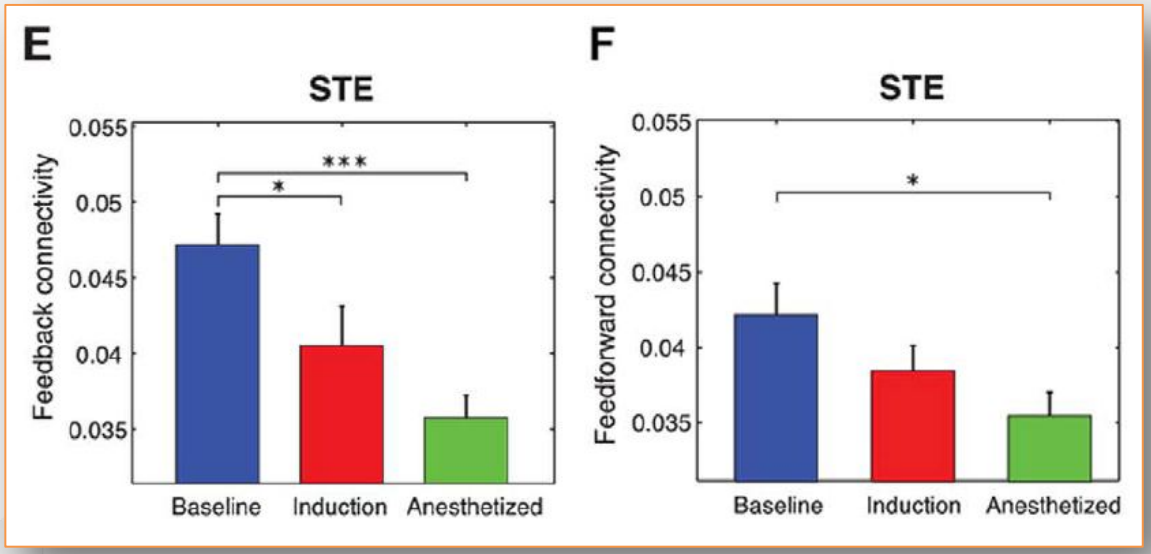
3. Futur

- Composante hypnotique

Corrélats fonctionnels

'Feedback and feed-forward fronto-parietal connectivity'

'Symbolic Transfer Entropy' (STE)



COMMENT?

Conscience – pas nécessairement connexité

Ku et al PlosOne 2011

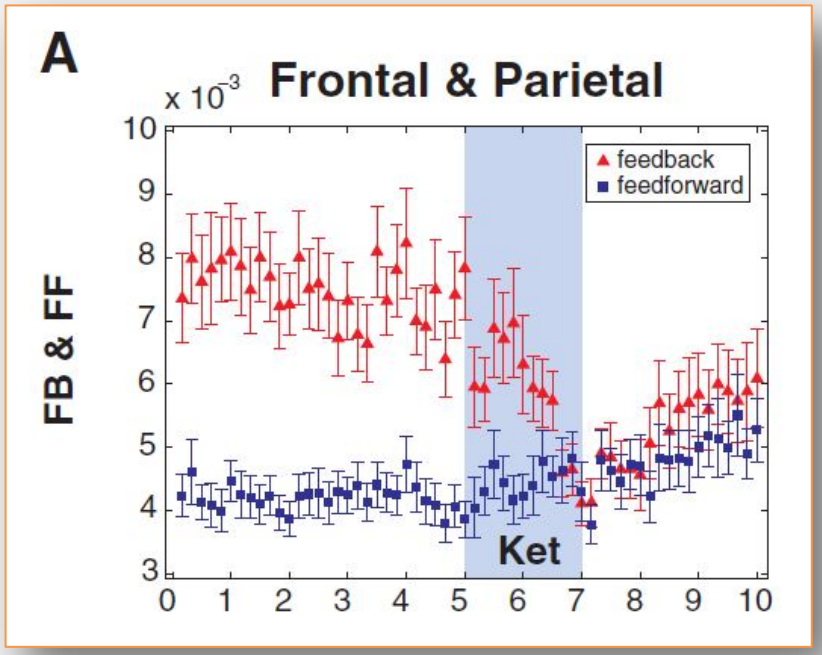
3. Futur

- Composante hypnotique

Corrélats fonctionnels

'Feedback and feed-forward fronto-parietal connectivity'

'Symbolic Transfer Entropy' (STE)



Conscience – pas nécessairement connexité

COMMENT?

Lee et al Anesthesiology 2013

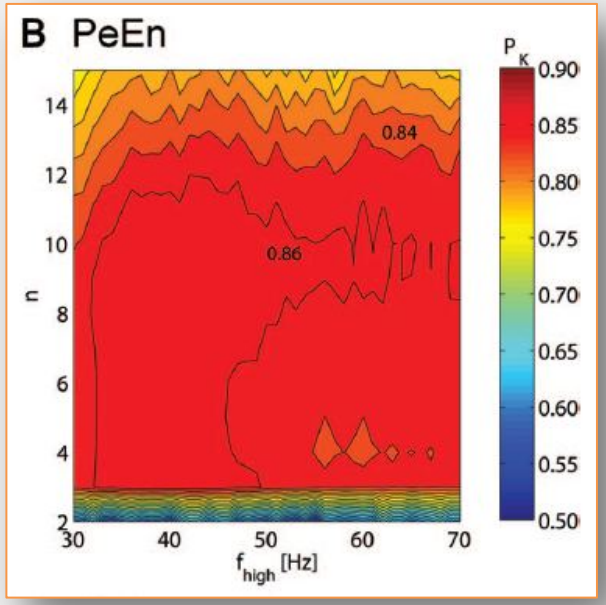
3. Futur

- Composante hypnotique

Corrélats fonctionnels

'Feedback and feed-forward fronto-parietal connectivity'

'Permutation Entropy' (PeEn)



Conscience – pas nécessairement connexité

COMMENT?

Jordan et al Anesthesiology 2008

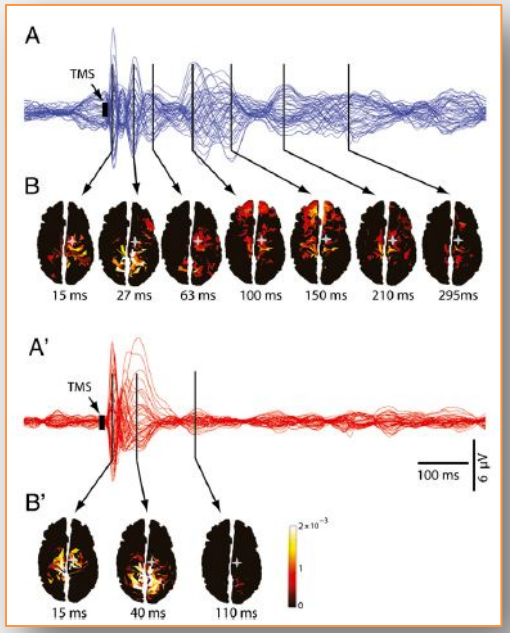
3. Futur

- Composante hypnotique

Corrélats fonctionnels

'Feedback and feed-forward fronto-parietal connectivity'

EEG haute densité - TMS



Conscience – pas nécessairement connexité

COMMENT?

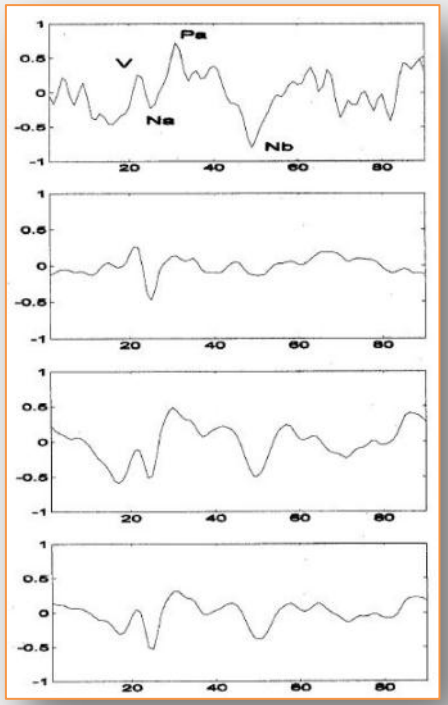
Ferrarelli et al PNAS 2010

3. Futur

- Composante hypnotique

Corrélats fonctionnels

Réponses évoquées de latence tardive



Connexité

COMMENT?

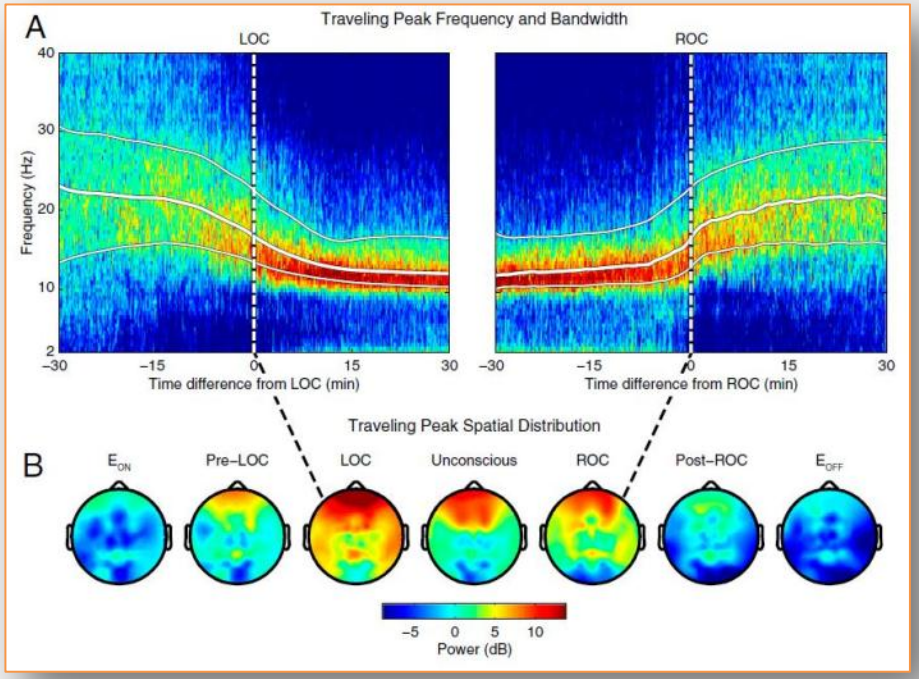
Bell et al Anesth Analg 2006

3. Futur

- Composante hypnotique

Corrélats fonctionnels

Distribution de phase – amplitude



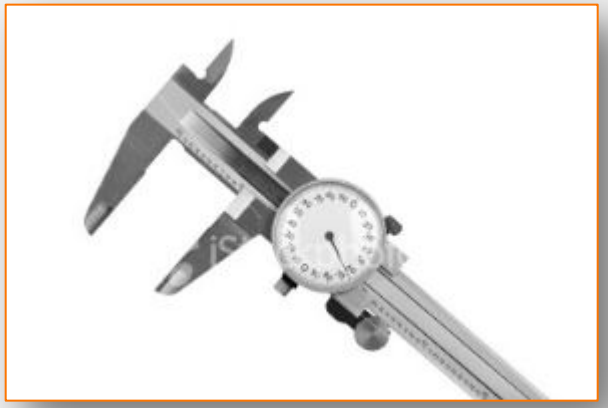
Réactivité

COMMENT?

Purdon et al PNAS 2013

3. Futur

- Nociception
  - Calibration individuelle ?
  - Contrôle des facteurs confondants
  - Témoin cortical spécifique ?



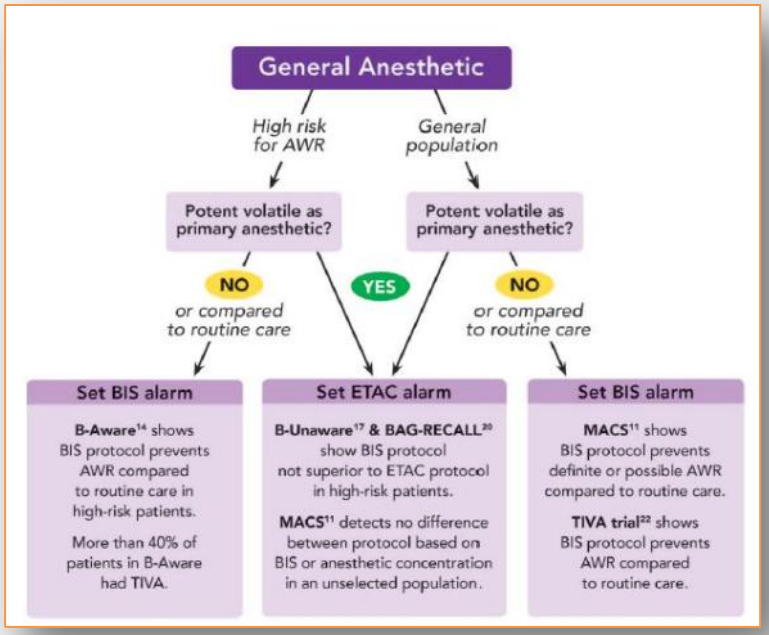
COMMENT?

QUAND?

1. Composante hypnotique

- Réveil accidentel + mémorisation
  - **Patients à haut risque**
  - **Procédures longues**
  - **Anesthésie totale intraveineuse**
- Ajustement individuel
  - **Tous les patients**

QUAND?



2. Nociception

Etudes à large échelle nécessaires

- Amélioration de l'ajustement ind.
- Limitation du stress chirurgical
- Prédiction de la douleur au réveil
- Amélioration de 'l'outcome'?

QUAND?

MERCI …