STIMULATION CÉRÉBRALE NON INVASIVE DANS LA RÉDUCTION DU CRAVING

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Les auteurs déclarent que ce travail a été réalisé en toute indépendance de l'industrie du tabac et qu'ils n'ont aucun lien d'intérêt avec l'industrie du tabac, de l'alcool et des jeux, ainsi que l'industrie de la cigarette électronique.

Les auteurs n'ont pas de lien d'intérêt.

DÉVELOPPEMENT D'UNE ADDICTION

1. INITIATION :

- 1ères consommations
- Plaisir, euphorie (système de récompense) = renforcement positif

2. CONSOMMATIONS EXCESSIVES ET CHRONIQUES :

- Tolérance pharmacologique
- Manifestations de sevrage à l'arrêt = renforcement négatif

3. CONSÉQUENCES NEUROBIOLOGIQUES :

- Craving
- Consommation compulsive (perte de contrôle)

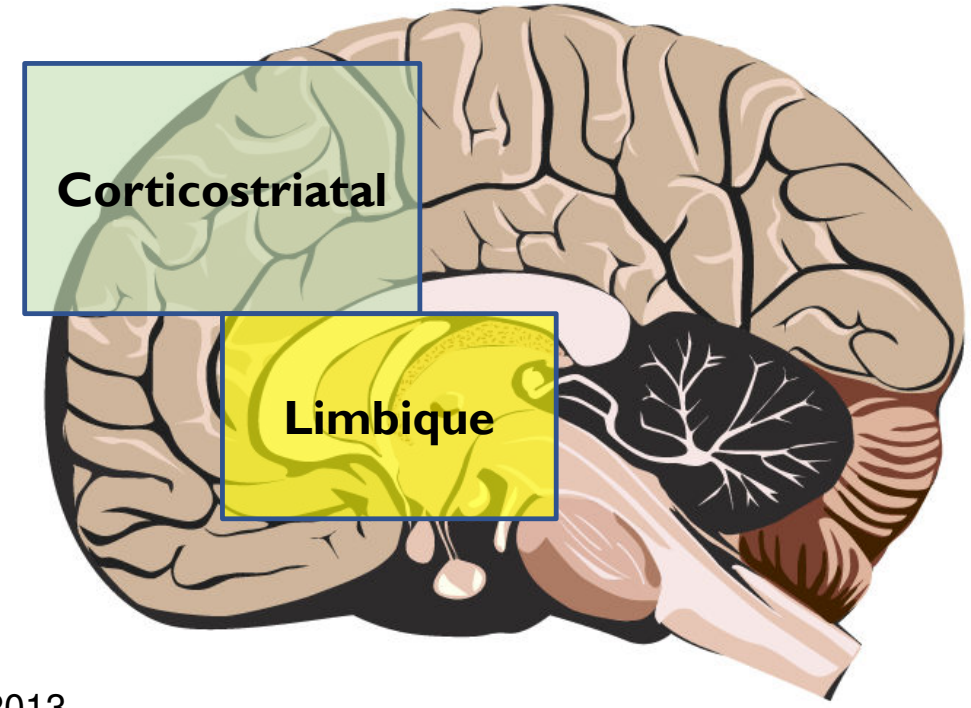
ADDICTION ET CRAVING

- Addiction = Incapacité de s'abstenir de consommer malgré les conséquences négatives
- Craving (désir ou une envie intense de consommer) puis consommation compulsive
- Le craving :
  1. Maintien le comportement de recherche de produit
  2. Facteur prédictif de rechute après abstinence
- Symptôme central – cible de choix

NEUROBIOLOGIE DU CRAVING

2 substrats neurobiologiques :

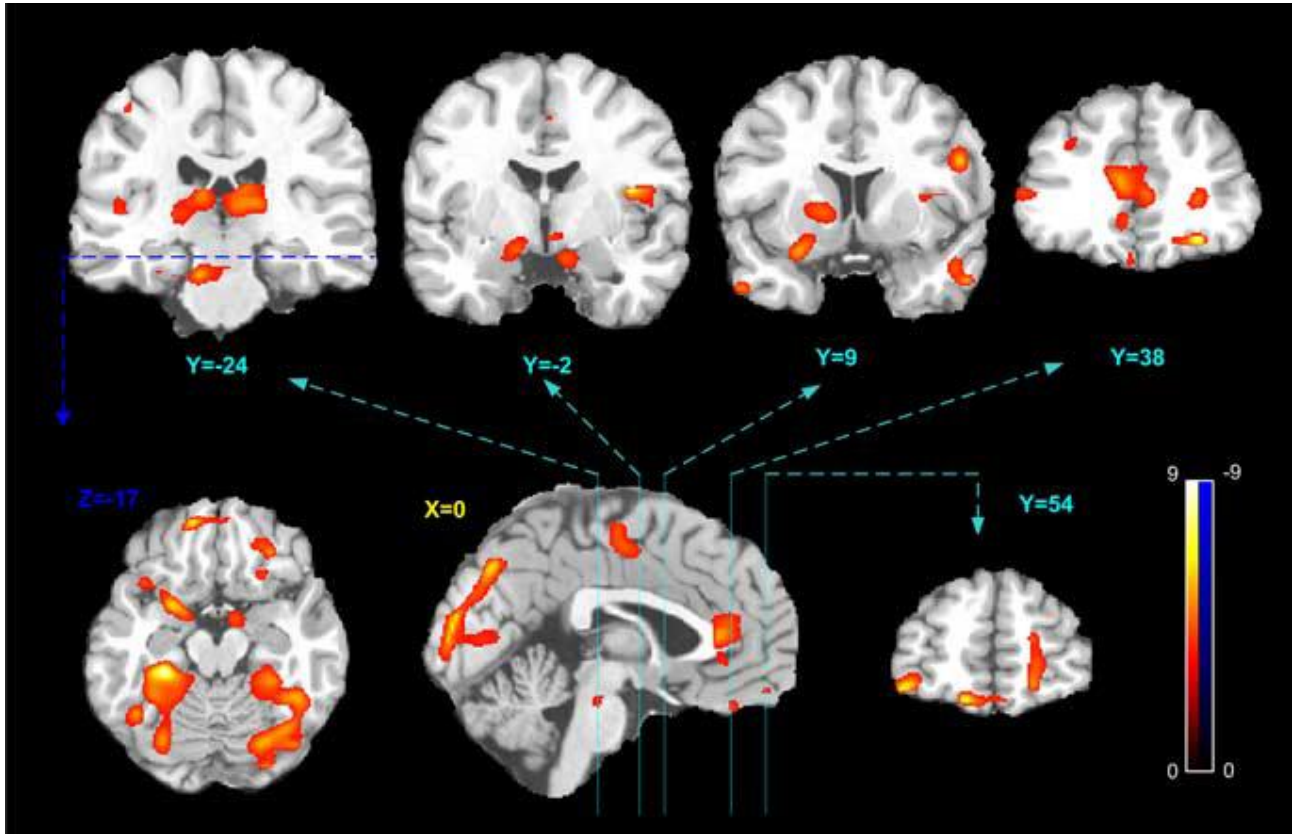
1. Altération des circuits dopaminergiques
2. Perturbation du contrôle préfrontal



Sinha R, Curr Opin Neurobiol 2013

CRAVING ET SEVRAGE TABAGIQUE

- Envies de fumer induites par l'abstinence = activation anormale de CPF
- Etude Wang : 15 fumeurs, abstinence (12h-14h) tabac vs satiété, IRM/ASL

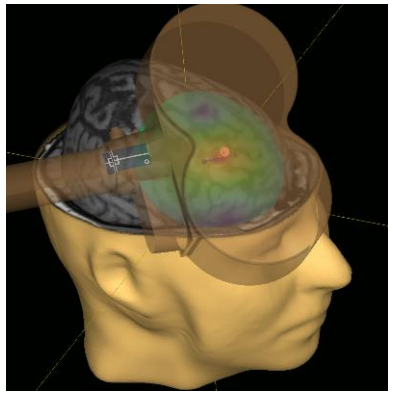


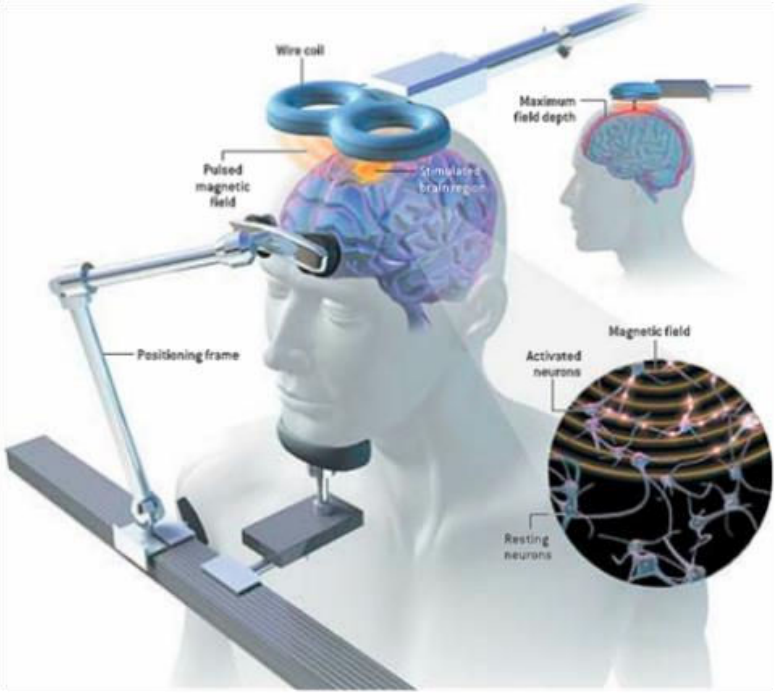
Association du craving-induit par l'abstinence avec les changements régionaux du flux sanguin cérébral

Wang, J Neurosci 2007

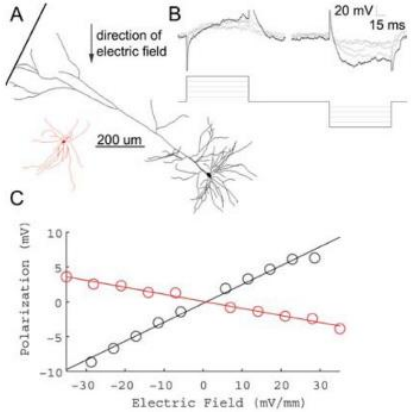
STIMULATION CÉRÉBRALE NON INVASIVE ?

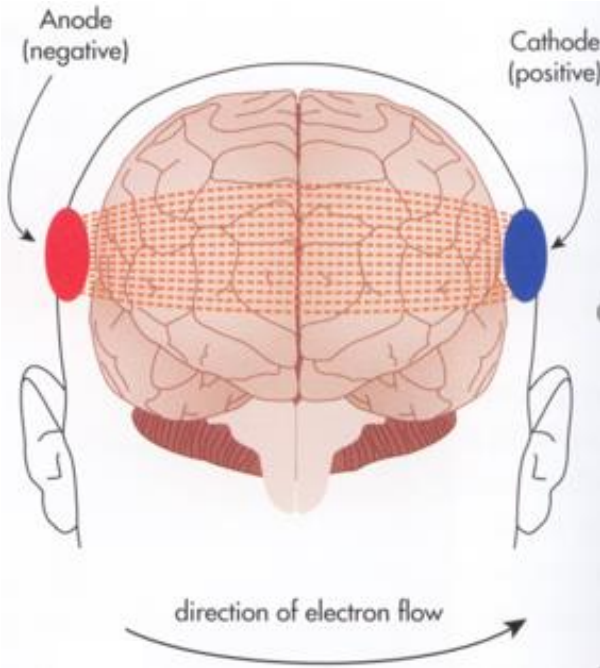
Stimulation Magnétique Transcrânnienne répétée (SMTr)





Stimulation Transcrânienne à Courant Continu (STCC)



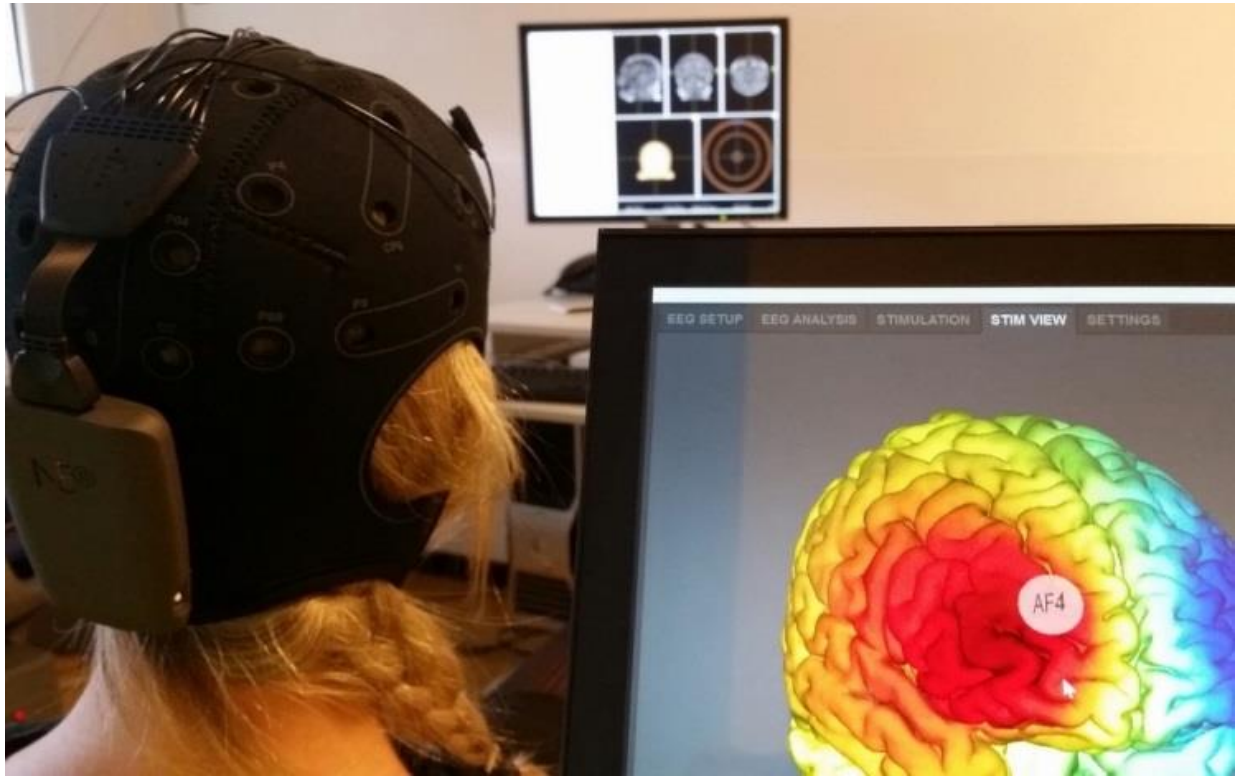


Iggins. 2009

STIMULATION CÉRÉBRALE NON INVASIVE ?

Stimulation Magnétique Transcrânnienne répétée (SMTr)

Stimulation Transcrânienne à Courant Continu (STCC)

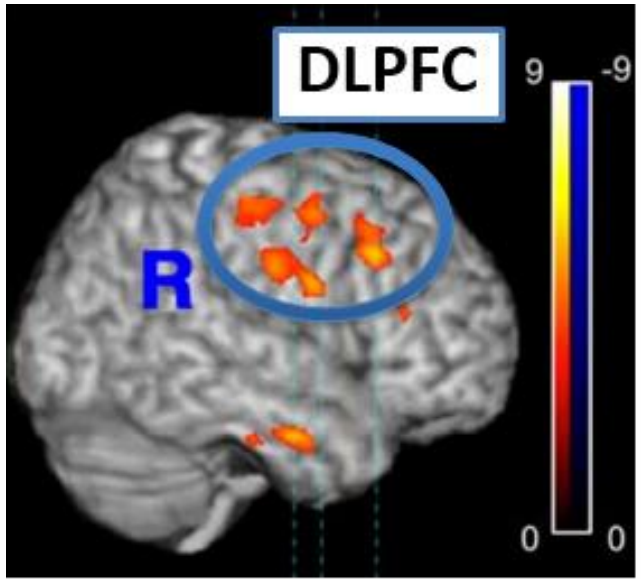


MÉCANISMES D'ACTION DE LA STIMULATION CÉRÉBRALE

Stimulation du CPFDL =

- **Réduction du craving**

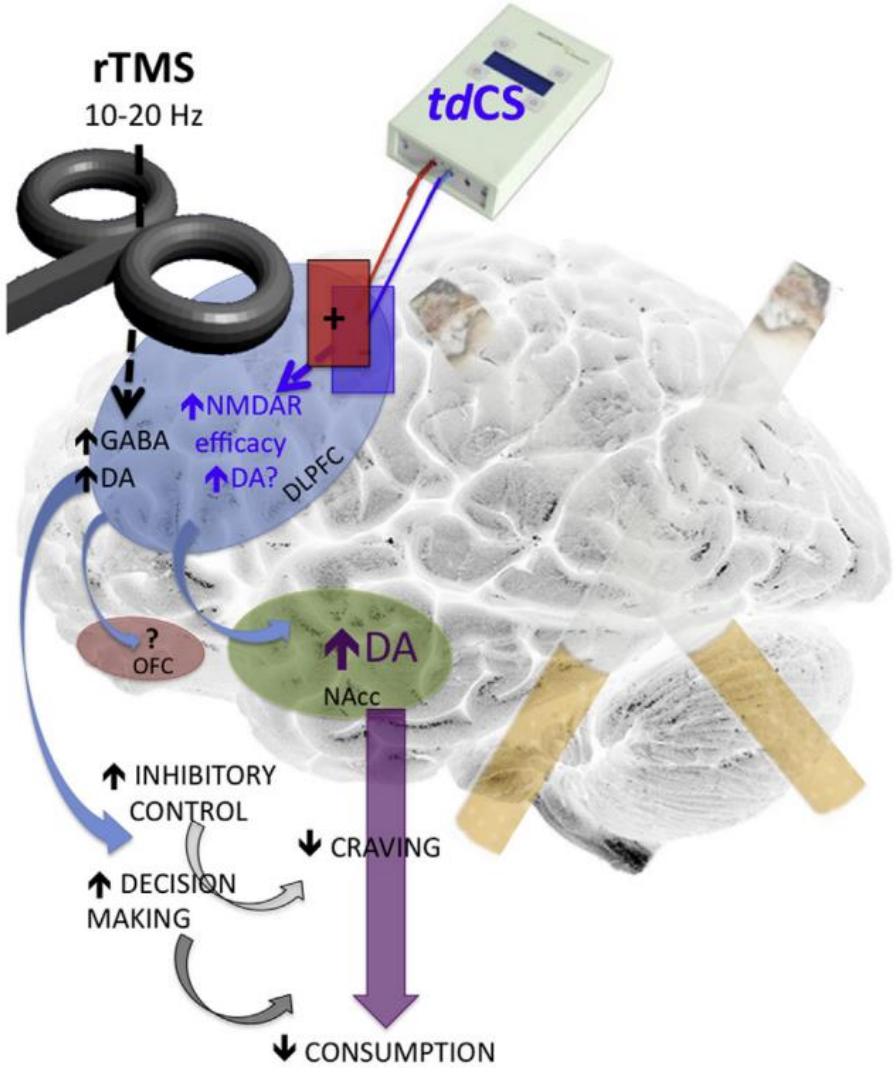
  ↘ de la sévérité des troubles addictifs
  ↘ du risque de rechute



- **Amélioration des fonctions cognitives**

  Processus de prise de décision
  ↘ impulsivité, ↘ prise de risque, ↘ choix d'une récompense immédiate

STIMULATION CÉRÉBRALE POUR TRAITER LE TABAGISME ?



« *La SMTr et la STCC représentent deux de nouvelles modalités de traitement* » (Wing 2013)

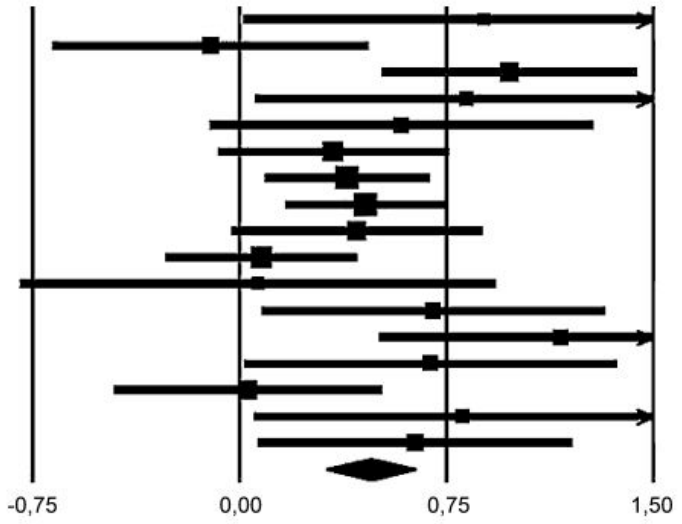
Wing, Brain Stimulation 2013

EFFICACITÉ SUR LE CRAVING

- 1ère méta-analyse en 2013
- SMTr et STCC sur le CPFCL : effet sur le craving ?

Study name	Technique	Stimulation site	Single or combined study	Number of sessions	Number of subjects	Hedge's g
Amiaz et al. (2009)	rTMS	Left	Single Study	10	21	0.888
Barth et al. (2011)	rTMS	Left	Single Study	2	10	−0.104
Boggio et al. (2008)	tDCS	Both	Combined	2	26	0.98
Boggio et al. (2009)	tDCS	Left	Single Study	5	27	0.824
Boggio et al. (2010)	tDCS	Both	Combined	1	33	0.587
Claudino et al. (2011)	rTMS	Left	Single Study	1	22	0.341
Fregni et al. (2008a) (food)	tDCS	Both	Combined	2	46	0.391
Fregni et al. (2008b) (smoking)	tDCS	Both	Combined	2	48	0.458
Goldman et al. (2011)	tDCS	Right	Single Study	2	19	0.427
Herremans et al. (2011)	rTMS	Right	Single Study	1	31	0.08
Hoppner et al. (2011)	rTMS	Left	Single Study	10	19	0.069
Johann et al. (2003)	rTMS	Left	Single Study	2	11	0.703
Mishra et al. (2010)	rTMS	Right	Single Study	10	45	1.165
Montenegro et al. (2012)	tDCS	Left	Single Study	2	9	0.694
Nakamura-Palacios et al. (2011)	tDCS	Left	Single Study	2	32	0.031
Uher et al. (2005)	rTMS	Left	Single Study	1	28	0.809
Wing et al. (2012)	rTMS	Bilateral	Single Study	50	13	0.639
						0.476

(Hedge's g) of 0.476 (CI: 0.316–0.636)



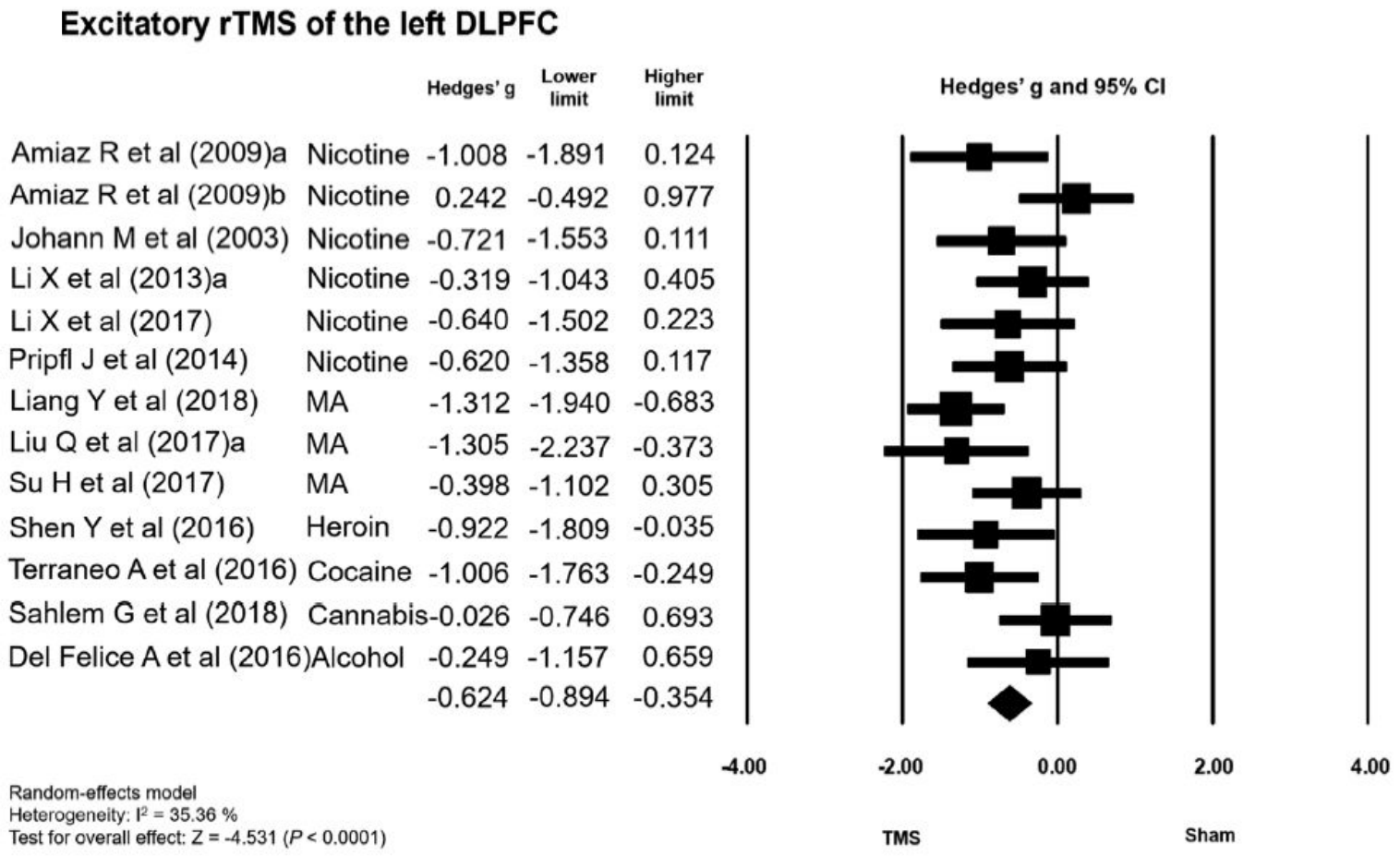
17 études : 5 nicotine, 6 food, 5 alcohol and 1 marijuana study

Taille de l'effet : <u>moyen</u> (vs PCB) sur la réduction du craving

Jansen, Neurosc Biobehav Rev 2013

EFFICACITÉ SUR LE CRAVING

- 2ème méta-analyse en 2019
- SMTr : effet sur le craving ?



Taille de l'effet : <u>moyen</u> (actives vs PCB) sur la réduction du craving

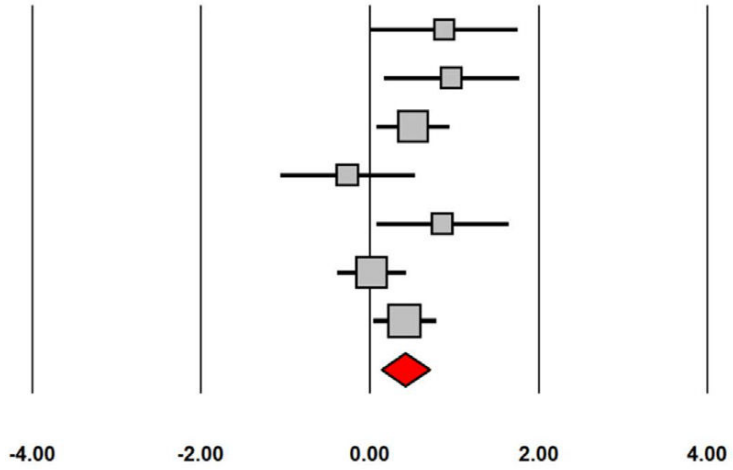
Zhang, Addiction 2019

EFFICACITÉ SUR LE CRAVING AU TABAC

- 3ème méta-analyse en 2019
- STCC : effet sur le craving au tabac?

Study Name	Outcome	*SMD*	LL	UL	*P*-value
Boggio 2009	Cue-provoked craving (VAS) at posttest [L&D]	0.88	0.02	1.73	0.04
Fecteau 2014	Cue-provoked craving (QSU) at posttest [R&D]	0.97	0.17	1.76	0.02
Fregni 2008	Cue-provoked craving (VAS) at posttest [R&D]	0.51	0.08	0.94	0.02
Kroczek 2016	Cue-provoked craving (VAS) at posttest [L&O]	-0.27	-1.05	0.52	0.51
Mondino 2018	Changes in cue-provoked craving (LSQ) [R&O]	0.86	0.09	1.63	0.03
Xu 2013	Cue-provoked craving (UTS) at posttest [L&O]	0.02	-0.38	0.42	0.93
Yang 2017	Cue-provoked craving (VAS) at posttest [L&D]	0.41	0.05	0.77	0.03
	Overall	0.42	0.13	0.71	0.004

Craving assessment. LSQ: a 5-itm Likert-type questionnaire of smoking urge; QSU: Questionnaire of Smoking Urges; UTS: urge to smoke scale; VAS: visual analogue scale. ***tDCS protocols***. L&D: anodal-tDCS on the left DLPFC & cathodal-tDCS on DLPFC regions; R&D: anodal-tDCS on the right DLPFC & cathodal-tDCS on DLPFC regions; L&O: anodal-tDCS on the left DLPFC & cathodal-tDCS on other regions.



SMD=0.422, SE=0.147; 95% CI=0.133-0.710; p=.004

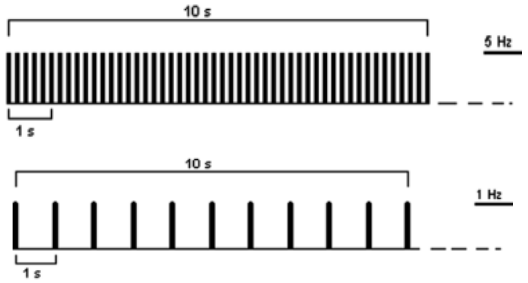
Taille de l'effet : <u>modéré</u> (actives vs PCB) sur la réduction du craving provoqué

Kang, Addictive Behaviors 2019

LIMITES…

1. Paramètres de stimulations :

- Fréq 1 Hz, 10-20 Hz, %SM… 1 ou 2 mA,
- CPF droit ou gauche,
- Nombre de séances, d'impulsions, durée…



2. Quel craving ?

- Sevrage ? Exposition ? Stimuli associé ? Stress?
- Outils de mesure : échelles, questionnaires, marqueurs physiologiques ?

EFFICACITÉ DANS LE SEVRAGE TABAGIQUE

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REVIEW

ADDICTION SSA

Non-invasive brain stimulation for smoking cessation: a systematic review and meta-analysis

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- Dernière méta-analyse
- Intervention : NIBS
- bases de données CENTRAL, MEDLINE, Embase et PsycINFO + registres d'essais cliniques
- RCT + essais cliniques
- Follow up ≥ 4 semaines

Petit et al., 2022

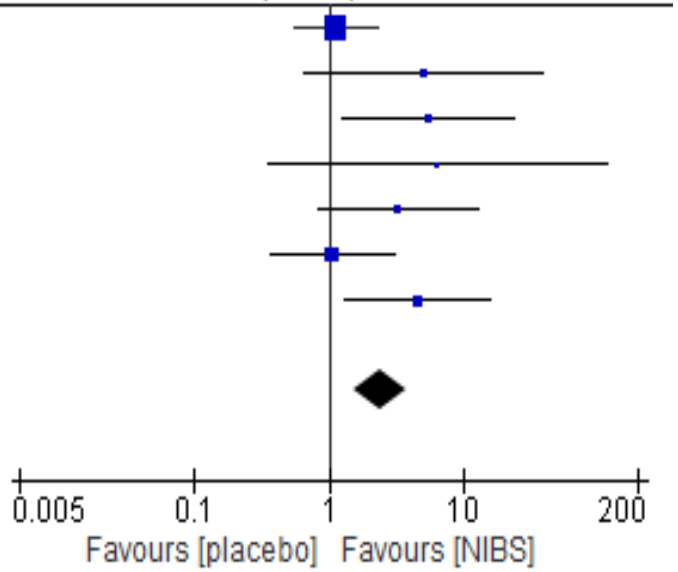
META-ANALYSE / SEVRAGE TABAGIQUE

- Réduction des rechutes (dans les 3-6 mois)

Study or Subgroup	NIBS Events	NIBS Total	Placebo Events	Placebo Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Dieler (6m) 2014	12	38	10	36	42.8%	1.14 [0.56, 2.30]
Dinur-Klein 2014	9	74	1	41	5.4%	4.99 [0.65, 37.98]
Ghorbani-Behnan 2019	11	70	2	70	8.3%	5.50 [1.26, 23.92]
Li 2020	3	22	0	20	2.2%	6.39 [0.35, 116.57]
Sheffer 2018	8	16	2	13	9.2%	3.25 [0.83, 12.74]
Trojak 2015	5	18	5	19	20.3%	1.06 [0.37, 3.04]
Zangen 2021	12	123	3	139	11.8%	4.52 [1.31, 15.65]
Total (95% CI)		**361**		**338**	**100.0%**	**2.40 [1.54, 3.73]**
Total events	60		23			

Heterogeneity: Chi² = 9.97, df = 6 (P = 0.13); I² = 40%

Test for overall effect: Z = 3.88 (P = 0.0001)



Comparison of the point prevalence of smoking abstinence in the mid-term (3 to 6 months) in randomized sham-controlled NIBS studies (fixed effect model). Note : Dieler 6 months, Dinur-Klein 6 months, Ghorbani-Behna 6 months, Li 3 months, Sheffer 3 months, Trojak 3 months, Zangen 4 months

Petit et al., addiction 2022

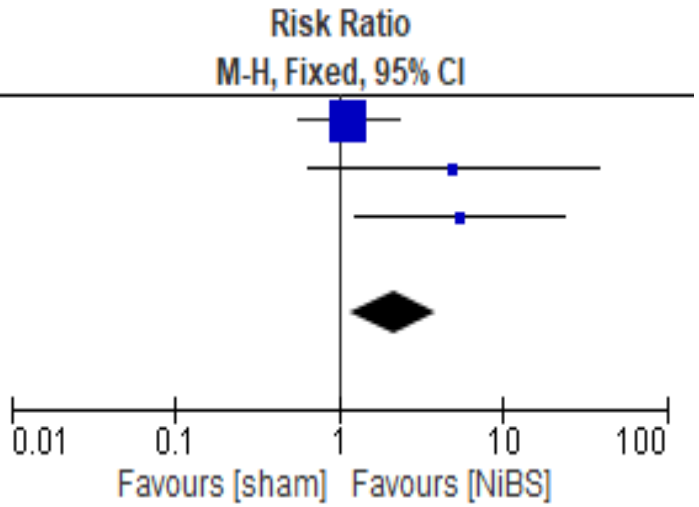
META-ANALYSE / SEVRAGE TABAGIQUE

- Réduction des rechutes (dans les 6 mois)

Study or Subgroup	NIBS Events	NIBS Total	Placebo Events	Placebo Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Dieler (6m) 2014	12	38	10	36	75.8%	1.14 [0.56, 2.30]
Dinur-Klein 2014	9	74	1	41	9.5%	4.99 [0.65, 37.98]
Ghorbani-Behnan 2019	11	70	2	70	14.8%	5.50 [1.26, 23.92]
Total (95% CI)		**182**		**147**	**100.0%**	**2.15 [1.18, 3.90]**
Total events	32		13			

Heterogeneity: Chi² = 5.36, df = 2 (P = 0.07); I² = 63%

Test for overall effect: Z = 2.50 (P = 0.01)



Smoking cessation at 6 months:
RR : 1.55 for NRT (95% CI: 1.49 to 1.61),
RR : 1.62 for bupropion (95% CI 1.49-1.76),
RR : 2.24 for varenicline (95%CI: 2.06-2.43)
RR : 1.69 for e-cigarette (95% CI: 1.25-2.27) compared to pcb or no pharmacotherapy

Petit et al., addiction 2022

PERSPECTIVES

- SCNI + TUT = **45 études**

Row	Saved	Status	Study Title	Conditions	Interventions	Locations
1	☐	Completed	Effects of rTMS on Cigarette Smoking and Cognition in Schizophrenia	• Schizophrenia • Nicotine Addiction	• Device: Repetitive Transcranial Magnetic Stimulation (rTMS) • Device: Sham Repetitive Transcranial Stimulation (rTMS)	• Centre for Addiction and Mental Health Toronto, Ontario, Canada
2	☐	Completed Has Results	tDCS Effects on Resisting Smoking: Dose Ranging Study	• Nicotine Addiction	• Device: transcranial direct current stimulation (tDCS)	• University of Pennsylvania Philadelphia, Pennsylvania, United States
3	☐	Unknown †	Deep Transcranial Magnetic Stimulation (dTMS) to Induce Smoking Cessation	• Smoking Cessation • Transcranial Magnetic Stimulation	• Device: Deep Transcranial Magnetic Stimulation	• Incor - Instituto do Coração do HCFMUSP São Paulo, Brazil
4	☐	Recruiting	Effectiveness of Transcranial Magnetic Stimulation (TMS) in Smoking Cessation, Combining Withdrawal Stimulation Followed by Maintenance Stimulation to Prevent Relapse	• Smoking Cessation	• Other: Transcranial Magnetic Stimulation sessions • Other: Evaluations	• Chu Dijon Bourgogne Dijon, France
5	☐	Completed	Evaluation of Deep Transcranial Magnetic Stimulation (DTMS) With the H-ADD Coil as an Aid to Smoking Cessation	• Smoking Cessation	• Device: Sham Treatment • Device: Active dTMS Treatment	• Pacific Institute of Medical Research Los Angeles, California, United States • University of California - San Diego Medical Center San Diego, California, United States • TMS Center of Colorado Denver, Colorado, United States • (and 15 more...)
6	☐	Completed	Enhancing Relapse Prevention for Smoking Cessation With Repetitive Transcranial Magnetic Stimulation	• Smoking Cessation	• Device: rTMS Active 20Hz • Device: rTMS Sham	• The City College of New York New York, New York, United States
7	☐	Withdrawn	Transcranial Direct Current Stimulation in a Smoking Cessation Trial	• Nicotine Dependence	• Device: active transcranial Direct Current Stimulation • Device: sham transcranial Direct Current Stimulation	• Centre for Addiction and Mental Health (Nicotine Dependence Clinic) Toronto, Ontario, Canada
8	☐	Completed	High-Frequency Repetitive Transcranial Magnetic Stimulation Assists In Smoking Cessation	• Heavy Smoking	• Device: Transcranial Magnetic Stimulation 10Hz • Device: Magnetic stimulation using a special sham coil	• Sheba Medical Center Ramat Gan, Israel
9	☐	Recruiting	Effectiveness of Transcranial Magnetic Stimulation (TMS) in Smoking Cessation, Combining Withdrawal Stimulation Followed by Maintenance Stimulation to Prevent Relapse	• Smoking Cessation	• Device: Active TCS • Device: Placebo TCS • Drug: nicotine treatment • Other: Questionnaires	• Chu Dijon Bourgogne Dijon, France

ClinicalTrials.gov (novembre 2022)

BrainsWay

Autorisation de la FDA dans le sevrage tabac à court terme

Zangen, World Psy 2021

Merci pour votre attention