



Effets de stimulations électriques magnétiques d'extrêmes basses fréquences sur la performance vestibulaire chez l'Homme.

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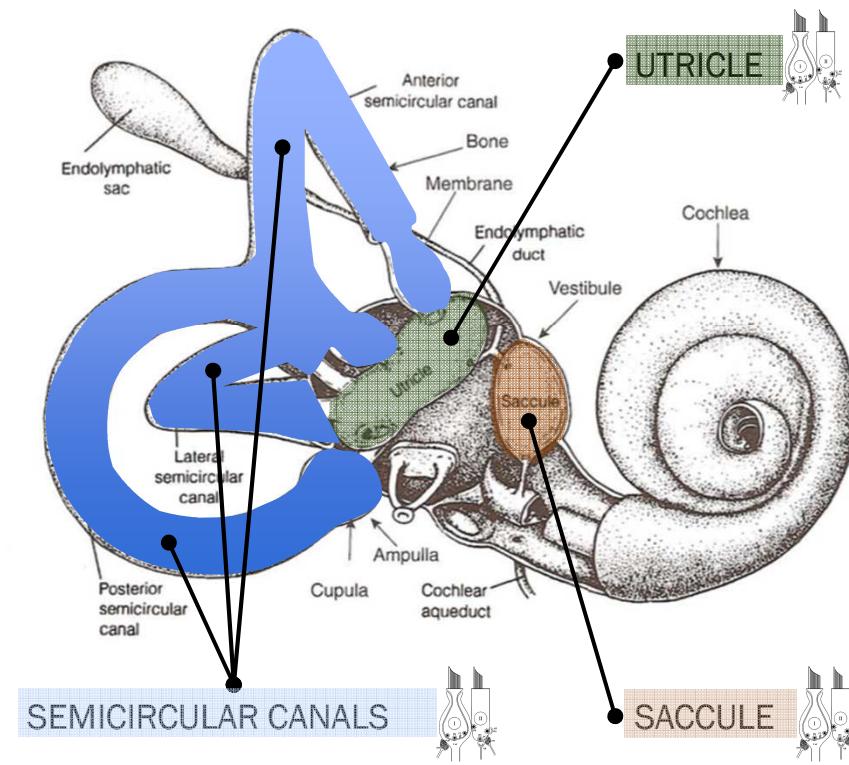
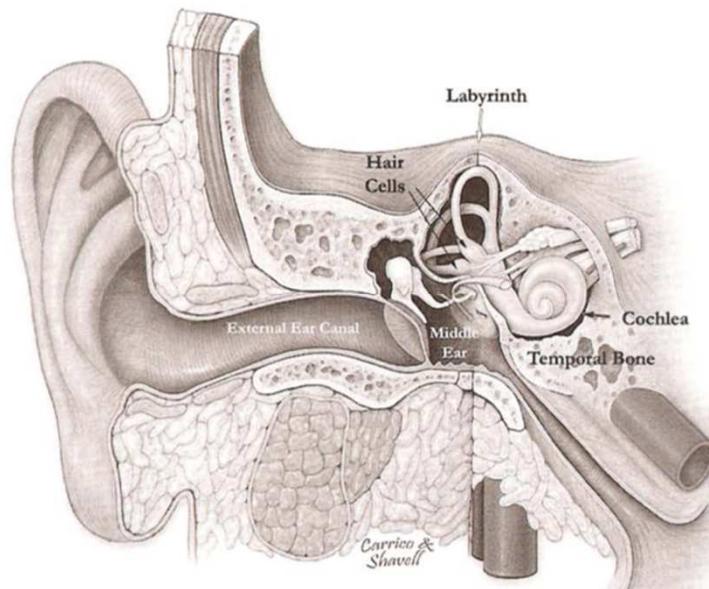
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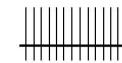
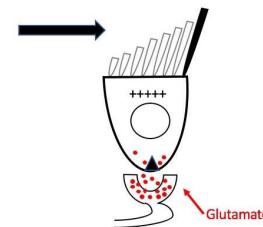
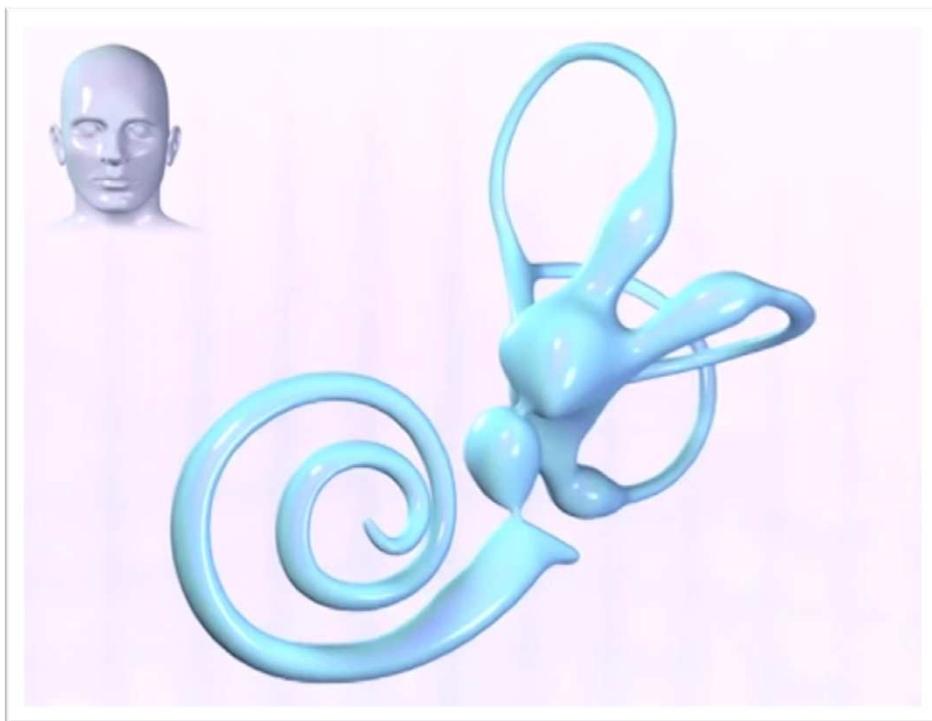
¹² NeuRA, Sydney, Australia



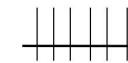
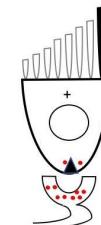
Le Système Vestibulaire



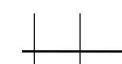
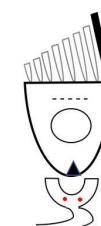
The Vestibular System: Hair Cells



160 spikes/secs
Excitation



90 spikes/secs
Resting

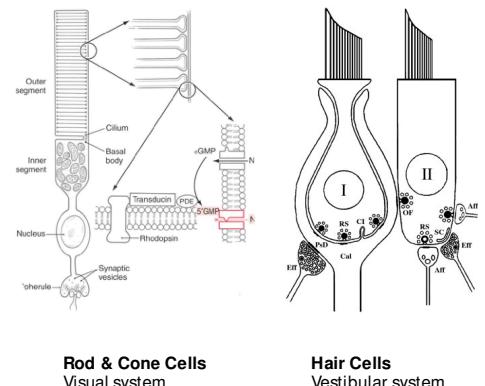


20 spikes/secs
Inhibition

Le Système Vestibulaire:

interaction avec un champ magnétique d'extrême basse fréquence (CM EBF)?

1 Similarités des cellules Visuelles-Vestibulaires



2 Effets oculomoteur avec CM EBF

Patel et al. J. Occup. Environ. Med. 2008
Heinrich et al. J. Magn. Reson. Imaging 2011
Heinrich et al. Radiology 2013.
De Vocht et al. 2003 Magn Reson Med
De Vocht et al. 2006 Magn. Reson. Imaging
De Vocht et al. 2007 Bioelectromagnetics

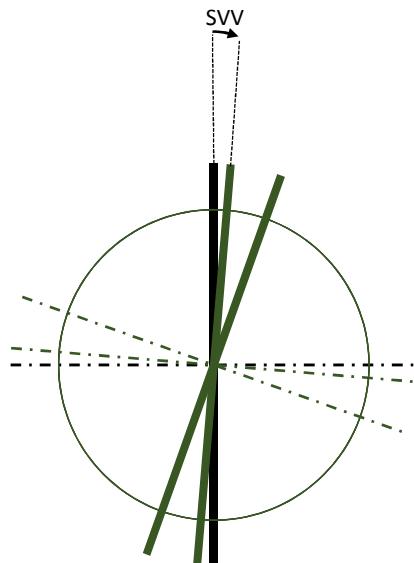
3 Effets oculomoteur de la SVG



Verticale Visuelle Subjective (VVS)

“La verticale Visuelle Subjective (VVS) est une mesure psychophysique de l’angle entre la verticale perçue et la vraie verticale gravitationnelle.”

Akin & Murnane, 2009, Seminars in hearing, vol. 30, 4, 281-286



EXPERIMENTS ON SENSORY-TONIC FIELD THEORY OF PERCEPTION: III. EFFECT OF BODY ROTATION ON THE VISUAL PERCEPTION OF VERTICALITY¹

BY SEYMOUR WAPNER, HEINZ WERNER, AND RICARDO B. MORANT

Clark University

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S. WAPNER, H. WERNER, AND R. B. MORANT

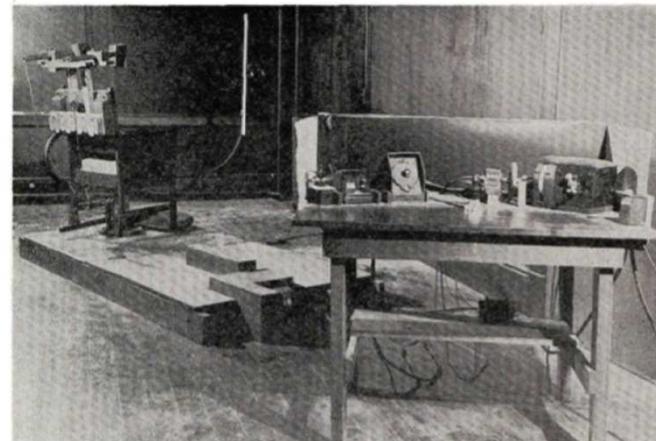


FIG. 1. Rotating chair and control desk

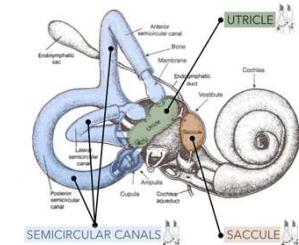
Introduite par Wapner et al., 1951

S. Wapner, H. Werner, K.A. Chandler, Experiments on sensory-tonic field theory of perception: I. Effect of extraneous stimulation on the visual perception of verticality., J. Exp. Psychol. 42 (1951) 341–345.

Lien avec le système vestibulaire en 1970

G. Friedmann, The judgement of the visual vertical and horizontal with peripheral and central vestibular lesions, brain. 93 (1970) 313–328.

Verticale Visuelle Subjective (VVS)

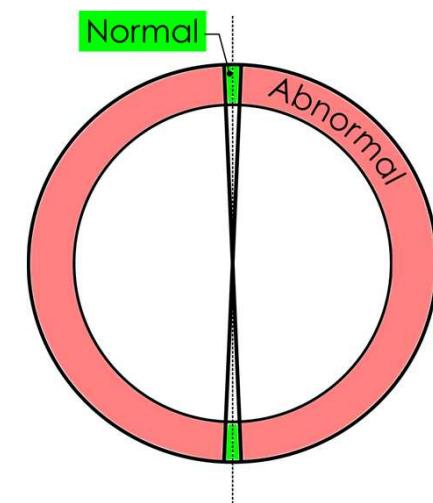


Fonction vestibulaire normale – VVS < 2.5°:

- $\pm 2.0^\circ$ (Akin & Murnane, 2009; Bohmer, 1999; Friedmann, 1970, Murray et al., 2007; Tabak et al., 1997; Vibert & Häusler, 2000)
- $\pm 2.5^\circ$ (Tribukait et al., 1996; Tribukait & Bergenius, 1998; Tribukait & Eiken, 2005, Tribukait et al. 2004)
- $\pm 3.0^\circ$ (Hafstrom et al. 2004; Karlberg et al., 2002)

Fonction vestibulaire anormale – VVS > 2.5°:

- Maladie de Ménière's disease: $< \pm 2.5^\circ$ pre-attack to abnormal during attack (Kumagami et al., 2009)
- Nevrite vestibulaire unilaterale : $\approx 3.5^\circ$ (Min et al., 2007)
- Déafferentation chirurgicale: $10-30^\circ$ (Vibert et al., 1999)
- Labyrintite vestibulaire (Vibert et al., 1999)



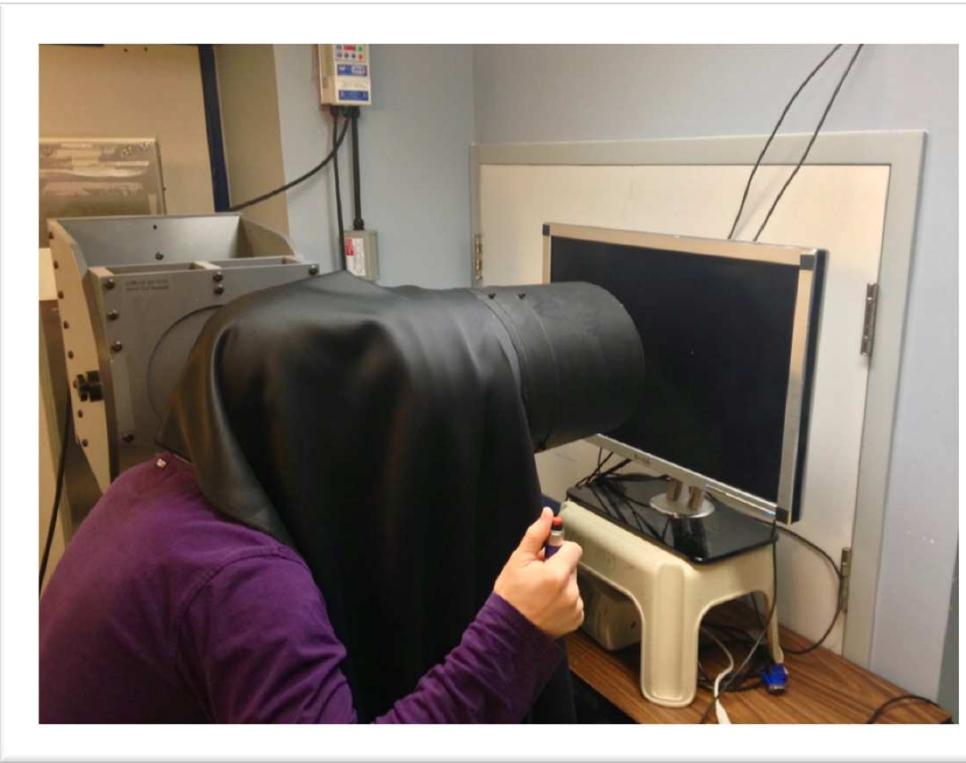
Déviation vers l'anode pendant SVG ($\pm 1^\circ$):

(Mars, 2001; Volkering et al., 2014, Oppenländer et al., 2015)

Diapositive 7

SV2 value of SVV for GVS studies
Sebastien Villard; 18/04/2017

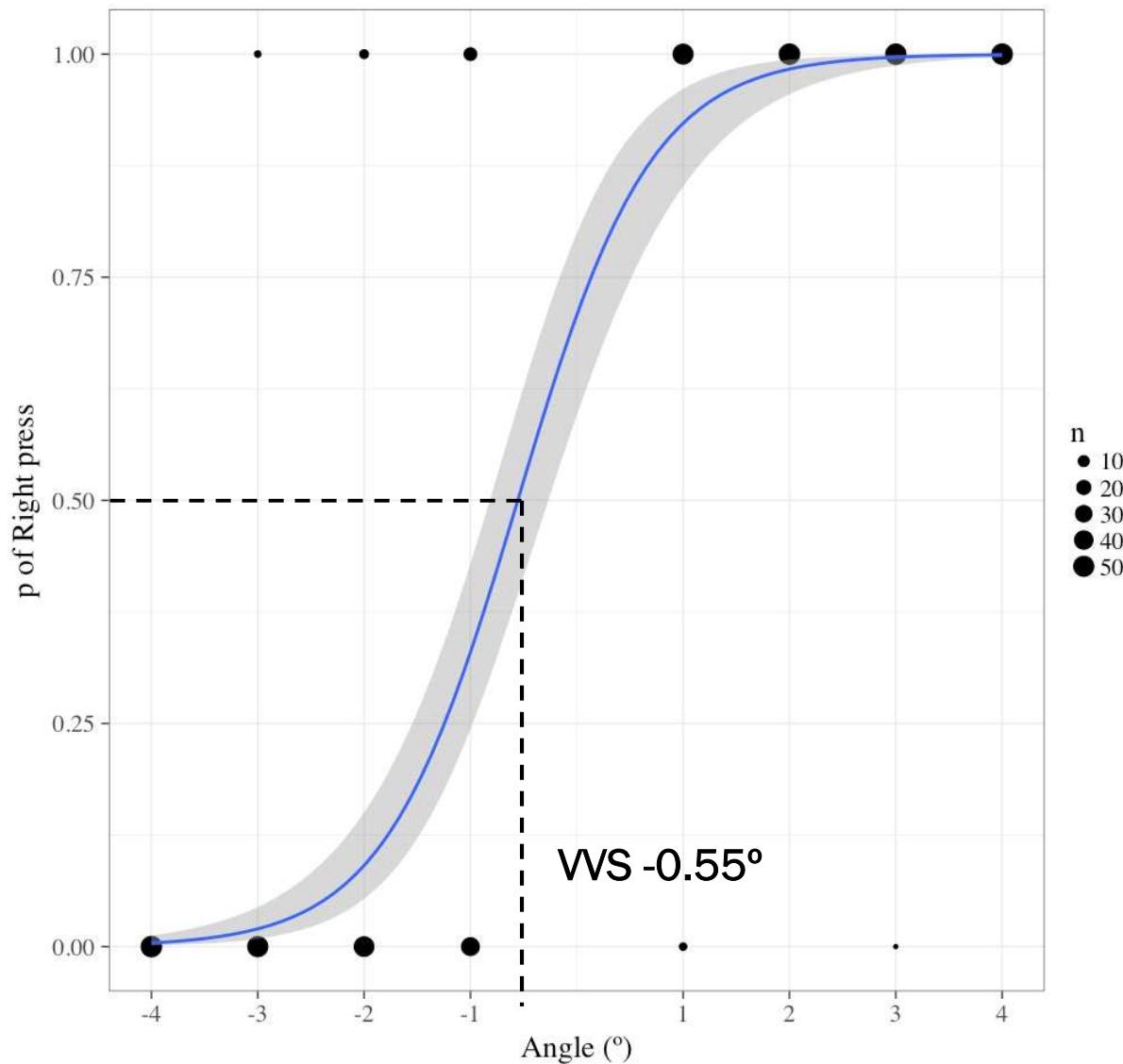
VVS: choix forcé à deux alternatives (CF2A)



“Vous allez voir en face de vous une ligne penchée vers la droite ou vers la gauche. Quand vous verrez cette ligne, pressez le bouton droit si la ligne est penchée sur la droite ou pressez le bouton gauche si la ligne est penchée sur la gauche. Si vous n’êtes pas sûr vous devez quand même choisir entre droite ou gauche.”



VVS: choix forcé à deux alternatives (CF2A)



VVS: méthodes



8 participants (étude pilote)
100mT @ 2cm

15 participants
100mT @ 2cm

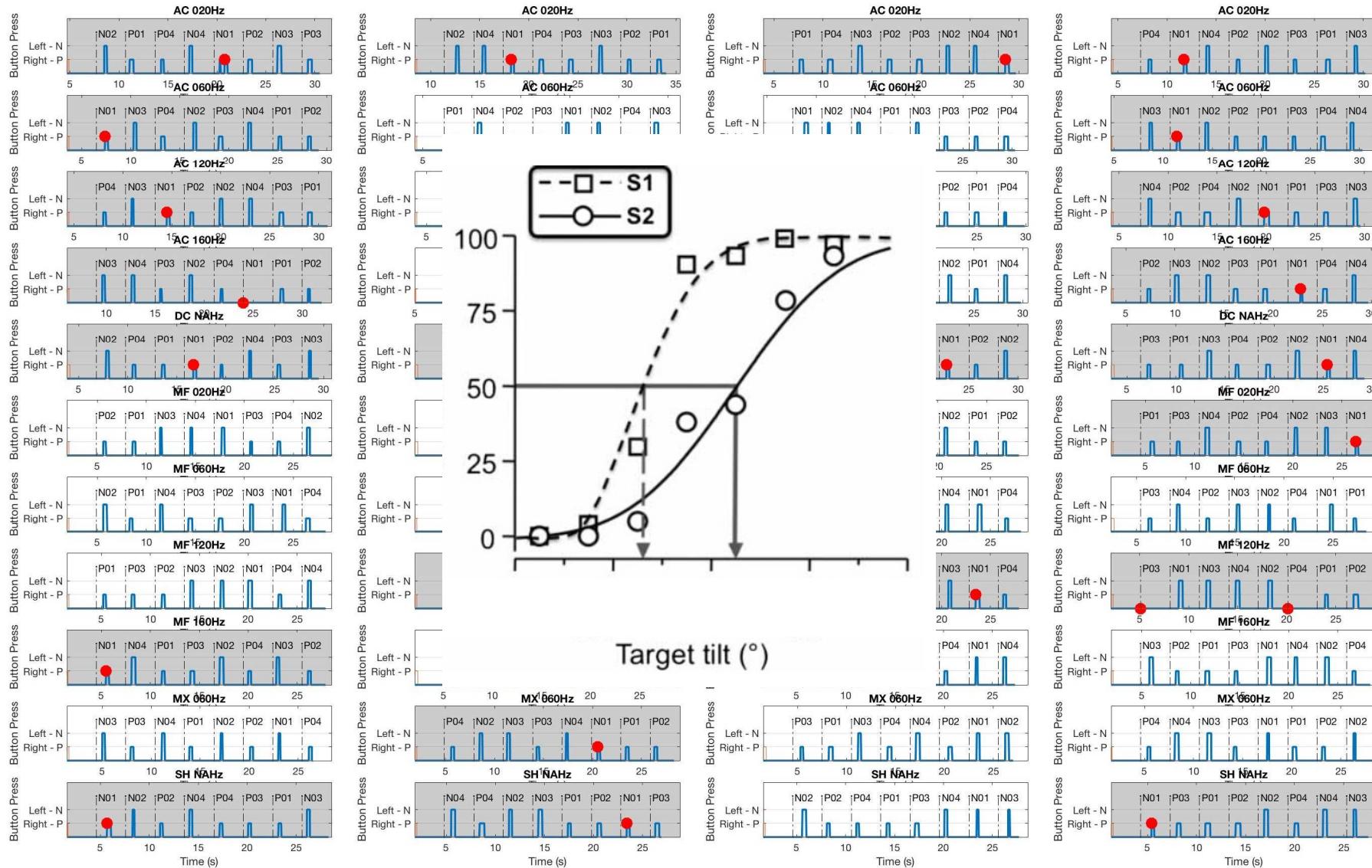
30s de stimulation: 4 stimulations
4 repetitions



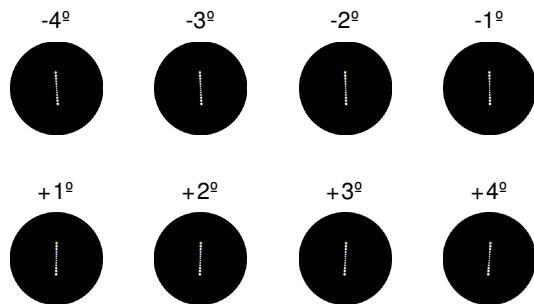
- 1. SHAM
 - 2. DC 2mA
 - 3. AC 2mA (60 Hz)
 - 4. MF 100 mT (60 Hz)
- Constant $\text{dB/dt} = 12.6 \text{T.s}^{-1}$
20 – 60 – 120 – 160 Hz

Simulator Sickness Questionnaire (SSQ):
Avant et Après experimentation

SV.1.1: 2AFC

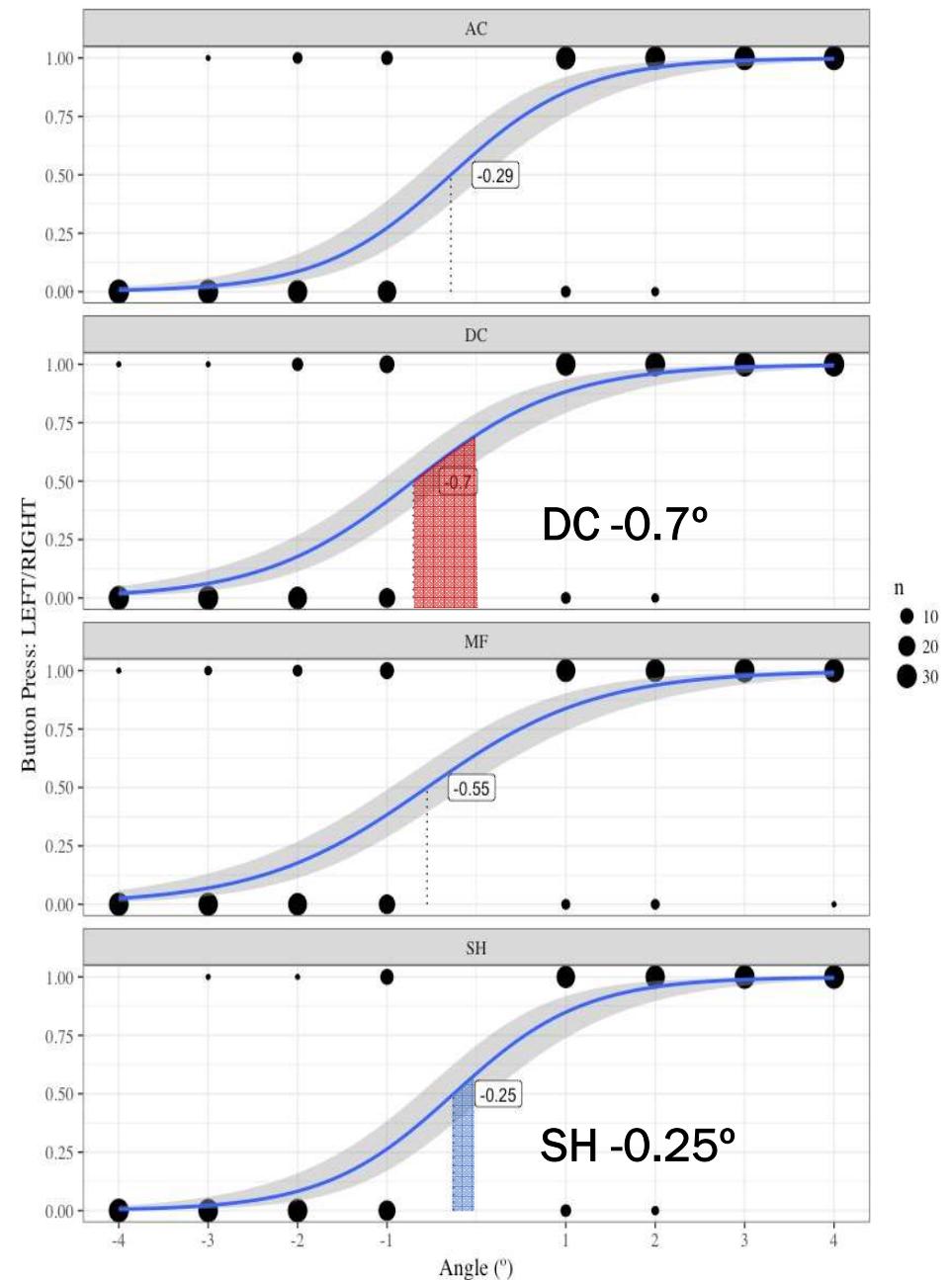


VVS: étude pilote 8 participants



Déviation vers la gauche pour DC et MF

SH et AC similaire



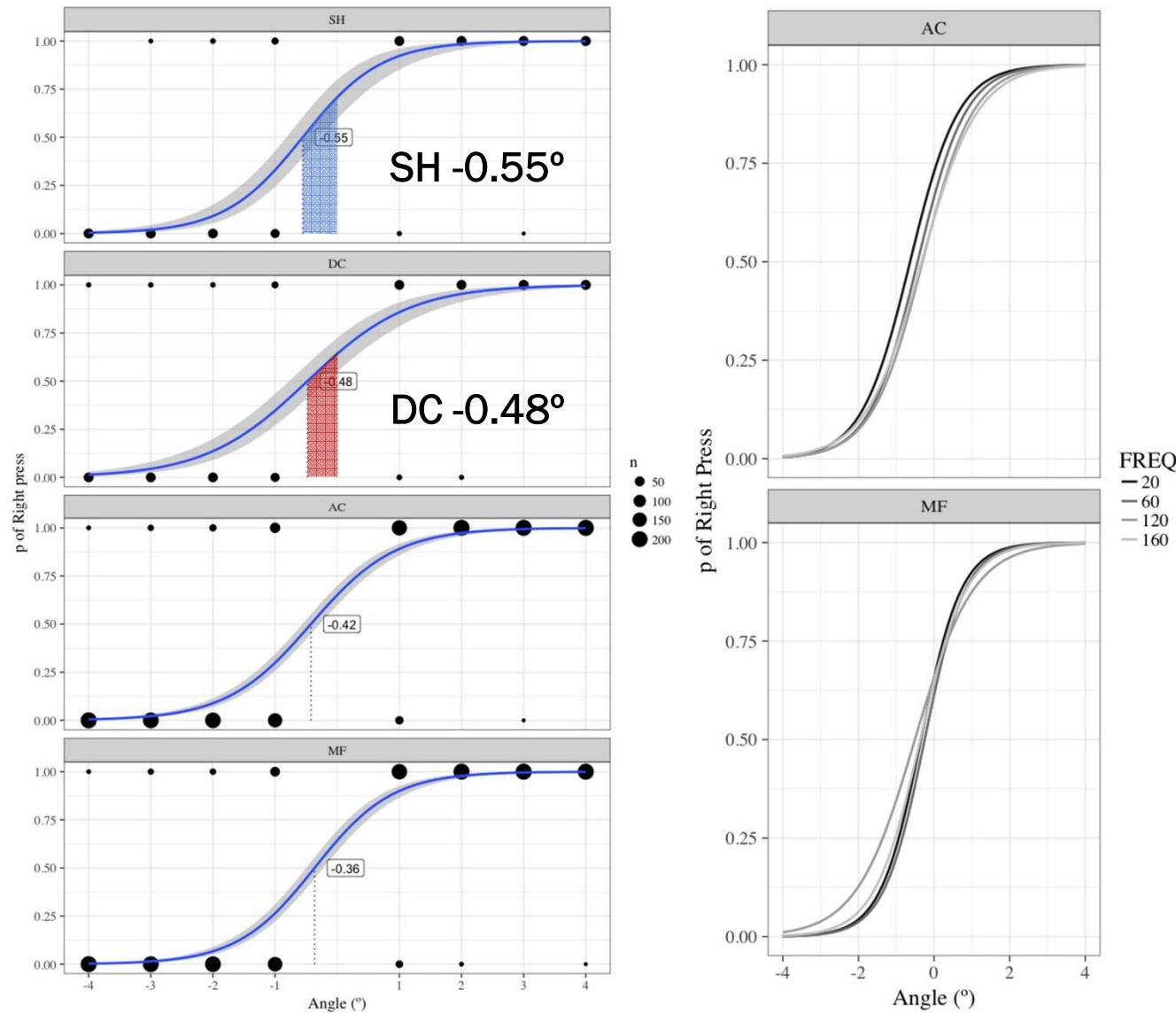
Diapositive 13

SV1

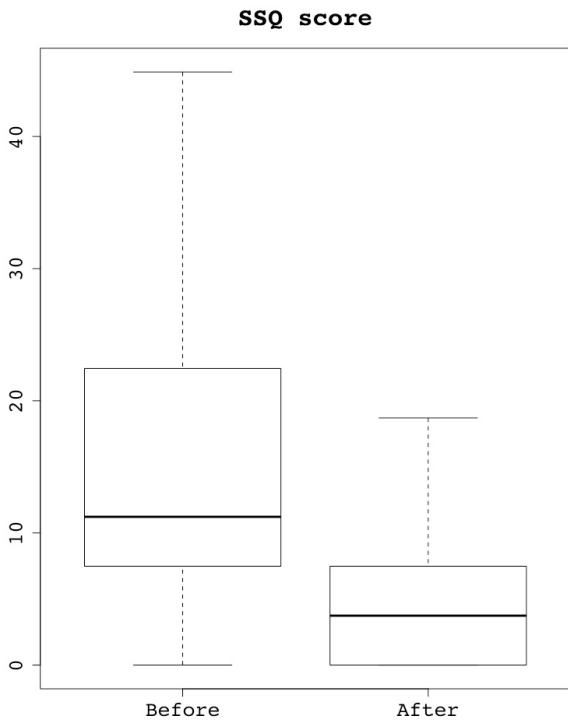
angles - slopes values

Sebastien Villard; 13/04/2017

VVS: 15 participants



SV.1.2: results



Wilcoxon signed rank test to compare the rank of pretest and posttest scores

p<.01

No _____ Date _____

SIMULATOR SICKNESS QUESTIONNAIRE

Kennedy, Lane, Berbaum, & Lilienthal (1993)***

Instructions : Circle how much each symptom below is affecting you **right now**.

| | | | | |
|--------------------------------|-------------|---------------|-----------------|---------------|
| 1. General discomfort | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 2. Fatigue | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 3. Headache | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 4. Eye strain | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 5. Difficulty focusing | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 6. Salivation increasing | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 7. Sweating | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 8. Nausea | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 9. Difficulty concentrating | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 10. « Fullness of the Head » | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 11. Blurred vision | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 12. Dizziness with eyes open | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 13. Dizziness with eyes closed | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 14. *Vertigo | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 15. **Stomach awareness | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 16. Burping | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |

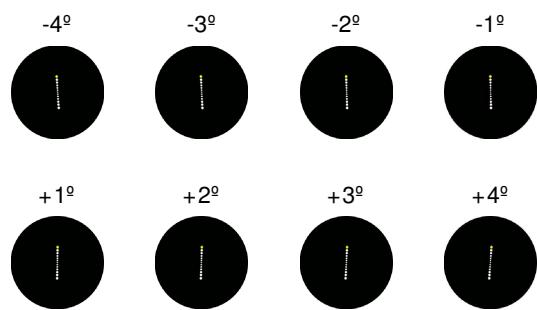
* Vertigo is experienced as loss of orientation with respect to vertical upright.

** Stomach awareness is usually used to indicate a feeling of discomfort which is just short of nausea.

***Original version : Kennedy, R.S., Lane, N.E., Berbaum, K.S., & Lilienthal, M.G. (1993). Simulator Sickness Questionnaire: An enhanced method for quantifying simulator sickness. *International Journal of Aviation Psychology*, 3(3), 203-220.

Kennedy et al., 1993, Int J Aviat Psychol

SVV: discussion/conclusion



Pas d'effet DC
Contrôle positif

Pas d' interaction ELF MF

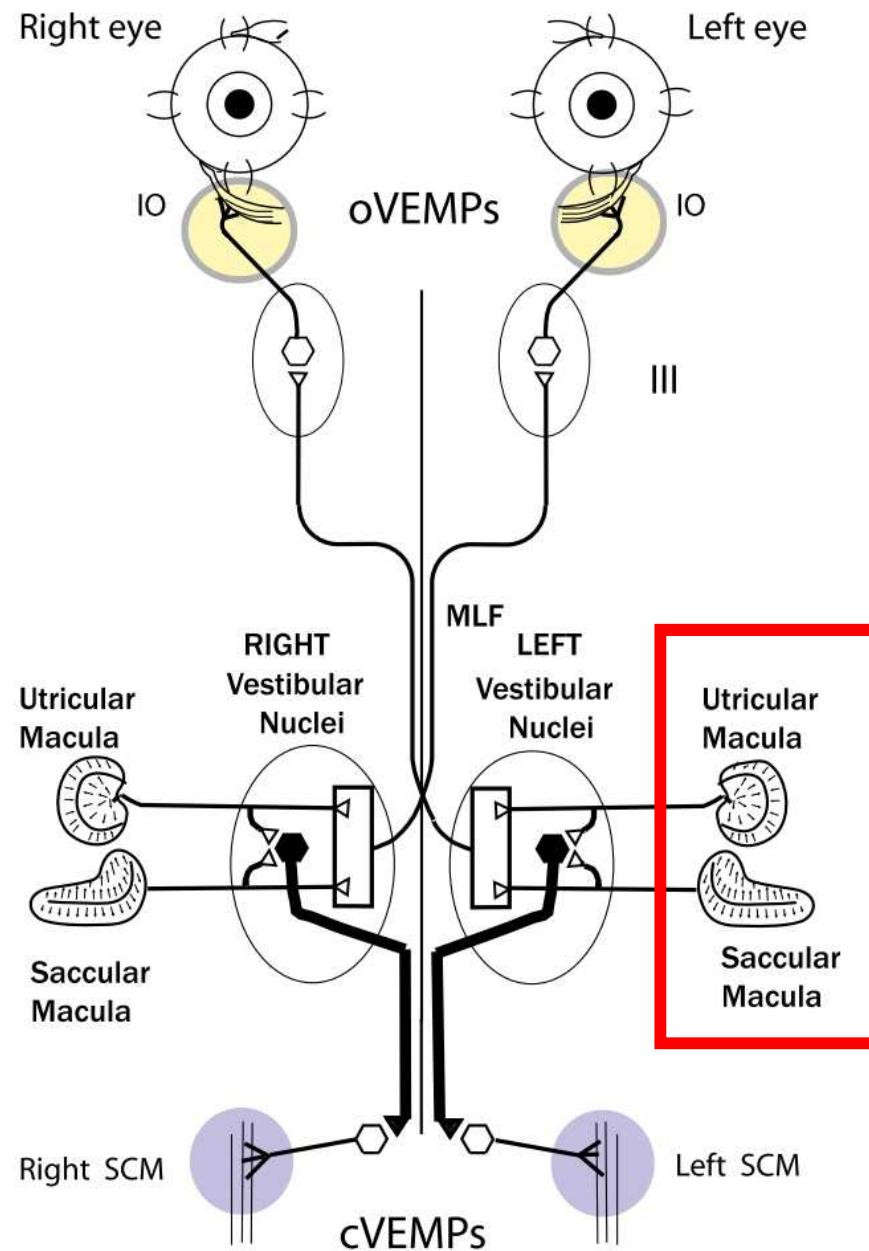
Biais vers la gauche :
Les informations vestibulaires sont
majoritairement intégrées dans l'hémisphère
cortex non dominant.

(Santos-Pontelli, 2016; Dieterich 2008 & 2010)
93% droitiers

Changement de mesure ...
Besoin d'une meilleure résolution



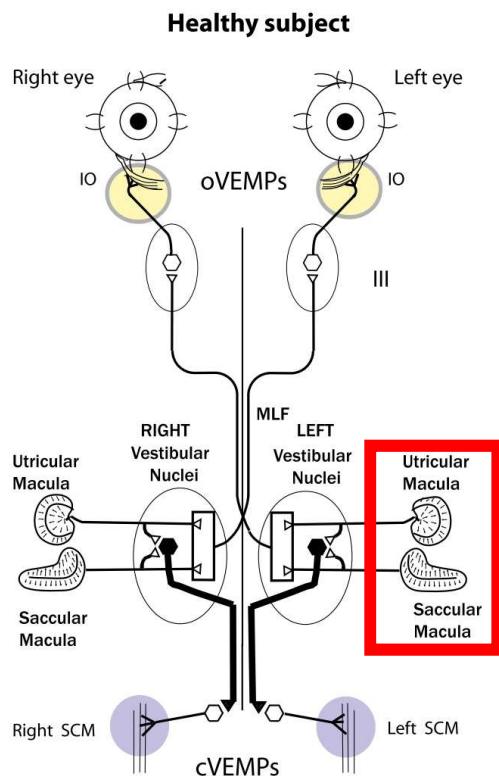
Discussion: SVV



Curthoys, 2017

Discussion : SVV

Réflexe vestibulo-oculaire : 6-8 ms



Cependant : la mesure de la SVV > de 0.7 ° à la mesure de la torsion oculaire.
Zink et al., 1998.

SVV = mesure de la représentation centrale de la gravité
Mars et al., 2001

Discussion: SVV

Perception avec CA (2.5 mA – 0.8 Hz): 400 ms après le début de la stimulation (Barnett-Cowan, 2009, Exp Brain res.)

Fréquence de Stimulation

Perception avec CA (2.5 mA – 0.1 to 5Hz):

- 100% @ 0.1 – 1Hz
- 91% @ 2Hz
- 40% @ 5Hz

(Stephan et al., 2005, NeuroImage)

Effet (<5Hz)?

Discussion : SVV

Variabilité Inter-individuelle

min 0.62 V.m^{-1}

max 1.43 V.m^{-1}

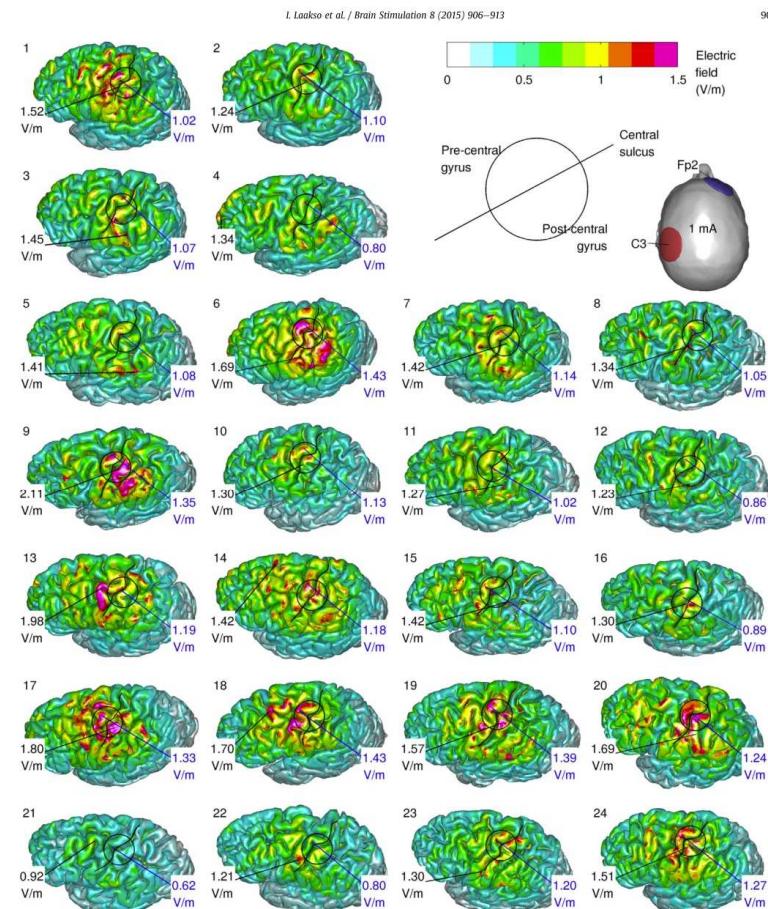
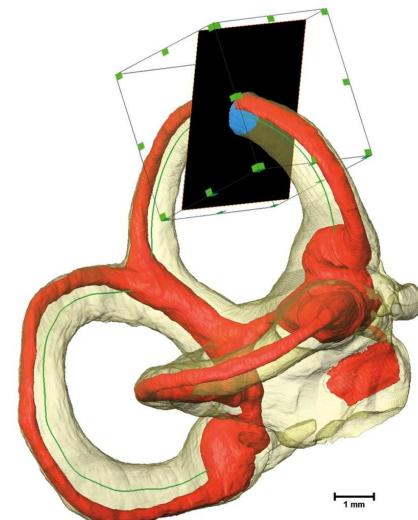
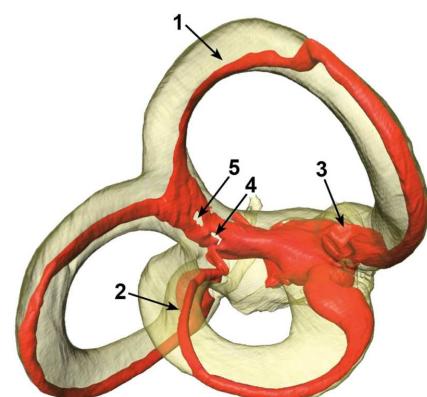


Figure 4. Electric fields on the left hemisphere of 24 subjects for tDCS of the motor cortex. The locations and magnitudes of the maximum electric field over the whole hemisphere (black) and maximum electric field in the region of interest (blue) are indicated for each subject. The circle surrounds the vicinity of the hand motor area. The brain surfaces are not drawn to scale. A current of 1 mA is used in the stimulation. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Laakso et al., 2015, Brain Stimulation

Discussion : SVV

Variabilité Inter-individuelle



Futures recherches: réflexe vestibulo-oculaire





Merci pour votre attention!

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