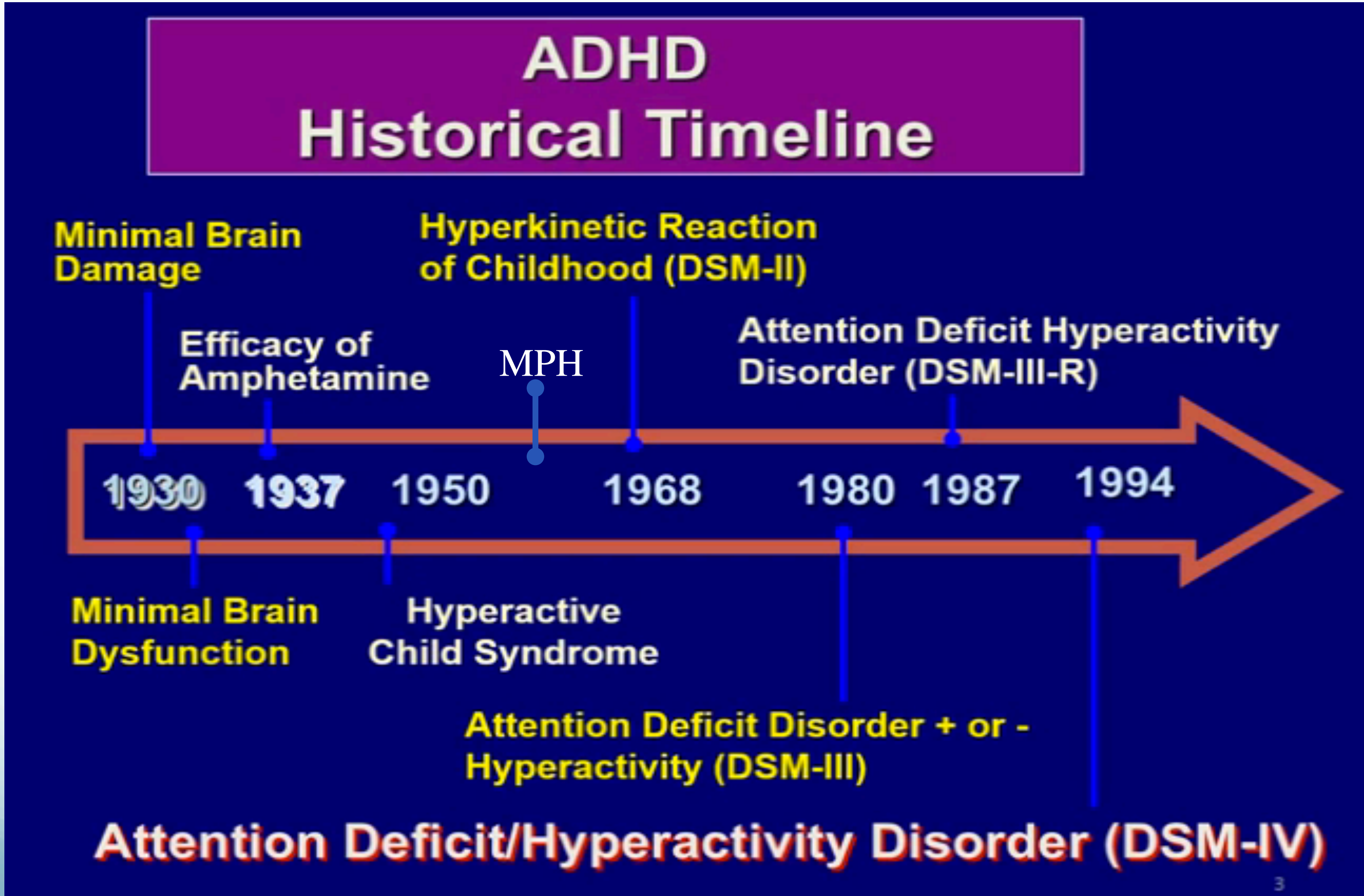
Cerveau et TDAH

Quelques concepts et données de la littérature scientifique récente

Michel Habib
Résodys et CERTA, Marseille


ADHD
Historical Timeline
Minimal Brain Damage
Efficacy of Amphetamine
MPH
Hyperkinetic Reaction of Childhood (DSM-II)
Attention Deficit Hyperactivity Disorder (DSM-III-R)
1930
1937
1950
1968
1980
1987
1994
Minimal Brain Dysfunction
Hyperactive Child Syndrome
Attention Deficit Disorder + or - Hyperactivity (DSM-III)
Attention Deficit/Hyperactivity Disorder (DSM-IV)
3

Attention Deficit Hyperactive Disorder

Must meet **at least 6** of the criteria within A1 and/or A2, and have experienced for at least the past 6 months.

A1: Inattention

a. Often fails to give close attention to details or makes careless mistakes in schoolwork, at work, or during other activities (e.g., overlooks or misses details, work is inaccurate).

b. Often has difficulty sustaining attention in tasks or play activities (e.g., has difficulty remaining focused during lectures, conversations, or reading lengthy writings).

c. Often does not seem to listen when spoken to directly (e.g., mind seems elsewhere, even in the absence of any obvious distraction).

d. Often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (e.g., starts tasks but quickly loses focus and is easily sidetracked; fails to finish schoolwork, household chores, or tasks in the workplace).

e. Often has difficulty organizing tasks and activities (e.g., difficulty managing sequential tasks; difficulty keeping materials and belongings in order; messy, disorganized, work; poor time management; tends to fail to meet deadlines).

f. Often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (e.g., schoolwork or homework; for older adolescents and adults, preparing reports, completing forms, or reviewing lengthy papers).

g. Often loses things necessary for tasks or activities (e.g., school materials, pencils, books, tools, wallets, keys, paperwork, eyeglasses, or mobile telephones).

h. Is often easily distracted by extraneous stimuli (for older adolescents and adults, may include unrelated thoughts).

i. Is often forgetful in daily activities (e.g., chores, running errands; for older adolescents and adults, returning calls, paying bills, keeping appointments).

A2: Hyperactivity and Impulsivity

a. Often fidgets with or taps hands or feet or squirms in seat.

b. Often leaves seat in situations when remaining seated is expected (e.g., leaves his or her place in the classroom, office or other workplace, or in other situations that require remaining seated).

c. Often runs about or climbs in situations where it is inappropriate. (In adolescents or adults, may be limited to feeling restless).

d. Often unable to play or engage in leisure activities quietly.

e. Is often "on the go," acting as if "driven by a motor" (e.g., is unable or uncomfortable being still for an extended time, as in restaurants, meetings, etc; may be experienced by others as being restless and difficult to keep up with).

f. Often talks excessively.

g. Often blurts out an answer before a question has been completed (e.g., completes people's sentences and "jumps the gun" in conversations, cannot wait for next turn in conversation).

h. Often has difficulty waiting his or her turn (e.g., while waiting in line).

i. Often interrupts or intrudes on others (e.g., butts into conversations, games, or activities; may start using other people's things without asking or receiving permission, adolescents or adults may intrude into or take over what others are doing).

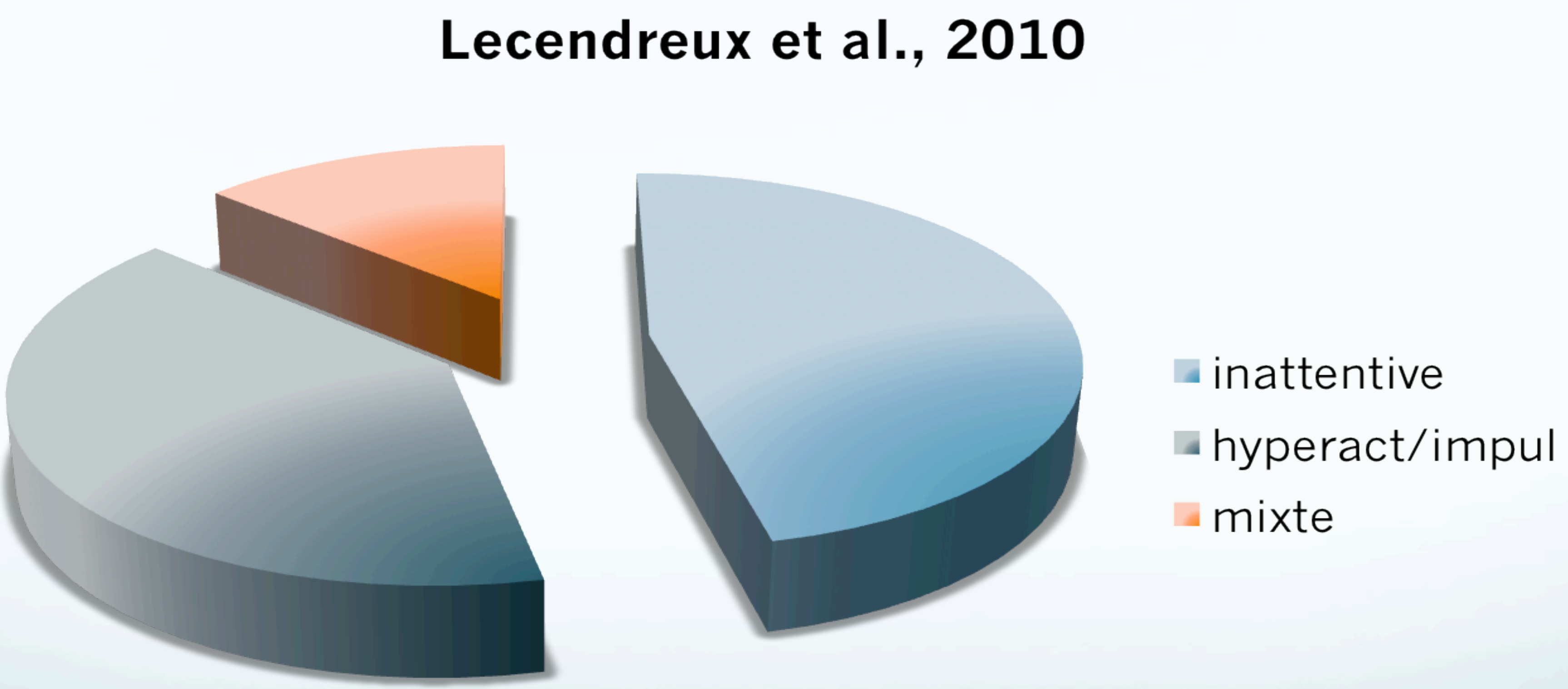
B. Several inattentive or hyperactive-impulsive symptoms were present prior to age 12.

C. Criteria for the disorder are met in two or more settings (e.g., at home, school or work, with friends or relatives, or in other activities).

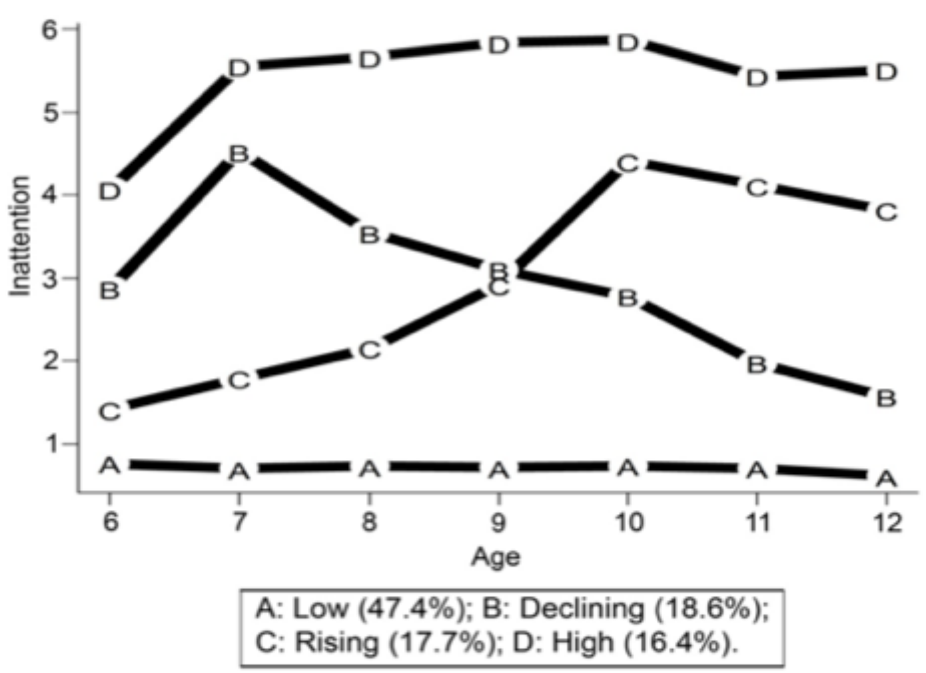
D. There must be clear evidence that the symptoms interfere with or reduce the quality of social, academic, or occupational functioning.

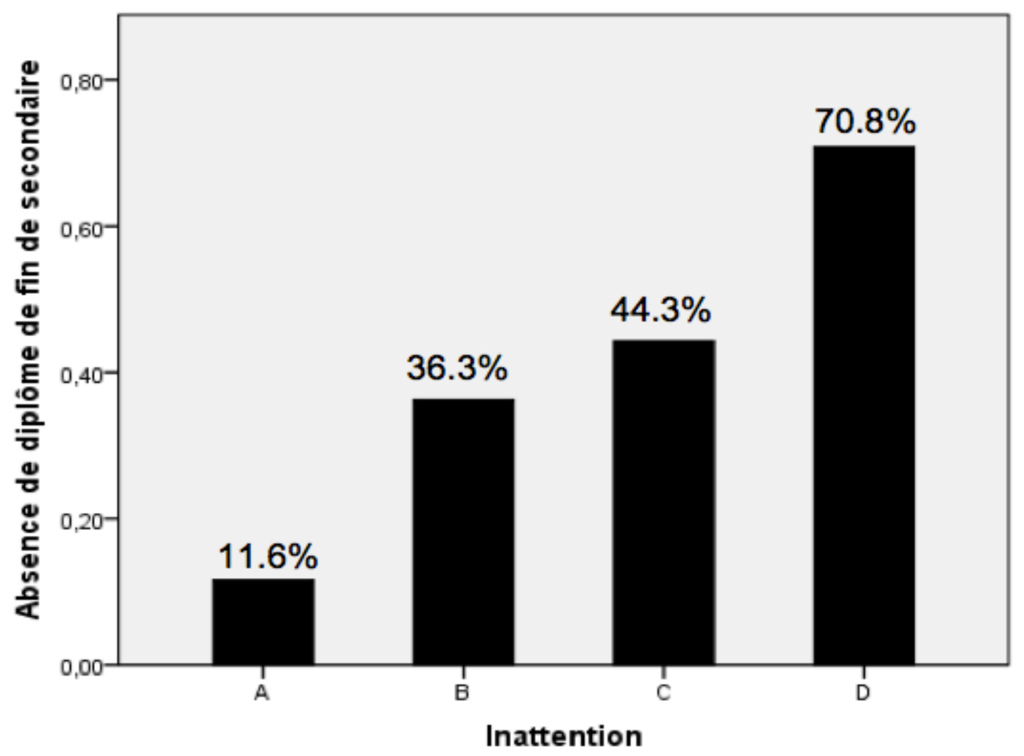
E. The symptoms do not occur exclusively during the course of schizophrenia or another psychotic disorder and are not better accounted for by another mental disorder (e.g., mood disorder, anxiety disorder, dissociative disorder, or a personality disorder).

Incidence en France : 3,5%



Trajectoires des symptômes d'inattention et résultats scolaires dans le TDAH (Pingault et al., Am Journal of Psychiatry, 2011)





« Inattention rather than hyperactivity during elementary school significantly predicts long-term educational attainment. Children with attention problems, regardless of hyperactivity, need preventive intervention early in their develop ment. »

Neurologie du TDAH

- Deux modèles qui s'opposent
  - modèle classique : TDAH = défaut d'inhibition de l'action (Barkley)
    - Ref : systèmes de contrôle exécutif : "cool" executive
  - Modèle plus récent : TDAH = défaut de capacité à différer la récompense (delay aversion = "hot executive")
    - Ref : modèle des circuits de la récompense
    - Cf. comorbidité troubles des conduites (CD) ~ 50%
- Les pistes actuelles : défaut de connectivité

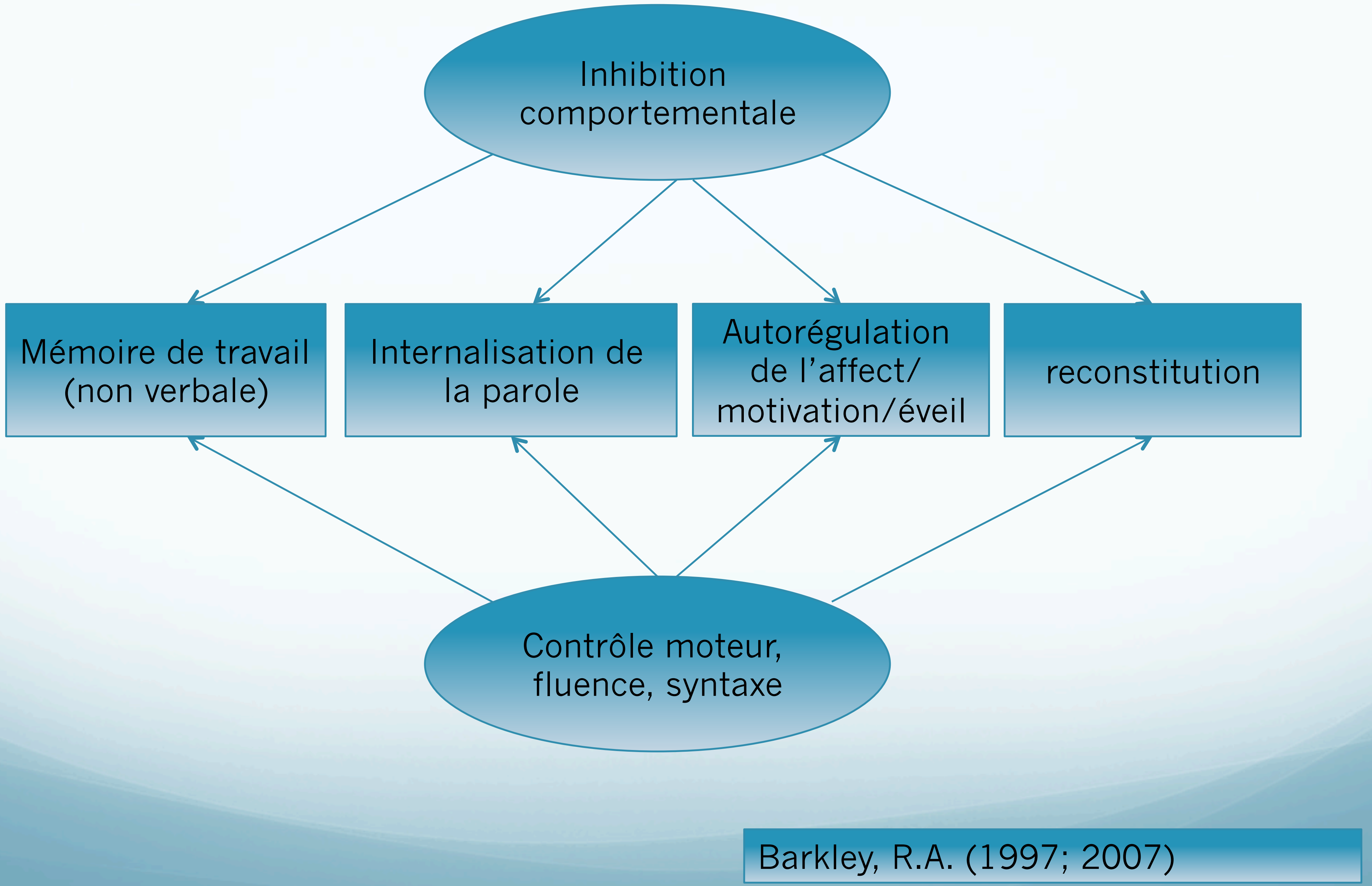
I/ Le modèle classique

= inhibition de l'action (Barkley)

Imagerie fonctionnelle dans des protocoles d'inhibition (go-no-go, stop signal, flanker, Stroop….)

→ Hypofonctionnement du cortex frontal

→ Notion de dysfonctionnement exécutif


Inhibition comportementale
Mémoire de travail (non verbale)
Internalisation de la parole
Autorégulation de l'affect/ motivation/éveil
reconstitution
Contrôle moteur, fluence, syntaxe
Barkley, R.A. (1997; 2007)

ADVANCING THE NEUROSCIENCE OF ADHD

Structural Brain Imaging of Attention-Deficit/
Hyperactivity Disorder

Larry J. Seidman, Eve M. Valera, and Nikos Mal

ELSEVIER SAUNDERS

Psychiatr Clin N Am 27 (2004) 323–347

Brain function and structure attention-deficit/hyperactiv

Larry J. Seidman, PhD[a–f,*], Eve M. George Bush, MD, MS

Neuropsychopharmacology REVIEWS (2010) 35, 27
© 2010 Nature Publishing Group All rights reserved 0893-133X/10
278 www.neuropsychopharmacol

Human Brain Mapping 31:904–916 (2010)

Is the ADHD Brain Wired Differently? A Review on Structural and Functional Connectivity in Attention Deficit Hyperactivity Disorder

Kerstin Konrad,[1,2,3]* and Simon B. Eickhoff[2,3,4]

[1]*Child Neuropsychology Section, Department of Child and Adolescent Psychiatry and Psychotherapy, University Hospital of the RWTH Aachen, Germany*
[2]*Institute of Neuroscience and Medicine (INM-2, INM-3), Research Center Juelich, Germany*
[3]*JARA – Translational Brain Medicine, Germany*
[4]*Department of Psychiatry and Psychotherapy, University Hospital of the RWTH Aachen University, Germany*

Attention-Deficit/Hyperactivity Disorder and Attention Networks

George Bush*,[1,2,3,4]

Eur Arch Psychiatry Clin Neurosci (2006) 256 [Suppl 1]:I/32–I/41

Marc Schneider · Wolfgang Retz · Andrew Coogan · Johannes Thome · Michael Rösler

Anatomical and functional brain imaging in adult attention-deficit/hyperactivity disorder (ADHD) – A neurological view

MENTAL RETARDATION AND DEVELOPMENTAL DISABILITIES RESEARCH REVIEWS *9: 184–195 (2003)*

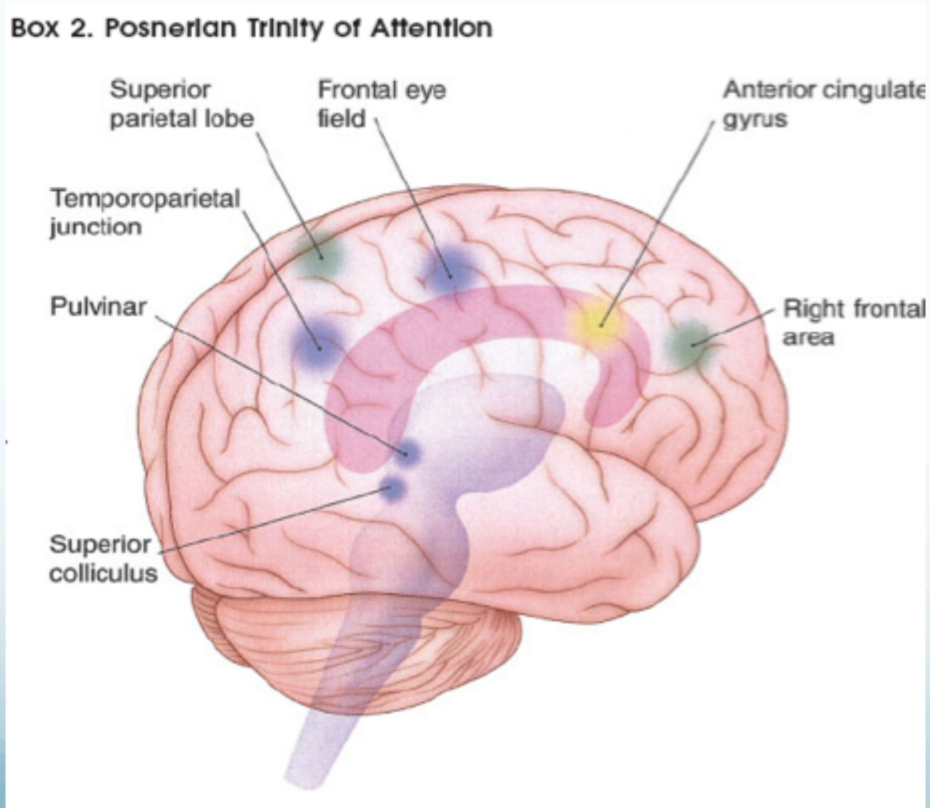
A REVIEW OF THE BIOLOGICAL BASES OF ADHD: WHAT HAVE WE LEARNED FROM IMAGING STUDIES?

Sarah Durston*

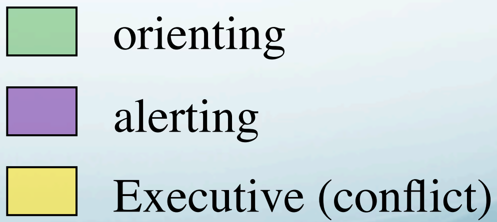
Department of Child and Adolescent Psychiatry, University Medical Center Utrecht, the Netherlands and Sackler Institute for Developmental Psychobiology, Weill Medical College of Cornell University, New York, New York

Substrat cérébral du trouble attentionnel

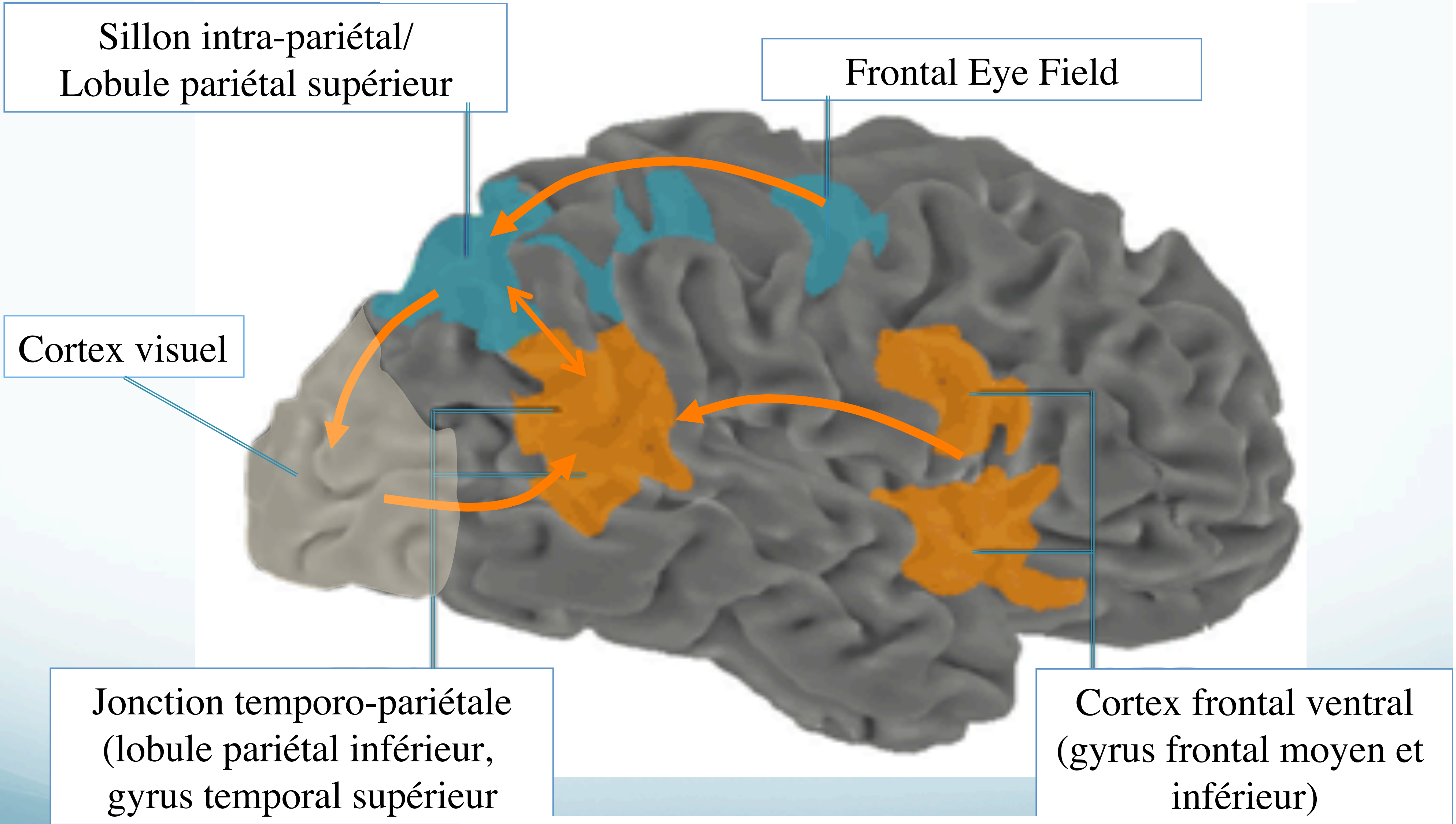
- Travaux de Posner et coll.



Le triple système de l'attention selon Posner : alerte, orientation, contrôle exécutif



Réseau fronto-pariétal dorsal (bilatéral) : attention endogène; génération d'un « set attentionnel » applicable lors du traitement du stimulus dans une tâche donnée

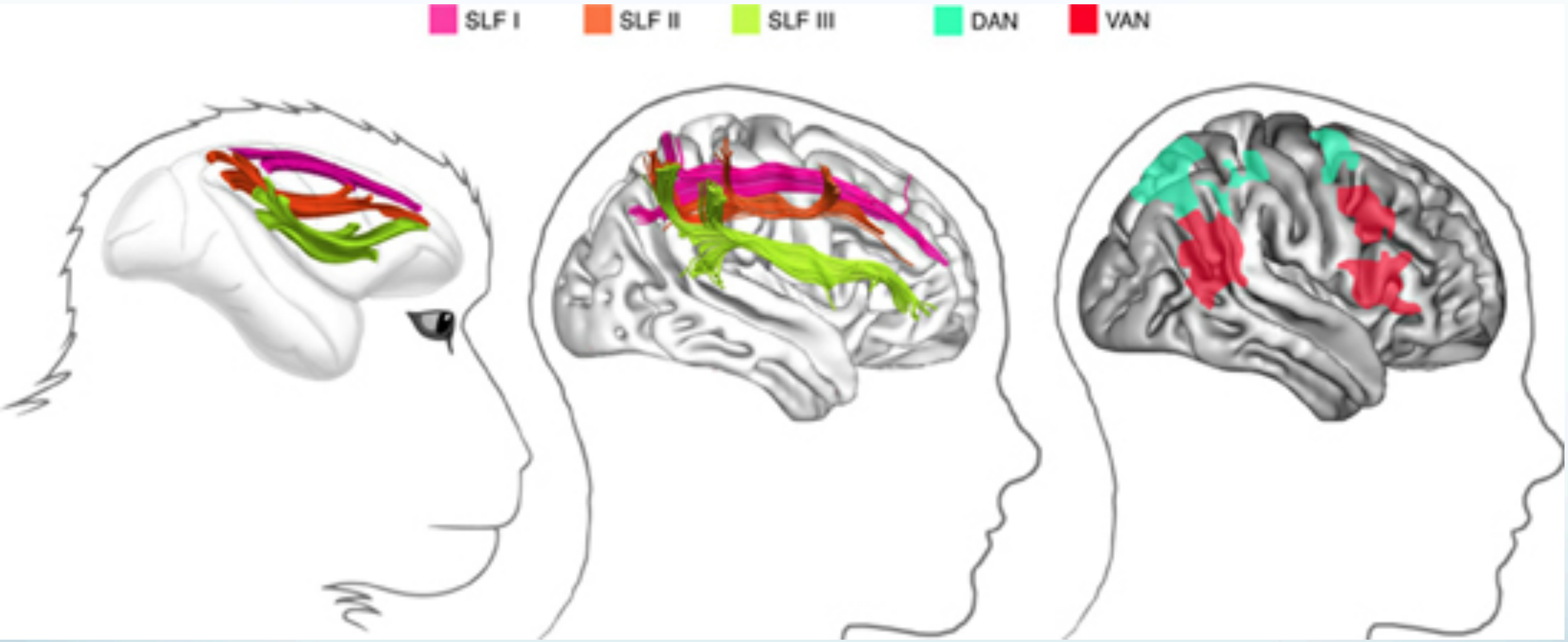


Corbetta et al., 2002

Réseau fronto-pariétal ventral (fortement latéralisé à droite) : attention exogène; détection de stimuli comportementalement pertinents. Système d'alerte pour le système dorsal.

Bilatéral et symétrique

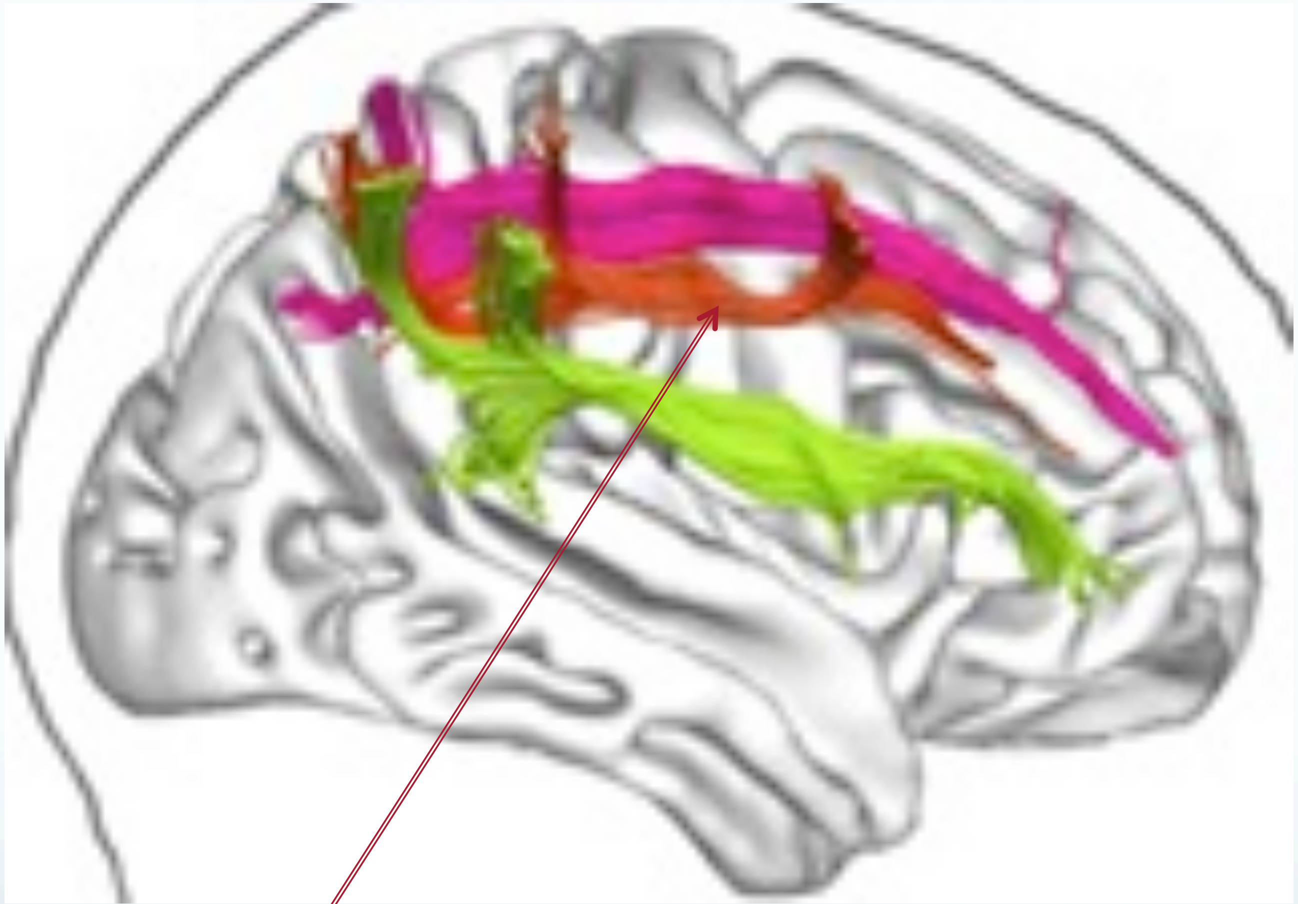
« Dorsal attentional network » : *orientation spatiale*



Fortement latéralisé à droite

« Ventral attentional network » : *détection événements motivants*

Thiebaut de Schotten, 2011



The SLF II connects the parietal component of the VAN to the prefrontal component of the DAN

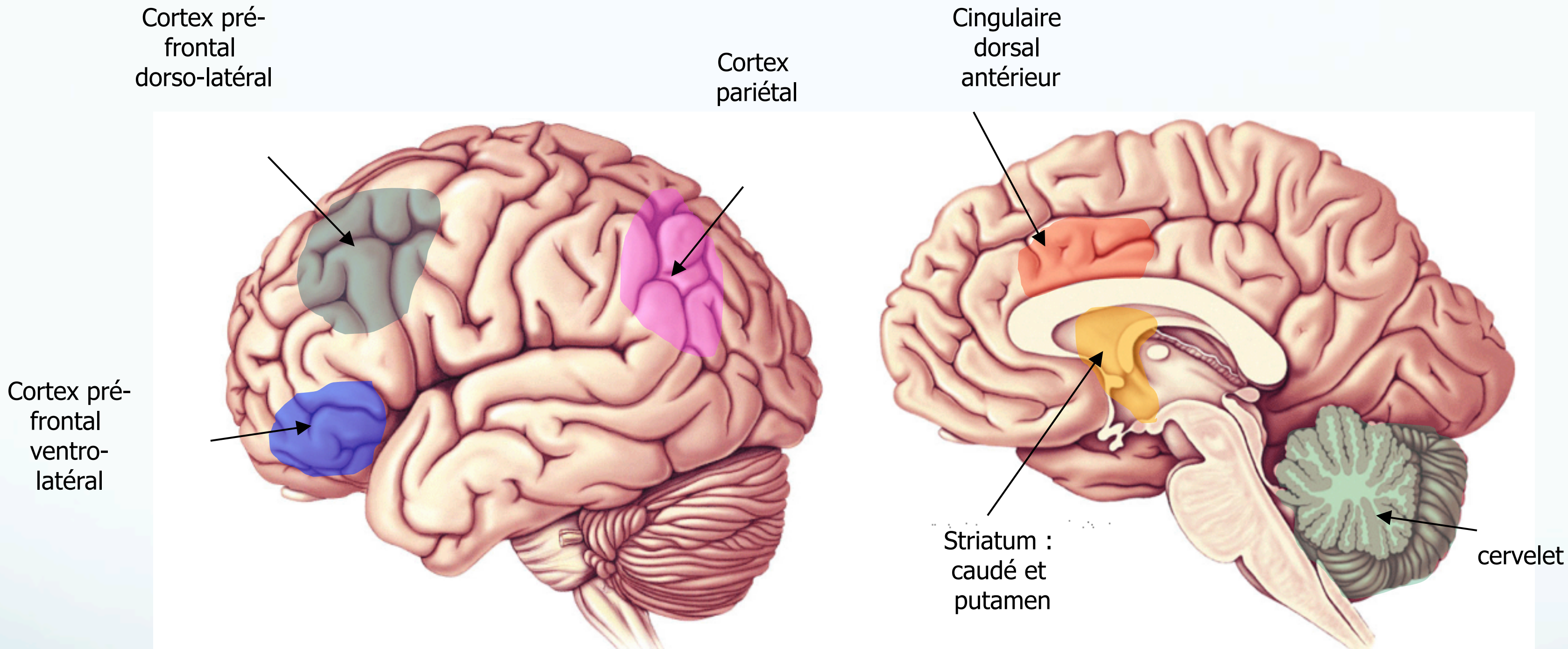
Neuropsychopharmacology REVIEWS (2010) 35, 278–300

www.neuropsychopharmacology.org

REVIEW

Attention-Deficit/Hyperactivity Disorder and Attention Networks

George Bush*,1,2,3,4



Les principales régions cérébrales dysfonctionnelles dans le TDAH (méta-analyse)

BIOL PSYCHIATRY
1999;45:1542–1552

Anterior Cingulate Cortex Dysfunction in Attention-Deficit/Hyperactivity Disorder Revealed by fMRI and the Counting Stroop

George Bush, Jean A. Frazier, Scott L. Rauch, Larry J. Seidman, Paul J. Whalen, Michael A. Jenike, Bruce R. Rosen, and Joseph Biederman

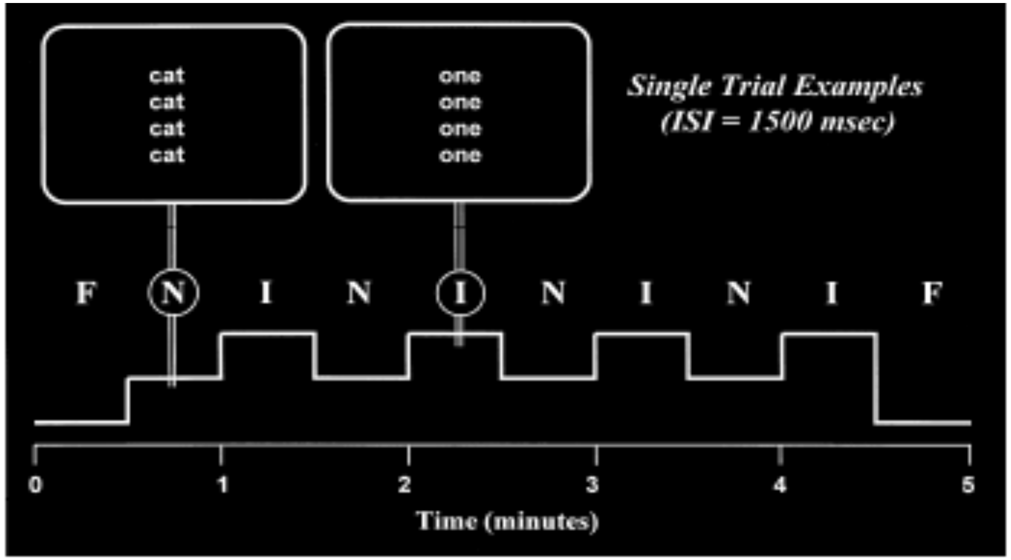
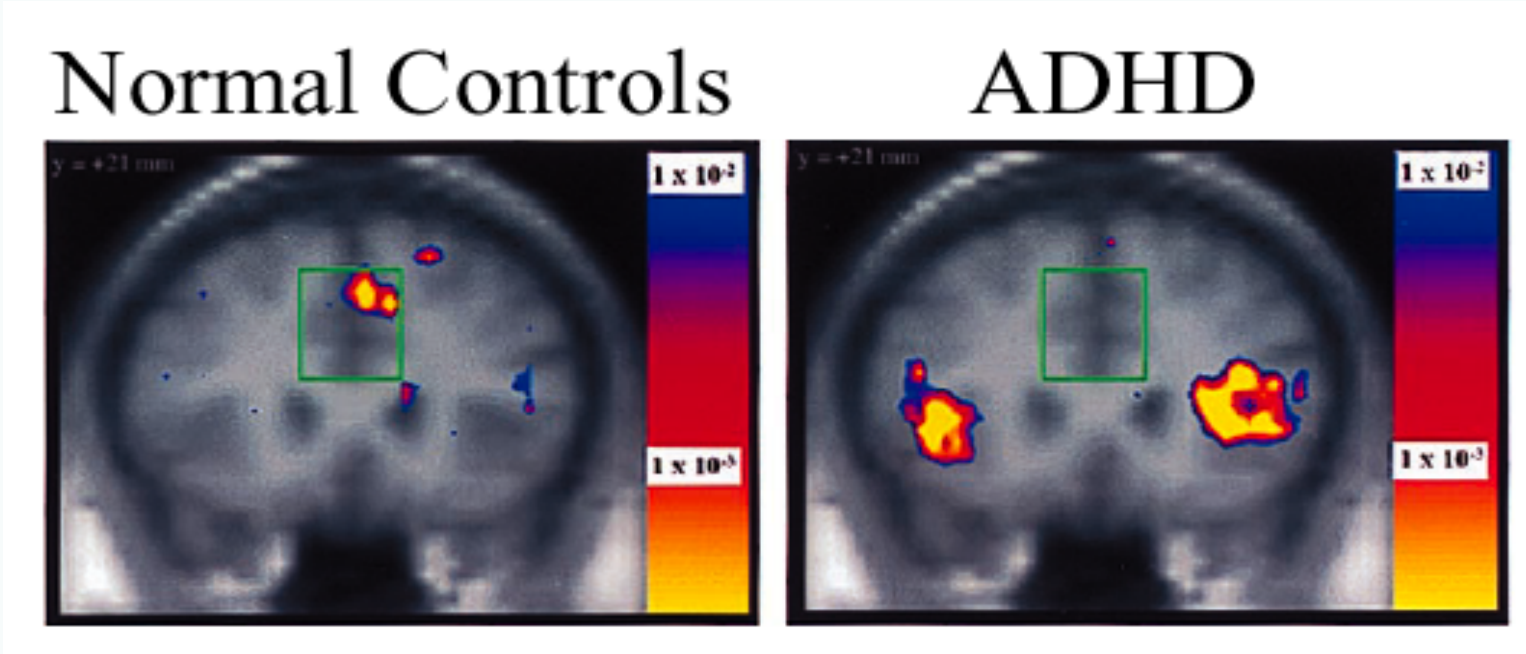
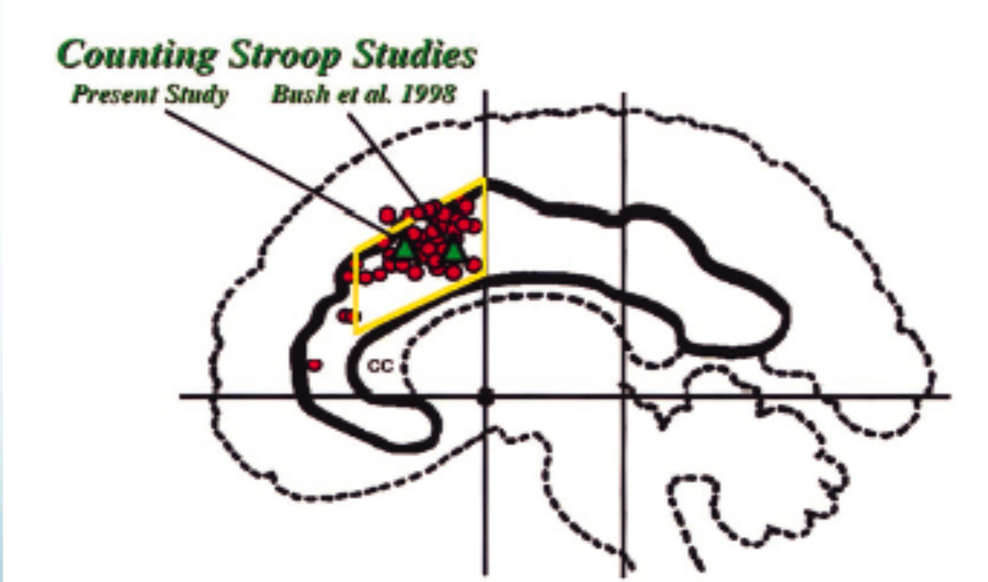


Figure 1. The Counting Stroop task: trial examples and block design. The top portion of this combination figure depicts examples of single trials for the two types of stimuli. Subjects were told that they would see sets of one to four identical words appear on the screen, and were instructed to report, via button-press, the number of words in each set, regardless of word meaning. During "neutral" trials, common animal names (dog, cat, bird, or mouse) were used. During "interference" blocks, the words consisted of number names (one, two, three, or four).

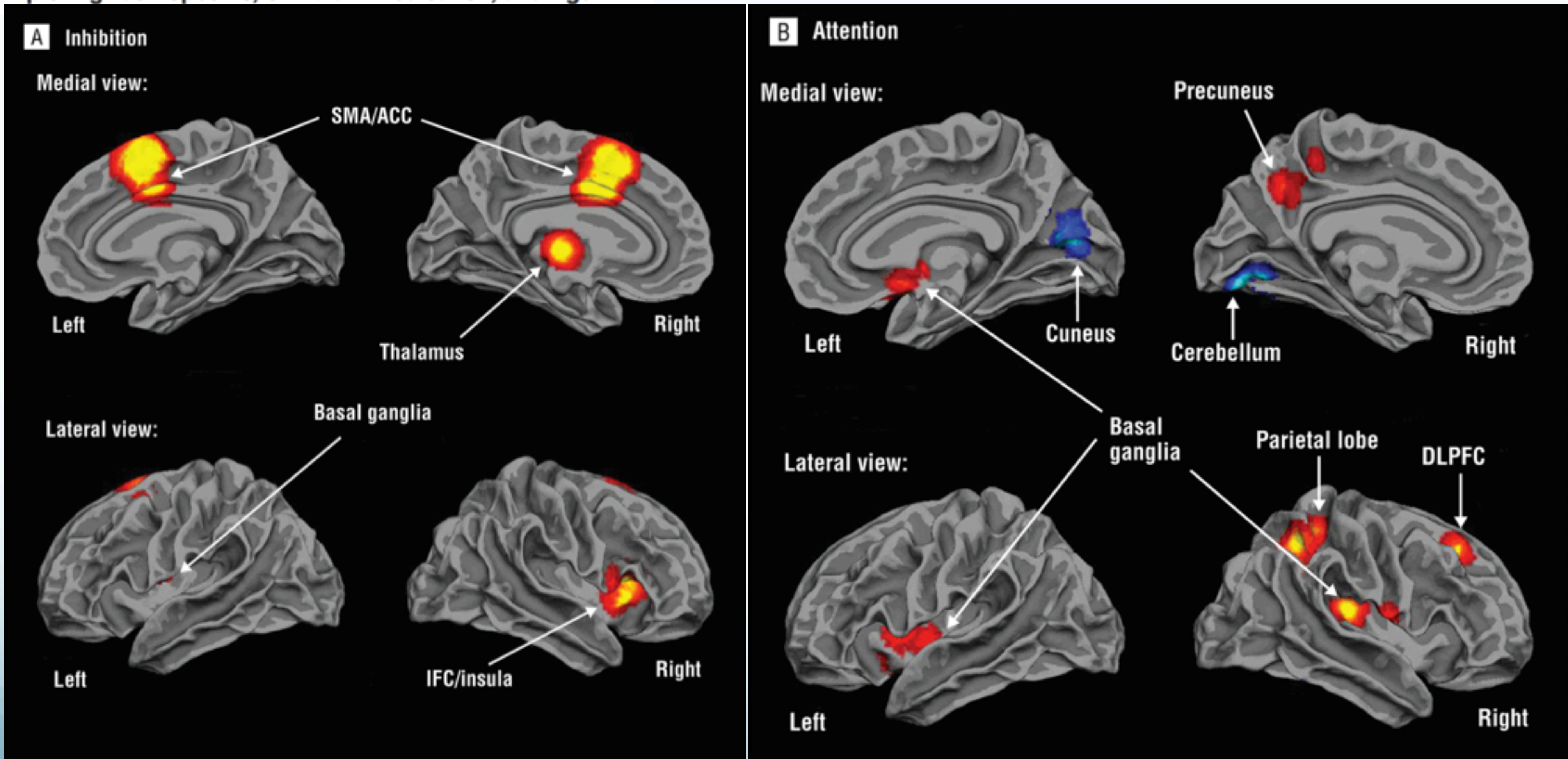

Normal Controls
ADHD
y = +21 mm
1×10^{-2}
1×10^{-3}
y = +21 mm
1×10^{-2}
1×10^{-3}

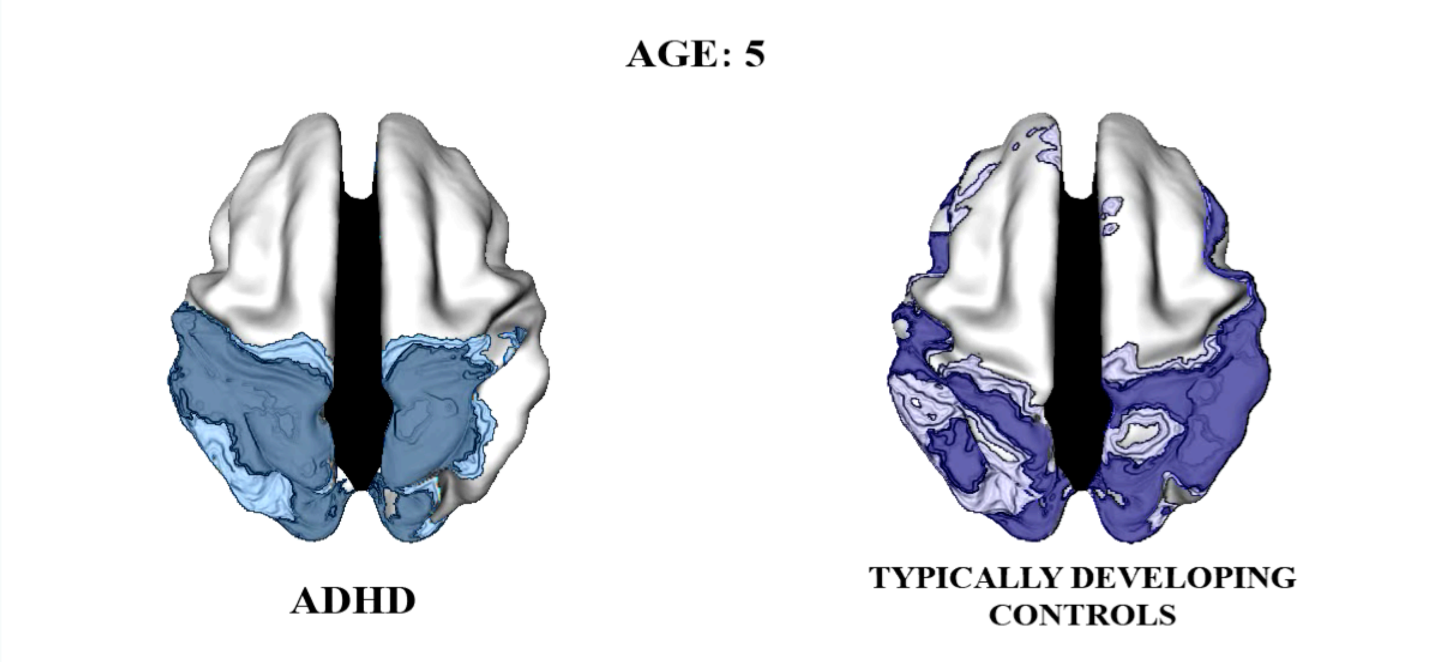

Counting Stroop Studies
Present Study
Bush et al. 1998
cc

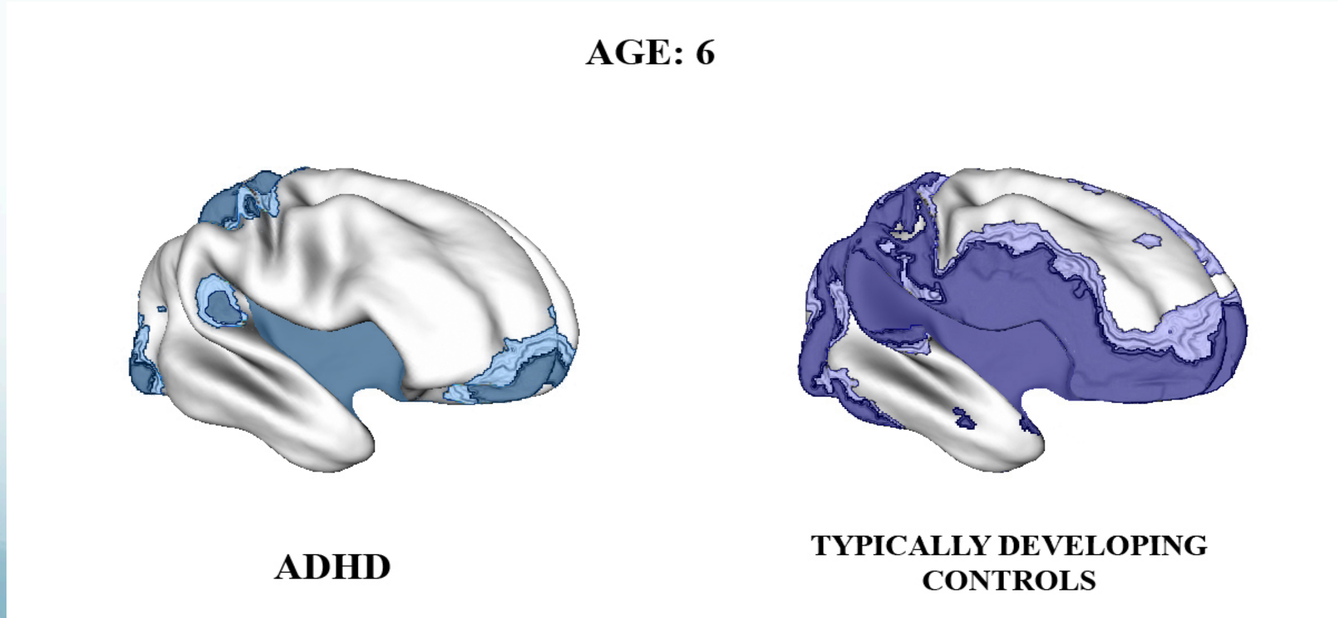
JAMA Psychiatry
Formerly Archives of General Psychiatry

Meta-analysis of Functional Magnetic Resonance Imaging Studies of Inhibition and Attention in Attention-deficit/Hyperactivity Disorder
Exploring Task-Specific, Stimulant Medication, and Age

Twenty-one data sets were included for inhibition (287 patients with ADHD and 320 control subjects), and 13 data sets were included for attention (171 patients with ADHD and 178 control subjects).




AGE: 5
ADHD
TYPICALLY DEVELOPING
CONTROLS


AGE: 6
ADHD
TYPICALLY DEVELOPING
CONTROLS

BMC Psychiatry

BioMed Central

Research article

Open Access

Structural brain change in Attention Deficit Hyperactivity Disorder identified by meta-analysis

Ian Ellison-Wright*[1,3], Zoë Ellison-Wright[2] and Ed Bullmore[3]

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Email: Ian Ellison-Wright* - ian.ew@inbox.com; Zoë Ellison-Wright - zoe.ellison-wright@dchft.nhs.uk; Ed Bullmore - etb23@cam.ac.uk

* Corresponding author

Published: 30 June 2008

Received: 7 May 2008

Méta-analyse de 7 études de la substance grise (143 témoins vs 114 patients TDAH) : seule significativité = putamen/pallidum droit

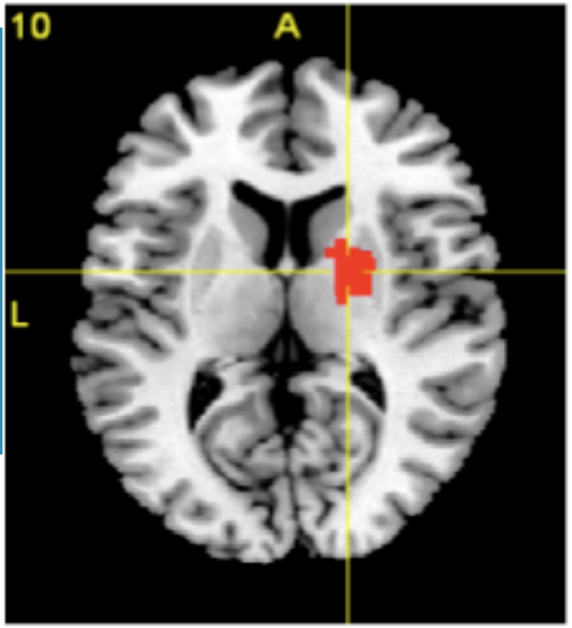


Figure 1
Gray Matter Decreases in ADHD. A transverse section at Talairach space level z = 10 showing gray matter reduction in ADHD in the right putamen/globus pallidus region, displayed on a template brain. The right side of the section represents the right side of the brain. Significant clusters were thresholded with a false discovery rate (FDR) at $P < 0.05$.

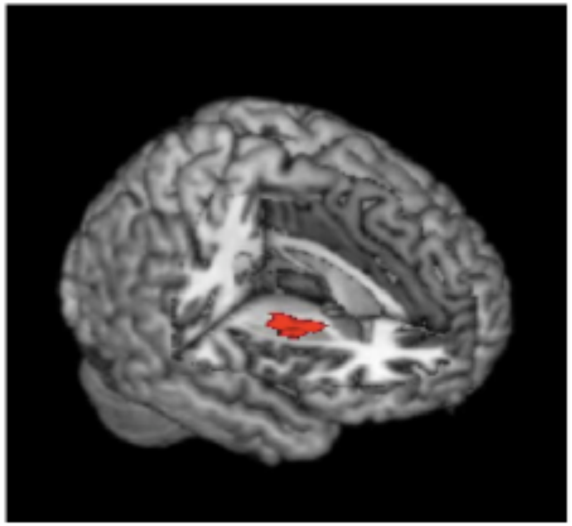


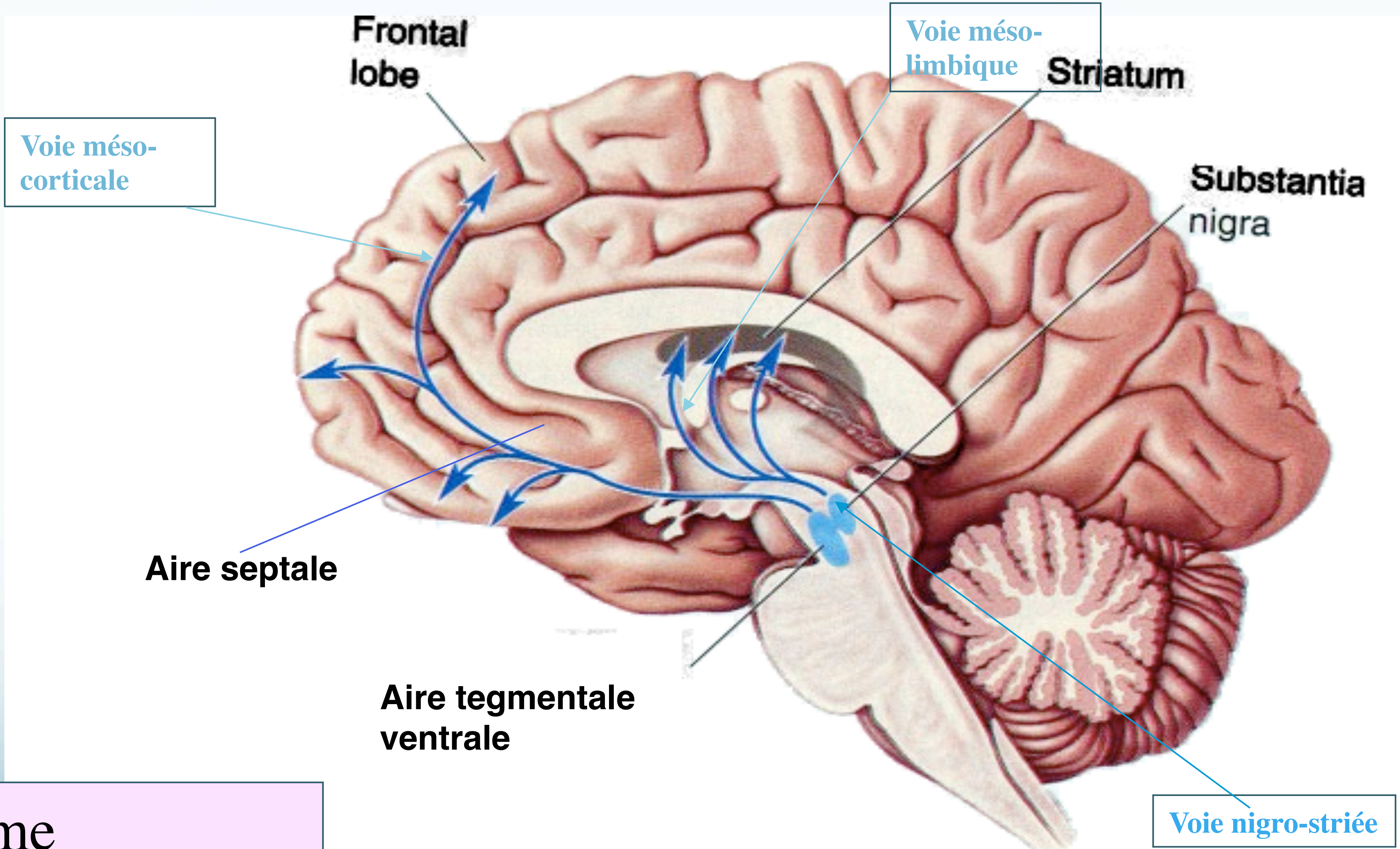
Figure 2
Gray Matter Decreases in ADHD. Gray matter signal decrease in ADHD in the right putamen/globus pallidus region, displayed on a three-dimensional rendered brain with right frontal lobe removed.

ADHD had more lesions localized in the right putamen [23]. Another study of ADHD symptoms in twenty-five children with focal stroke lesions found that the symptoms were most commonly associated with lesions of the

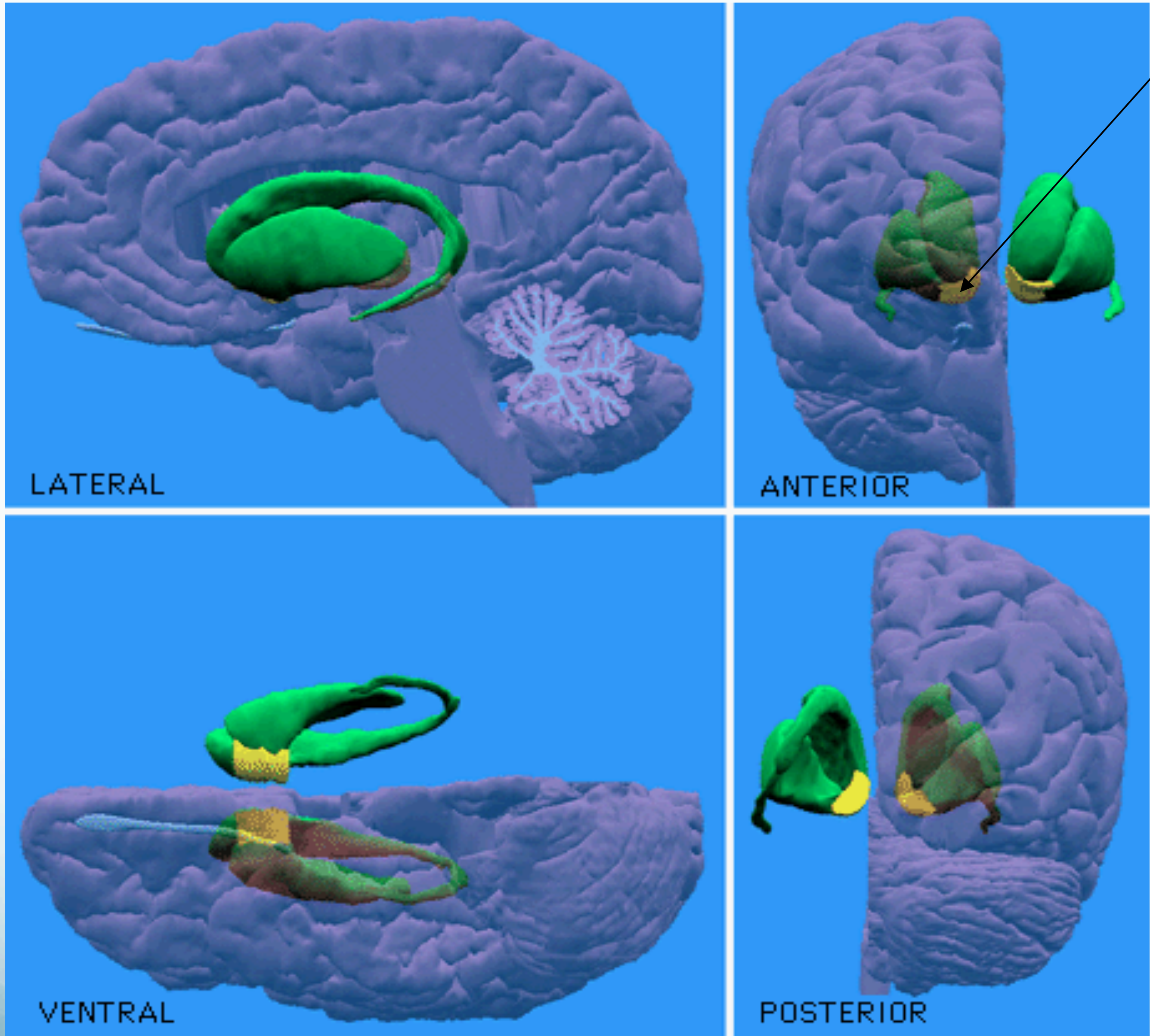
II/ Le modèle alternatif

= défaut des systèmes de la récompense (Sonuga-Barke)
Imagerie fonctionnelle dans des protocoles de récompense

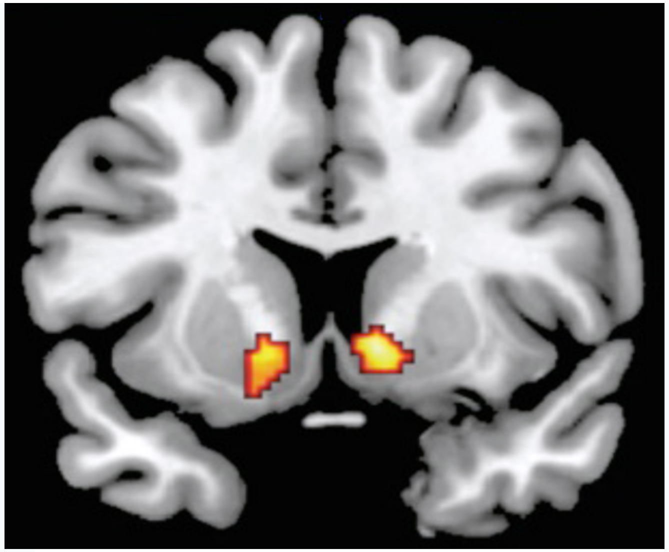
→ Dysfonctionnement des circuits cortico-striés



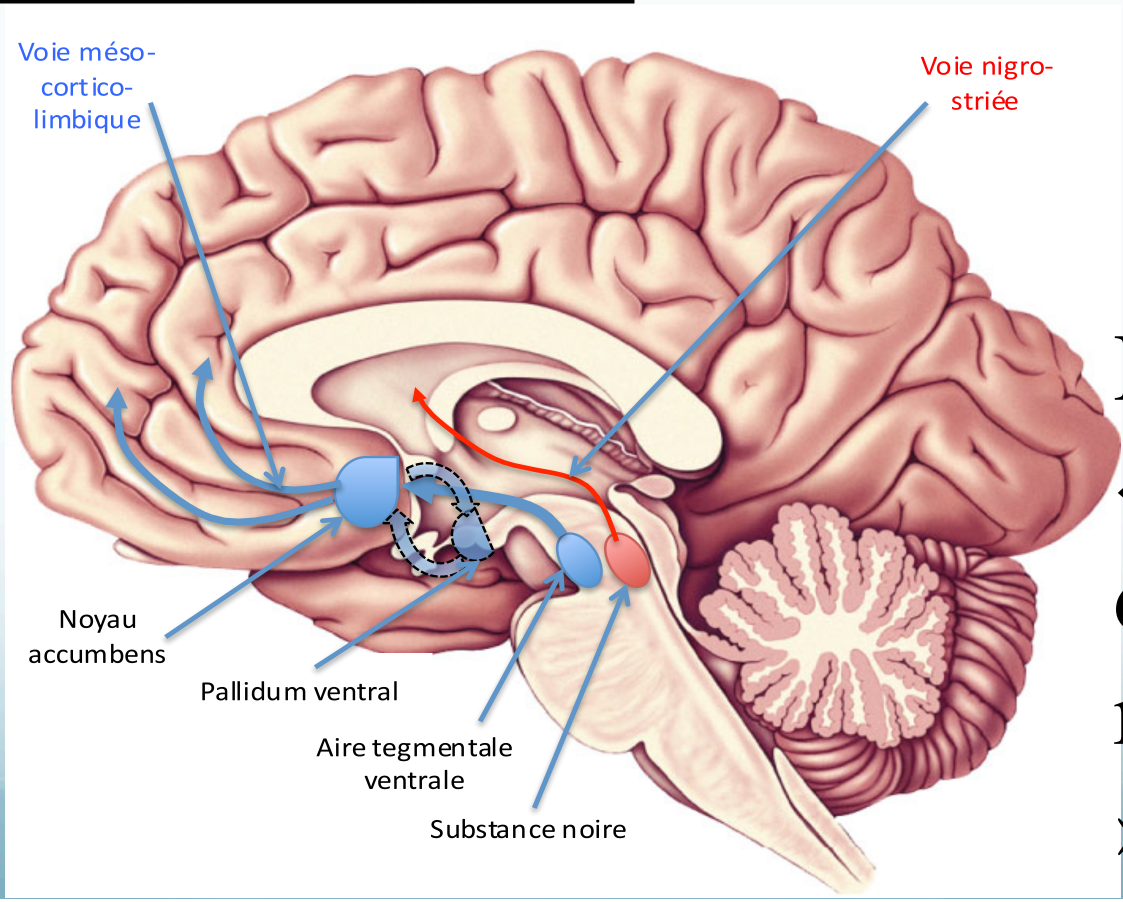
Système dopaminergique



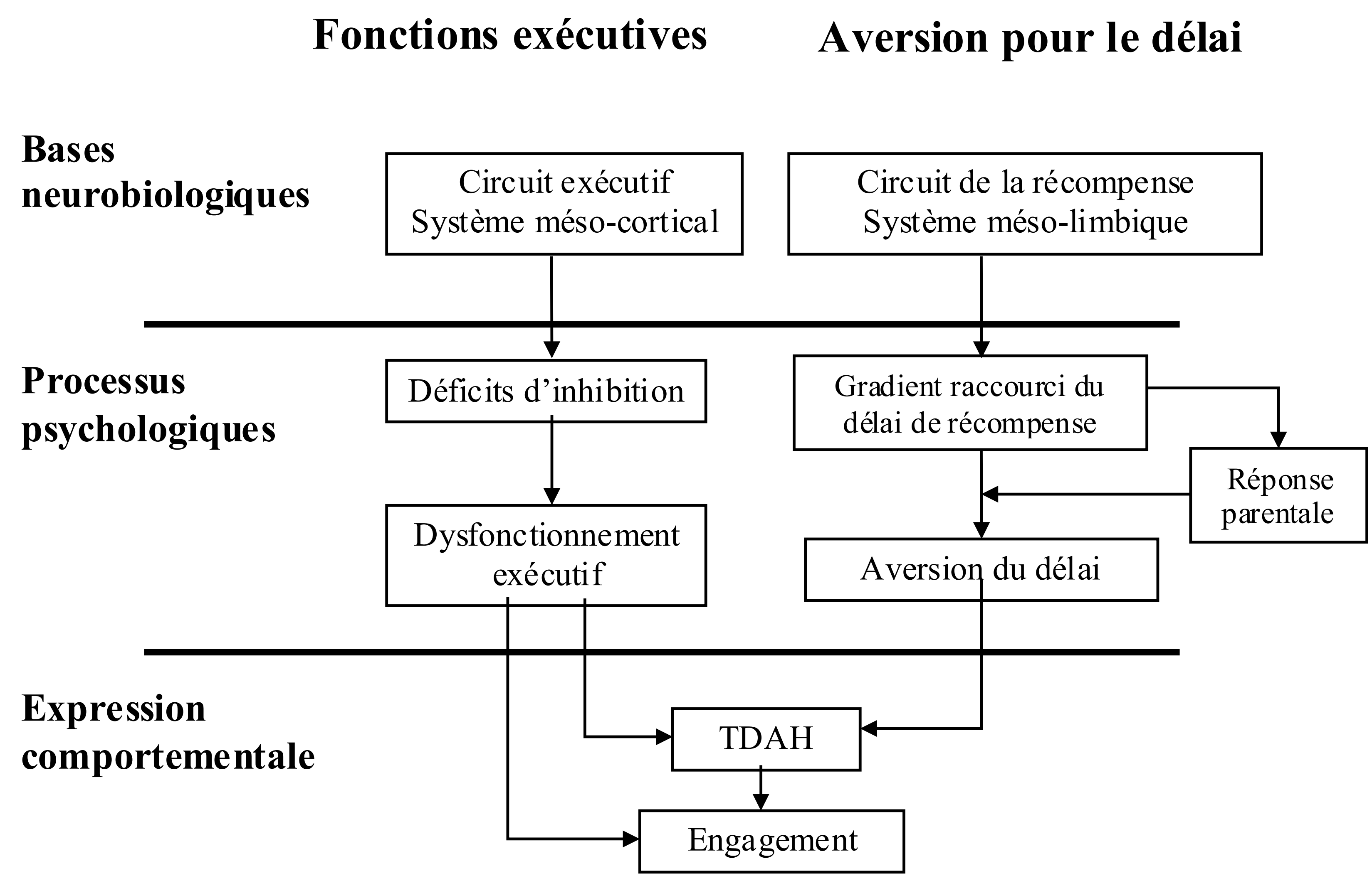
Noyau accumbens
Chez l'animal : en activité lors de l'anticipation d'une récompense, l' évaluation de la magnitude d'une récompense
Chez l'homme impliqué dans les conduites à risque et addictives



Noyau accumbens activé lors d'une tâche de gambling en IRM fonctionnelle



Le « système de la récompense »



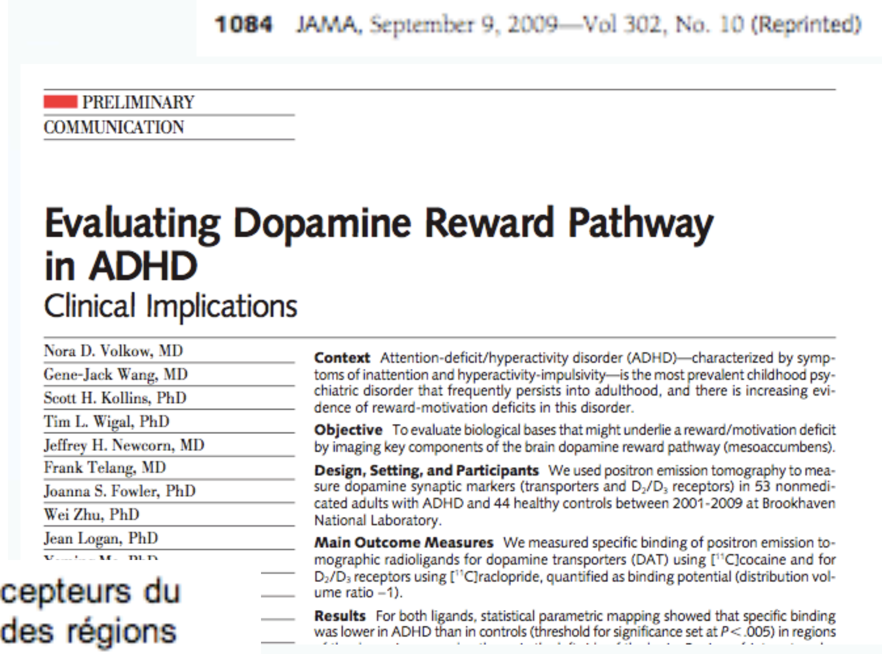
Physiopathologie du TDAH (D'après Sonuga-Barke, 2002, 2003)

Le TDAH lié à une anomalie neurologique du système de la motivation

PsychoMédia - Publié le 09 septembre 2009

L'inattention associée au trouble déficit d'attention et hyperactivité (TDAH) pourrait s'expliquer en partie par la sous-stimulation des centres du cerveau dits de la récompense, impliqués dans la motivation, selon une étude publiée dans le Journal of the American Medical Association.

Les chercheurs ont comparé des images cérébrales de 53 adultes atteints du TDAH, ne prenant pas de médicaments, et 44 personnes n'ayant pas le TDAH.



1084 JAMA, September 9, 2009—Vol 302, No. 10 (Reprinted)

PRELIMINARY COMMUNICATION

Evaluating Dopamine Reward Pathway in ADHD

Clinical Implications

Nora D. Volkow, MD
Gene-Jack Wang, MD
Scott H. Kollins, PhD
Tim L. Wigal, PhD
Jeffrey H. Newcorn, MD
Frank Telang, MD
Joanna S. Fowler, PhD
Wei Zhu, PhD
Jean Logan, PhD

Context Attention-deficit/hyperactivity disorder (ADHD)—characterized by symptoms of inattention and hyperactivity-impulsivity—is the most prevalent childhood psychiatric disorder that frequently persists into adulthood, and there is increasing evidence of reward-motivation deficits in this disorder.

Objective To evaluate biological bases that might underlie a reward/motivation deficit by imaging key components of the brain dopamine reward pathway (mesoaccumbens).

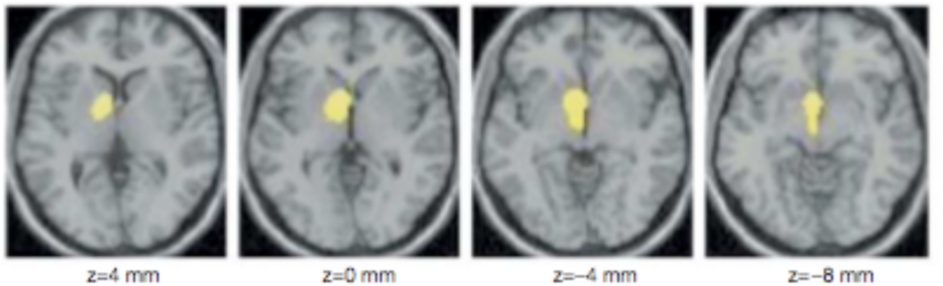
Design, Setting, and Participants We used positron emission tomography to measure dopamine synaptic markers (transporters and D_2/D_3 receptors) in 53 nonmedicated adults with ADHD and 44 healthy controls between 2001-2009 at Brookhaven National Laboratory.

Main Outcome Measures We measured specific binding of positron emission tomographic radioligands for dopamine transporters (DAT) using [^{11}C]cocaine and for D_2/D_3 receptors using [^{11}C]raclopride, quantified as binding potential (distribution volume ratio −1).

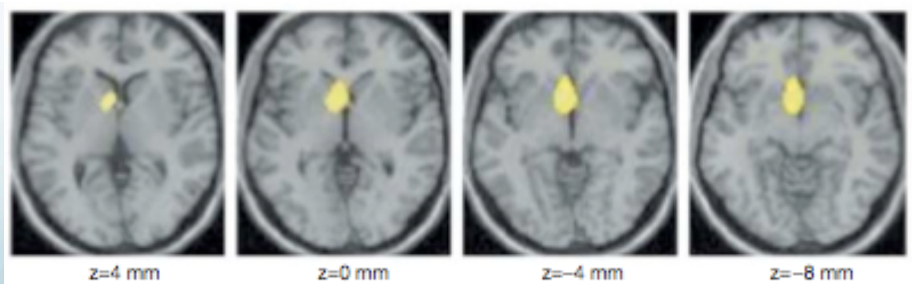
Results For both ligands, statistical parametric mapping showed that specific binding was lower in ADHD than in controls (threshold for significance set at $P < .005$) in regions

Les personnes ayant le TDAH présentaient de faibles niveaux de certains récepteurs du neurotransmetteur dopamine dans le mésencéphale et le noyau accumbens, des régions clés du circuit dopaminergique de la récompense, ont constaté Nora D. Volkow du National Institute on Drug Abuse (États-Unis) et ses collègues. De bas niveaux des récepteurs de la dopamine étaient associés avec des résultats plus faibles à des tests d'attention.

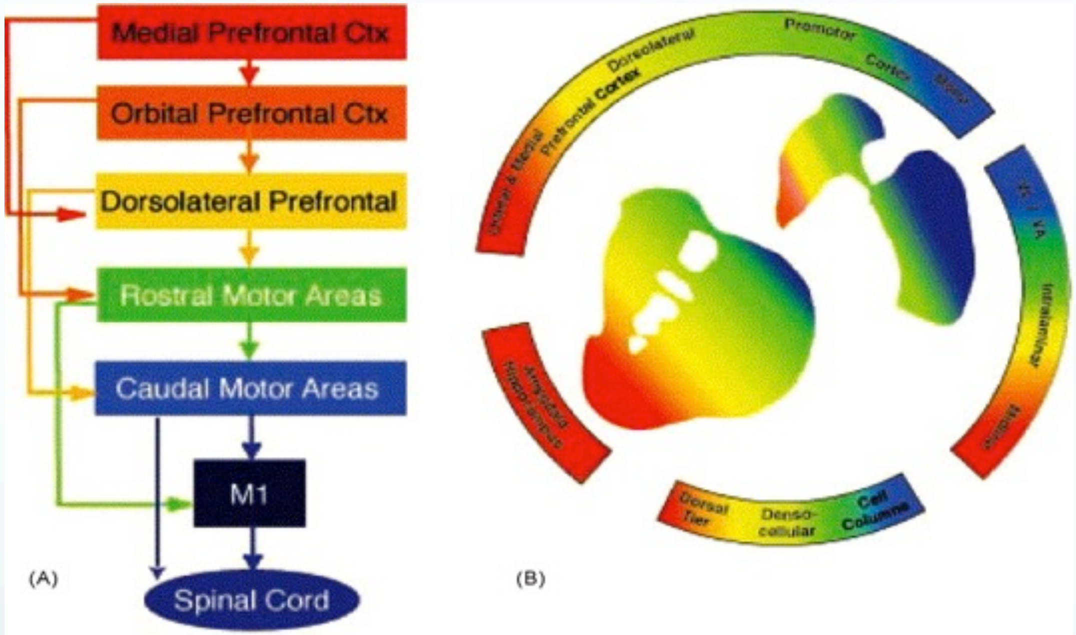
"Cela peut expliquer pourquoi les déficits d'attention des personnes atteintes du TDAH sont plus importants dans des tâches qui sont considérées comme ennuyantes, répétitives et inintéressantes ainsi qu'expliquer la propension aux complications telles que la toxicomanie et l'obésité (la dopamine étant impliquée dans les addictions)", écrivent les auteurs.



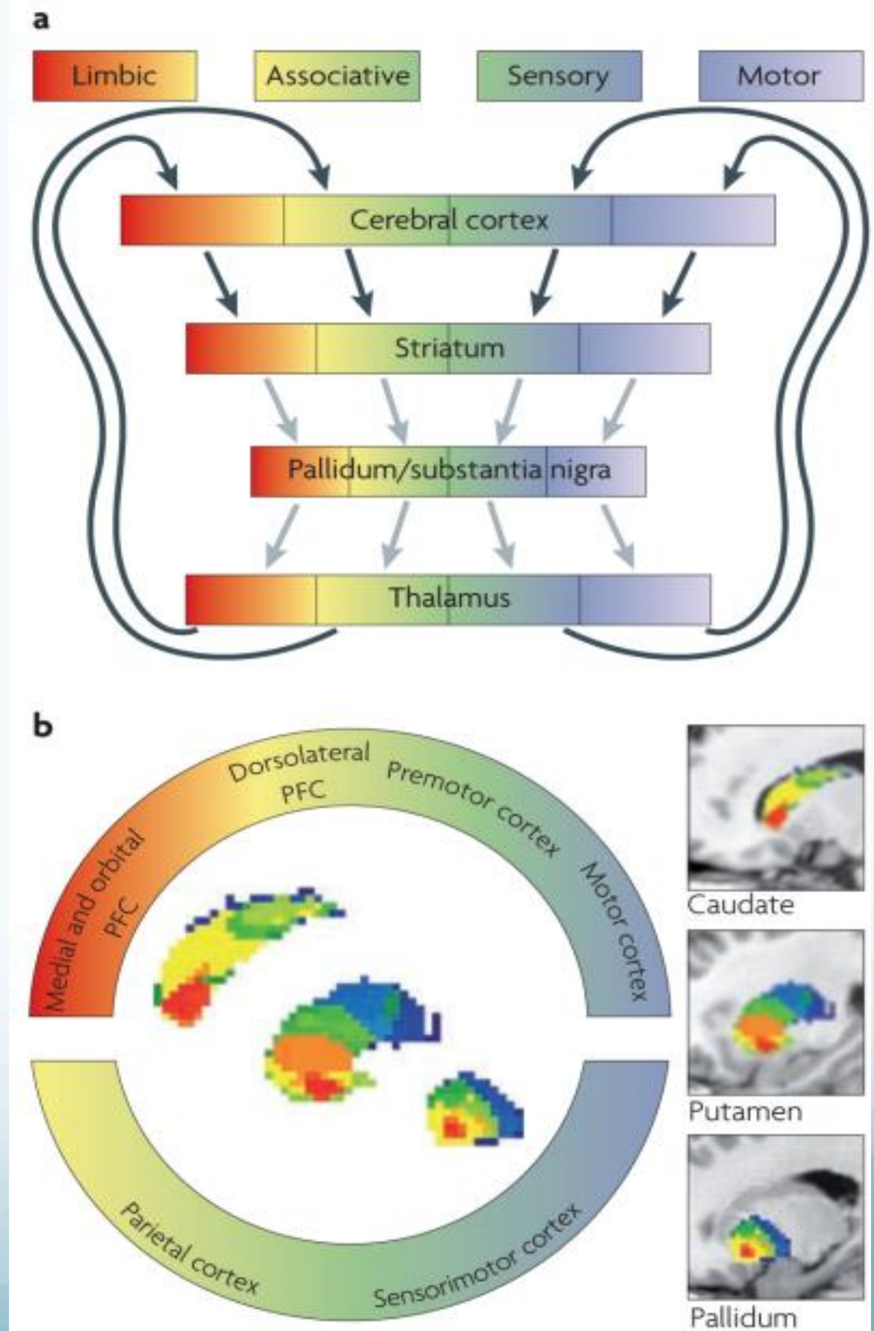
Dopamine D 2/D3 receptor availability



Dopamine transporter availability



Haber, S.N. (2003) The primate basal ganglia: parallel and integrative networks. J. Chem. Neuroanat. 26, 317–330



THE AMERICAN JOURNAL OF
PSYCHIATRY

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The American Journal of Psychiatry, VOL. 166, No. 1

ARTICLE | January 01, 2009

Basal Ganglia Volume and Shape in Children With Attention Deficit Hyperactivity Disorder

Anqi Qiu, Ph.D.; Deana Crocetti, B.S.; Marcy Adler, B.A.; E. Mark Mahone, Ph.D.; Martha B. Denckla, M.D.; Michael I. Miller, Ph.D.; Stewart H. Mostofsky, M.D.

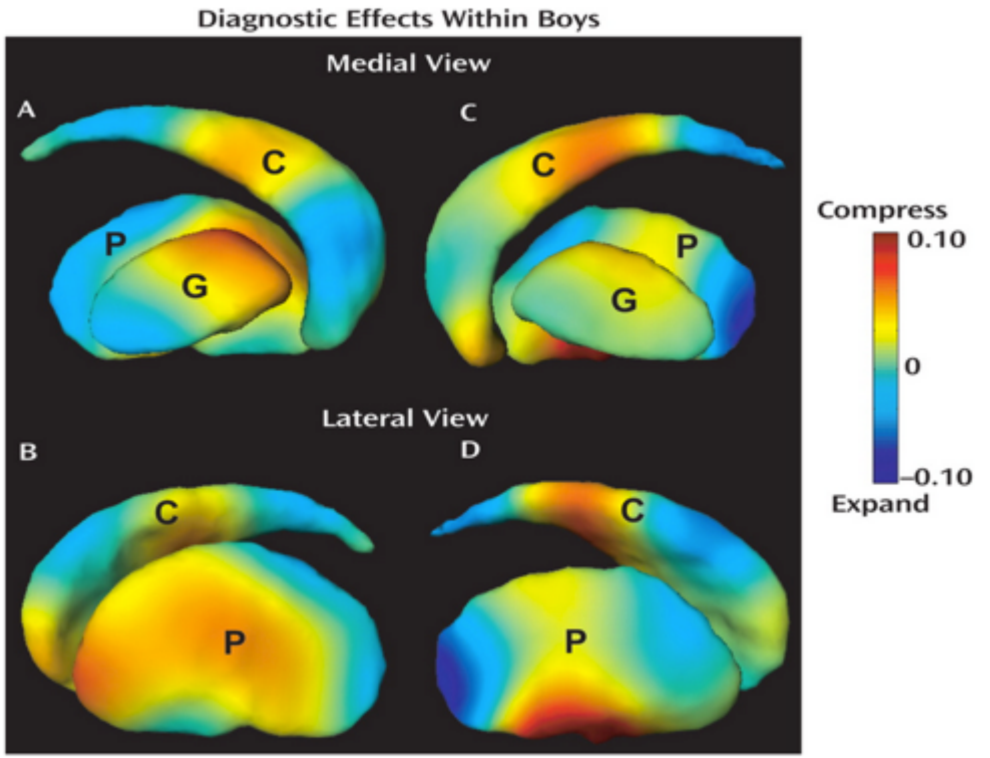
Am J Psychiatry 2009;166:74-82. doi:10.1176/appi.ajp.2008.08030426

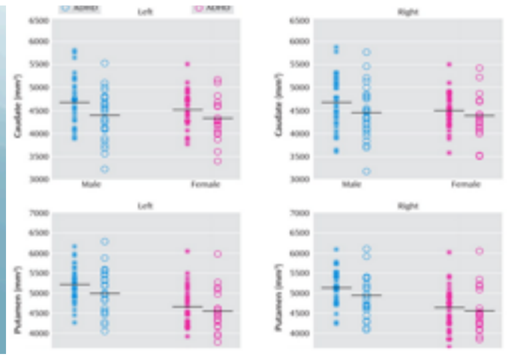
Journal of the American Academy of Child & Adolescent Psychiatry
Volume 53, Issue 7, July 2014, Pages 780–789.e11

New research

Mapping the Development of the Basal Ganglia in Children With Attention-Deficit/Hyperactivity Disorder

Philip Shaw, MD, PhD[a], Pietro De Rossi, MD[b], Bethany Watson, BA[a], Amy Wharton, BA[a], Deanna Greenstein, PhD[c], Armin Raznahan, MD, PhD[c], Wendy Sharp, MSW[d], Jason P. Lerch, PhD[e], M. Mallar Chakravarty, PhD[f]





In the **ventral striatal surfaces**, there was a diagnostic difference in developmental trajectories (t = 5.6, $p < .0001$). Here, the typically developing group showed **surface area expansion with age** (estimated rate of increase of 0.54 mm^2 per year, standard error [SE] 0.29 mm^2 per year), whereas **the ADHD group showed progressive contraction** (decrease of 1.75 mm^2 per year, SE 0.28 mm^2 per year). The ADHD group also showed significant**, fixed surface area reductions in dorsal striatal** regions, which were detected in childhood at study entry and persisted into adolescence.

Ventral Striatal Hyporesponsiveness During Reward Anticipation in Attention-Deficit/Hyperactivity Disorder

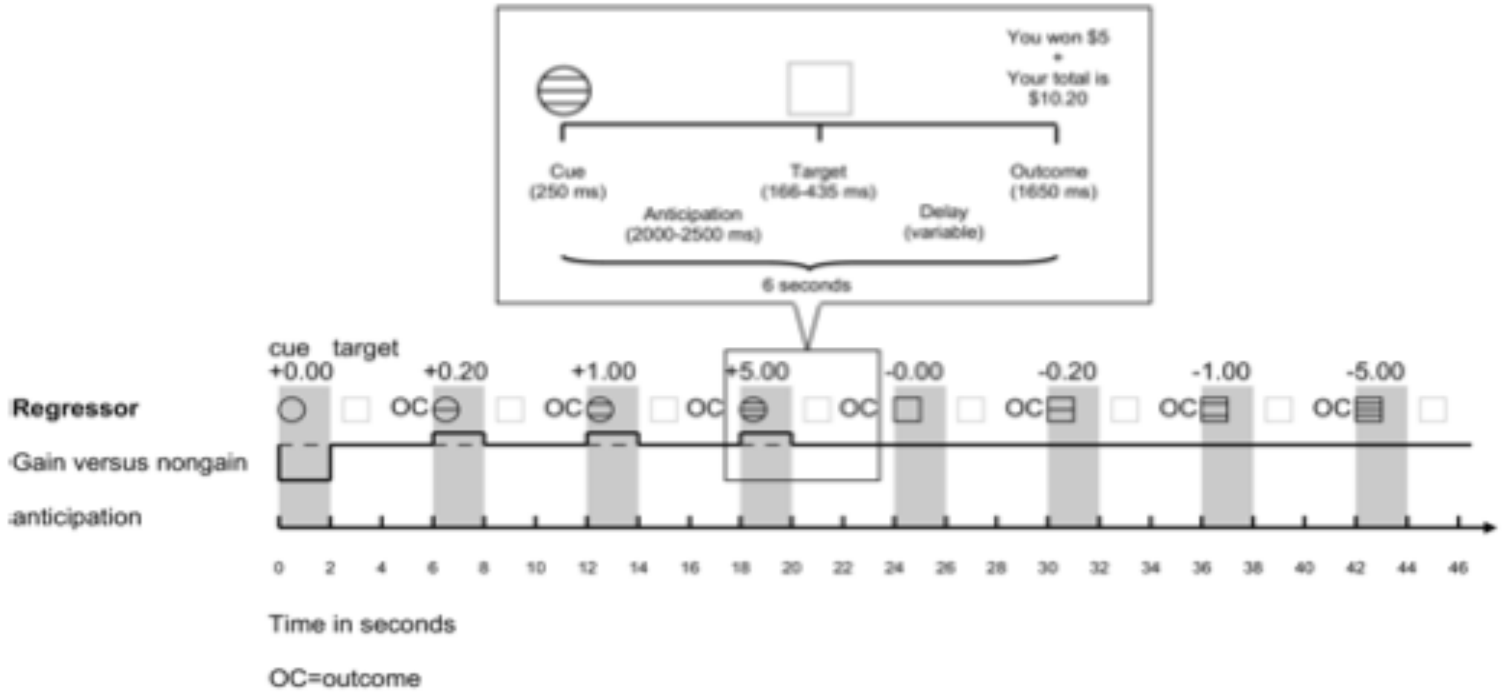
Anouk Scheres, Michael P. Milham, Brian Knutson, and Francisco Xavier Castellanos

Background: Although abnormalities in reward processing have been proposed to underlie attention-deficit/hyperactivity disorder (ADHD), this link has not been tested explicitly with neural probes.

Methods: This hypothesis was tested by using fMRI to compare neural activity within the striatum in individuals with ADHD and healthy controls during a reward-anticipation task that has been shown previously to produce reliable increases in ventral striatum activity in healthy adults and healthy adolescents. Eleven adolescents with ADHD (5 off medication and 6 medication-naïve) and 11 healthy controls (ages 12–17 y) were included. Groups were matched for age, gender, and intelligence quotient.

Results: We found reduced ventral striatal activation in adolescents with ADHD during reward anticipation, relative to healthy controls. Moreover, ventral striatal activation was negatively correlated with parent-rated hyperactive/impulsive symptoms across the entire sample.

Conclusions: These findings provide neural evidence that symptoms of ADHD, and impulsivity or hyperactivity in particular, may involve diminished reward anticipation, in addition to commonly observed executive dysfunction.



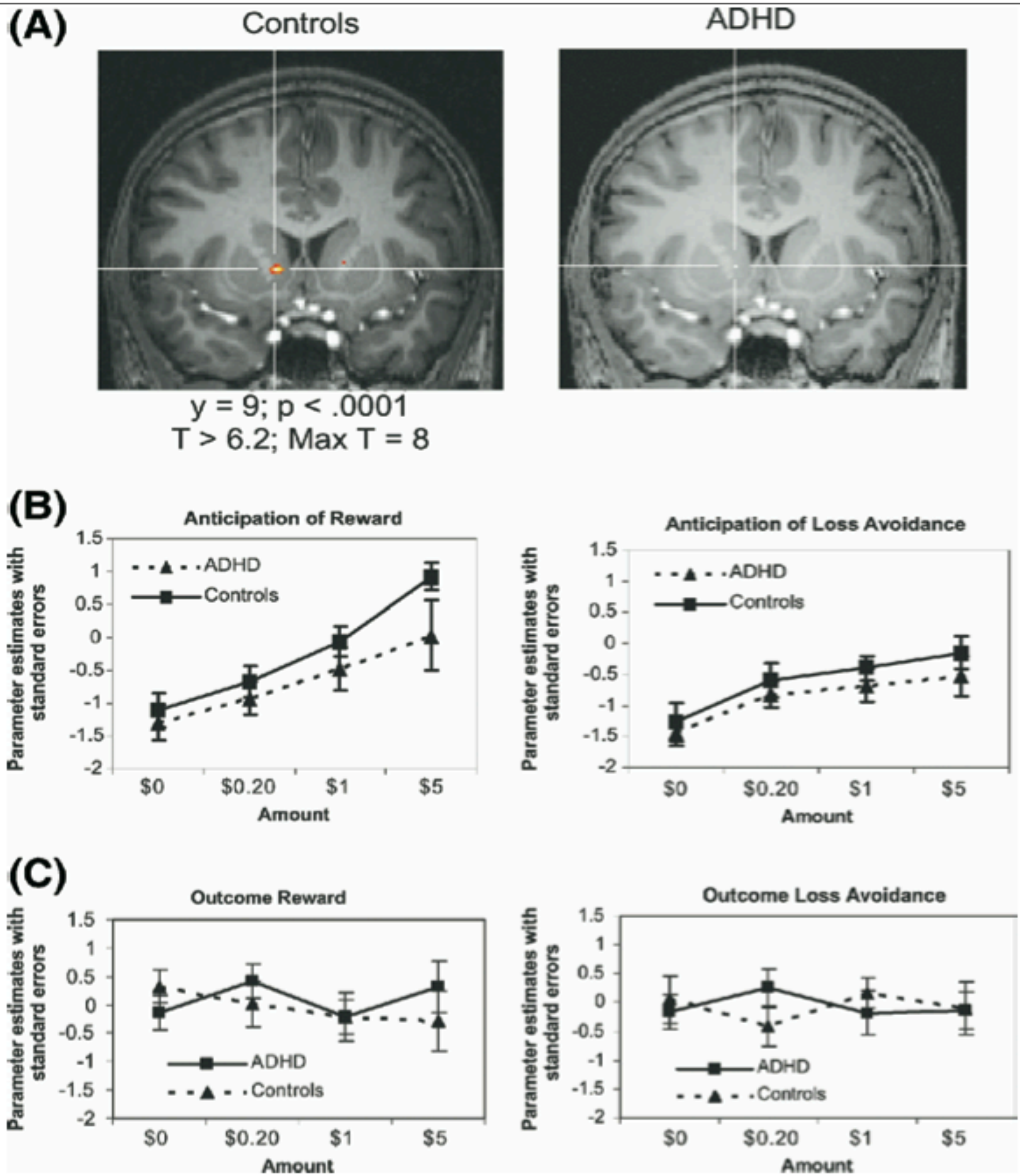


Figure 2. Impact of reward anticipation and outcome on ventral striatum (VS) activity.

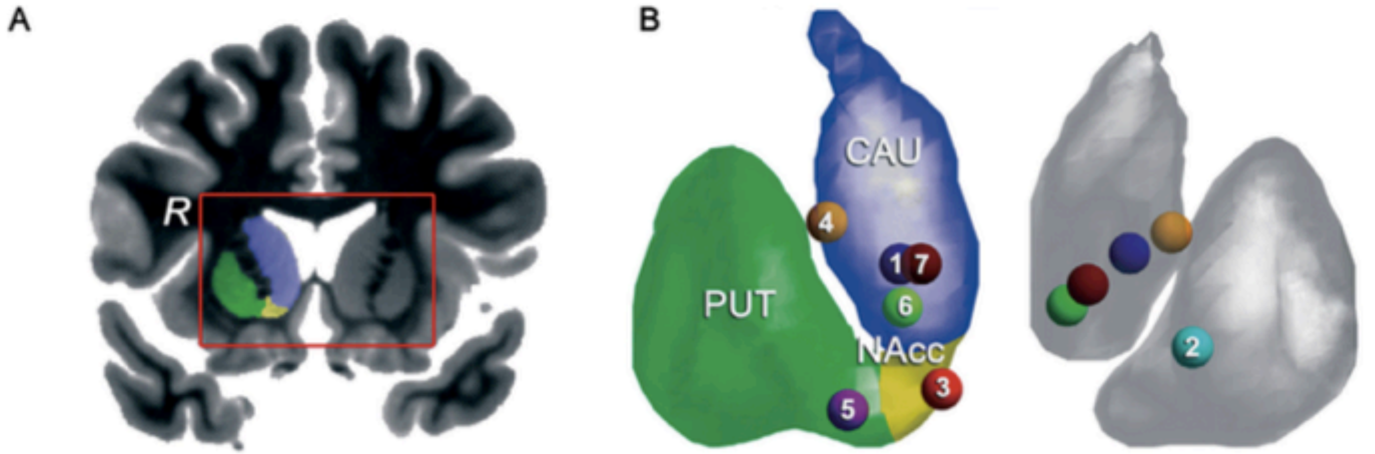
TDAH : hypoactivation du striatum ventral lors de l'anticipation de la récompense

Review

Ventral–striatal responsiveness during reward anticipation in ADHD and its relation to trait impulsivity in the healthy population: A meta-analytic review of the fMRI literature

Michael M. Plichta[a,*], Anouk Scheres[b]

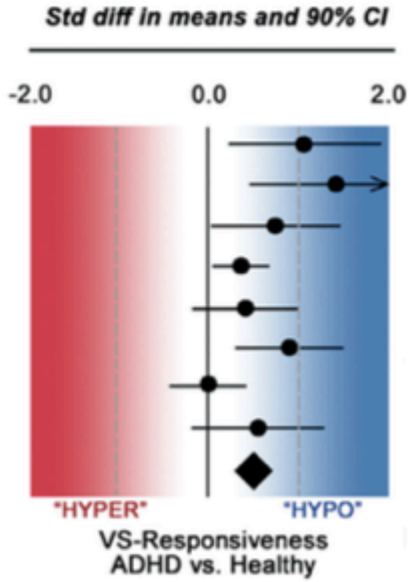
[a] Central Institute of Mental Health, Department of Psychiatry and
Germany
[b] Developmental Psychology, Behavioural Science Institute, Radbo



C

Statistics for each study

Study	Year		Std diff in means	Standard error	Variance	Lower limit	Upper limit	z-value	Total N
Scheres	2007	1	1.060	0.519	0.270	0.205	1.914	2.041	22
Ströhle	2008	2	1.438	0.597	0.357	0.455	2.420	2.407	20
Plichta	2009	3	0.746	0.445	0.198	0.014	1.478	1.677	26
Hoogman	2011	4	0.368	0.202	0.041	0.035	0.701	1.819	104
Stoy	2011	5	0.418	0.361	0.130	-0.176	1.012	1.157	35
Camona	2012	6	0.906	0.371	0.138	0.296	1.517	2.442	38
Paloyelis[a]	2012	⃠	0.000	0.267	0.071	-0.440	0.440	0.000	59
Edel[b]	2013	7	0.563	0.468	0.220	-0.208	1.333	1.224	36
OVERALL			**0.476**	**0.120**	**0.014**	**0.279**	**0.673**	**3.974**	**340**



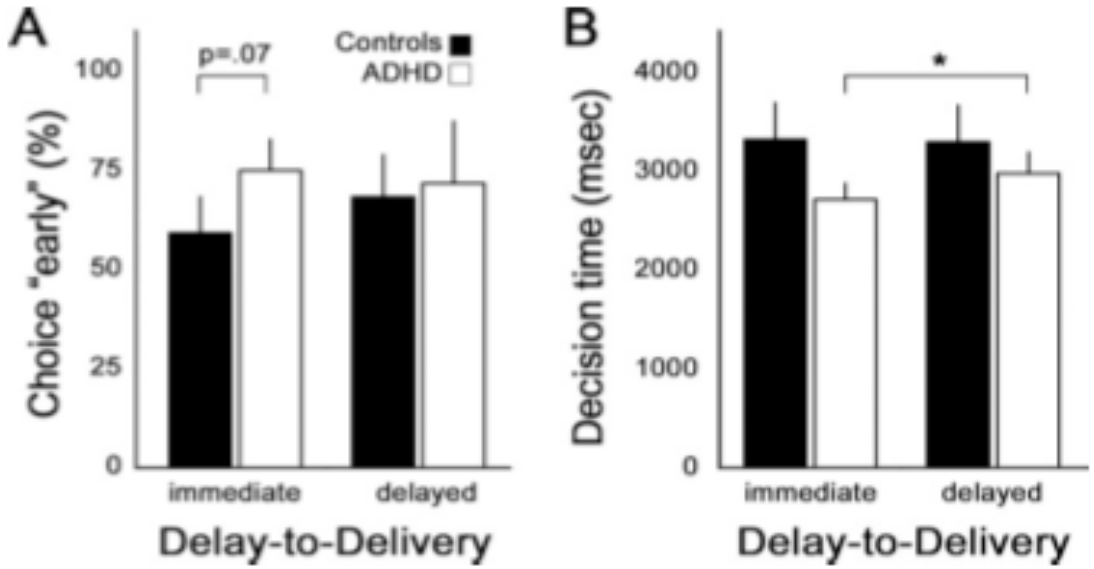
Neural Hyporesponsiveness and Hyperresponsiveness During Immediate and Delayed Reward Processing in Adult Attention-Deficit/Hyperactivity Disorder

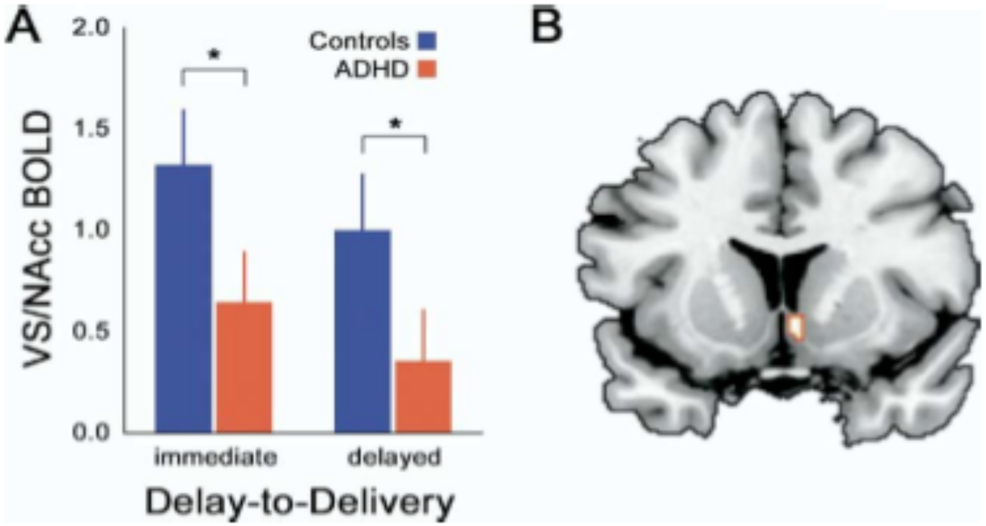
Michael M. Plichta, Nenad Vasic, Robert Christian Wolf, Klaus-Peter Lesch, Dagmar Brummer, Christian Jacob, Andreas J. Fallgatter, and Georg Grön

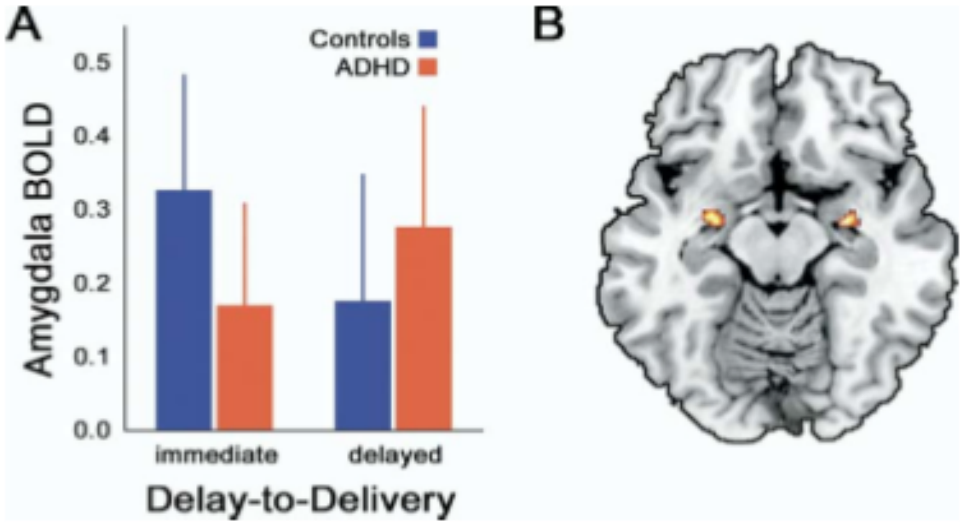
BIOL PSYCHIATRY 2009;65:7–14

ADHD : hyporesponsiveness of the ventral-striatal reward system for both immediate and delayed rewards

delayed rewards evoked hyperactivation in dorsal caudate nucleus and amygdala of ADHD patients.





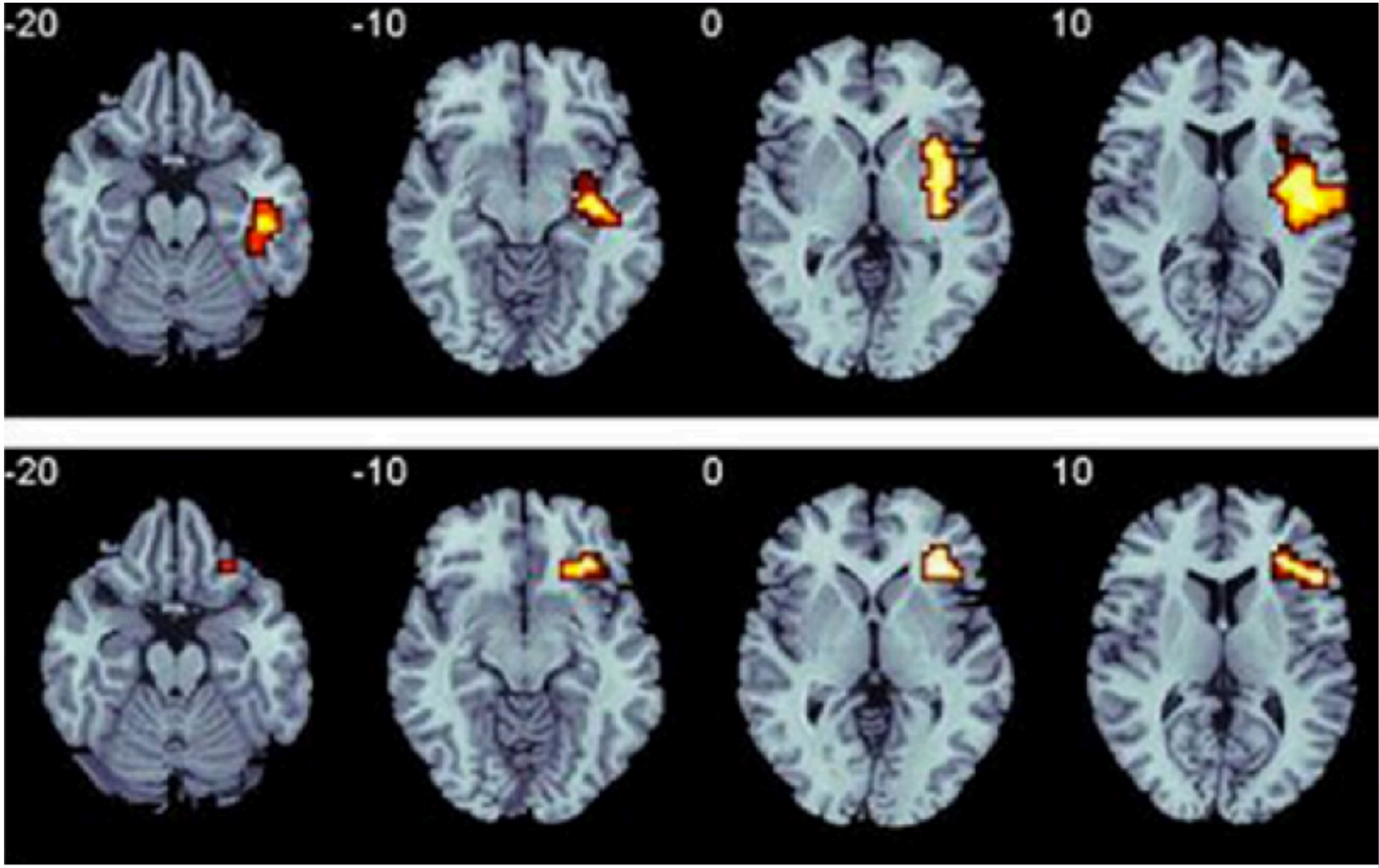


Review

"Cool" Inferior Frontostriatal Dysfunction in Attention-Deficit/Hyperactivity Disorder Versus "Hot" Ventromedial Orbitofrontal-Limbic Dysfunction in Conduct Disorder: A Review

Katya Rubia

Areas of hypoactivation in CD children compared to ADHD and controls



Sustained attention

(Hippoc.+insula)

Reward

(ventro-lateral orbital)

A review of fronto-striatal and fronto-cortical brain abnormalities in children and adults with Attention Defic Hyperactivity Disorder (ADHD) and new evidence for dysfunction in adults with ADHD during motivation and attention

*Ana Cubillo, Rozmin Halari, Anna Smith, Eric Taylor and Katya Rubia**

Department of Child Psychiatry, King's College London, Institute of Psychiatry, London, UK

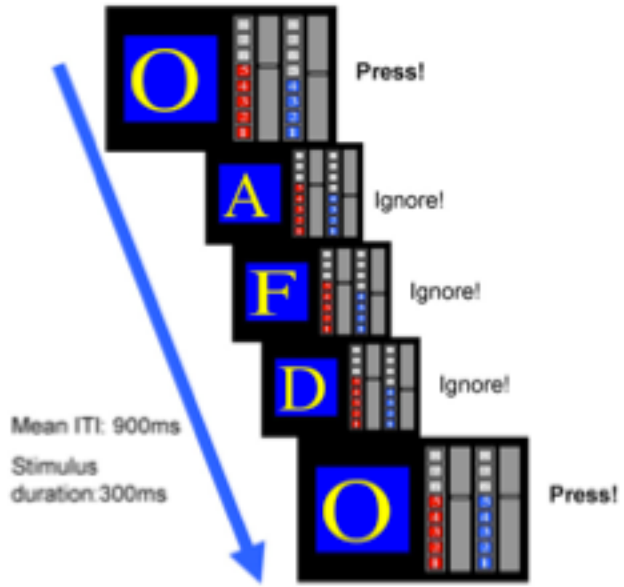
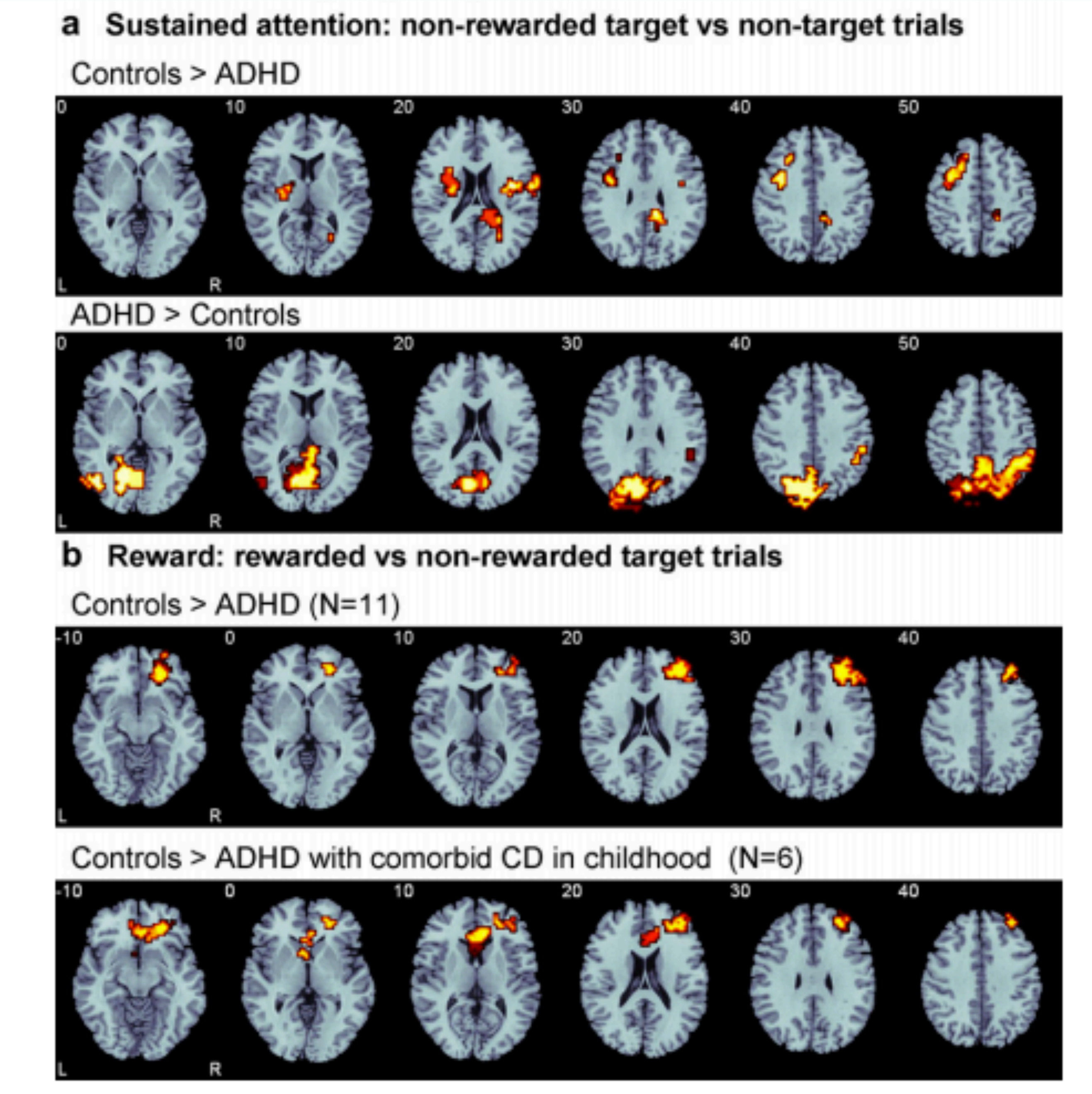


Fig. 1 – Schematic illustration of the Rewarded Continuous Performance Test. Response required to "X" or "O", not to any other letters. Reward is given for each response to one of the two target letters (which letter was rewarded was randomised across subjects). Red/blue bars indicate correct responses to targets (X/O). Three correct responses make one score on the bar for the rewarded and non-rewarded targets, but only the rewarded target scores are remunerated with £1. Up to £8 can be won on the task.

Comparaison adulte/enfant : tâche d'attention soutenue : hypoactivation fronto-pariéto-striatale (comme chez l'enfant)
Tâche récompensée : hypoactivation ventro-médiane, mais seulement si trouble des conduites comorbide

Rewarded CPT
1£ pour 3 bonnes réponses (hits)



Effet de la cible : sous-activation fronto-striatale

Effet de la récompense : sous activation frontale antérieure gauche

OPEN ACCESS Freely available online
PLOS ONE

Abnormal Striatal BOLD Responses to Reward Anticipation and Reward Delivery in ADHD

Emi Furukawa[1*], Patricia Bado[2,3], Gail Tripp[1], Paulo Mattos[2,3], Jeff R. Wickens[1], Ivanei E. Bramati[2,3], Brent Alsop[4], Fernanda Meireles Ferreira[2], Debora Lima[2], Fernanda Tovar-Moll[2,3], Joseph A. Sergeant[5], Jorge Moll[2]

1 Okinawa Institute of Science and Technology Graduate University (OIST), Okinawa, Japan, 2 D'Or Institute for Research and Education (IDOR), Rio de Janeiro, Brazil, 3 Federal University of Rio de Janeiro, Rio de Janeiro, Brazil, 4 University of Otago, Dunedin, New Zealand, 5 VU University Amsterdam, Amsterdam, The Netherlands

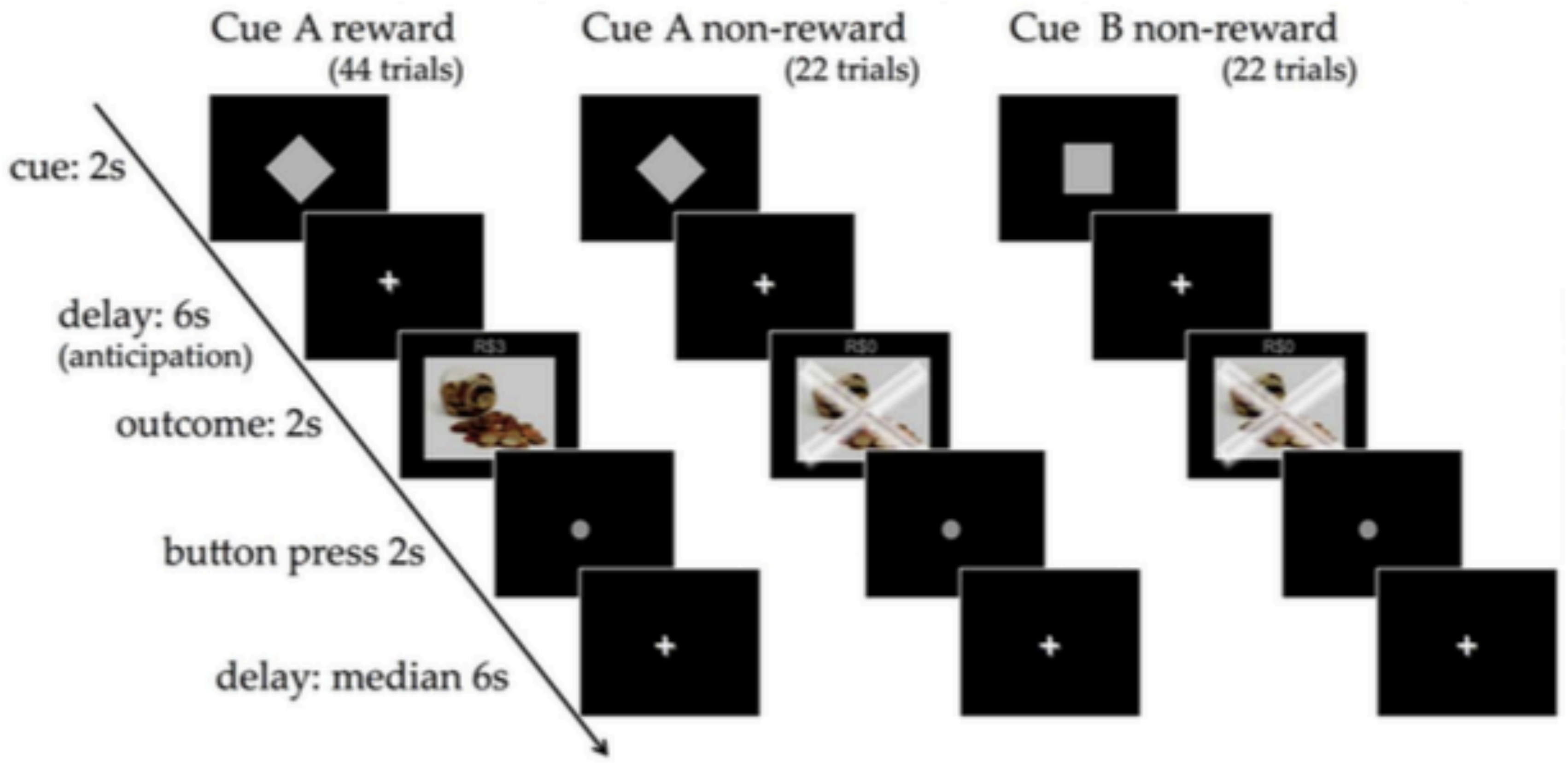
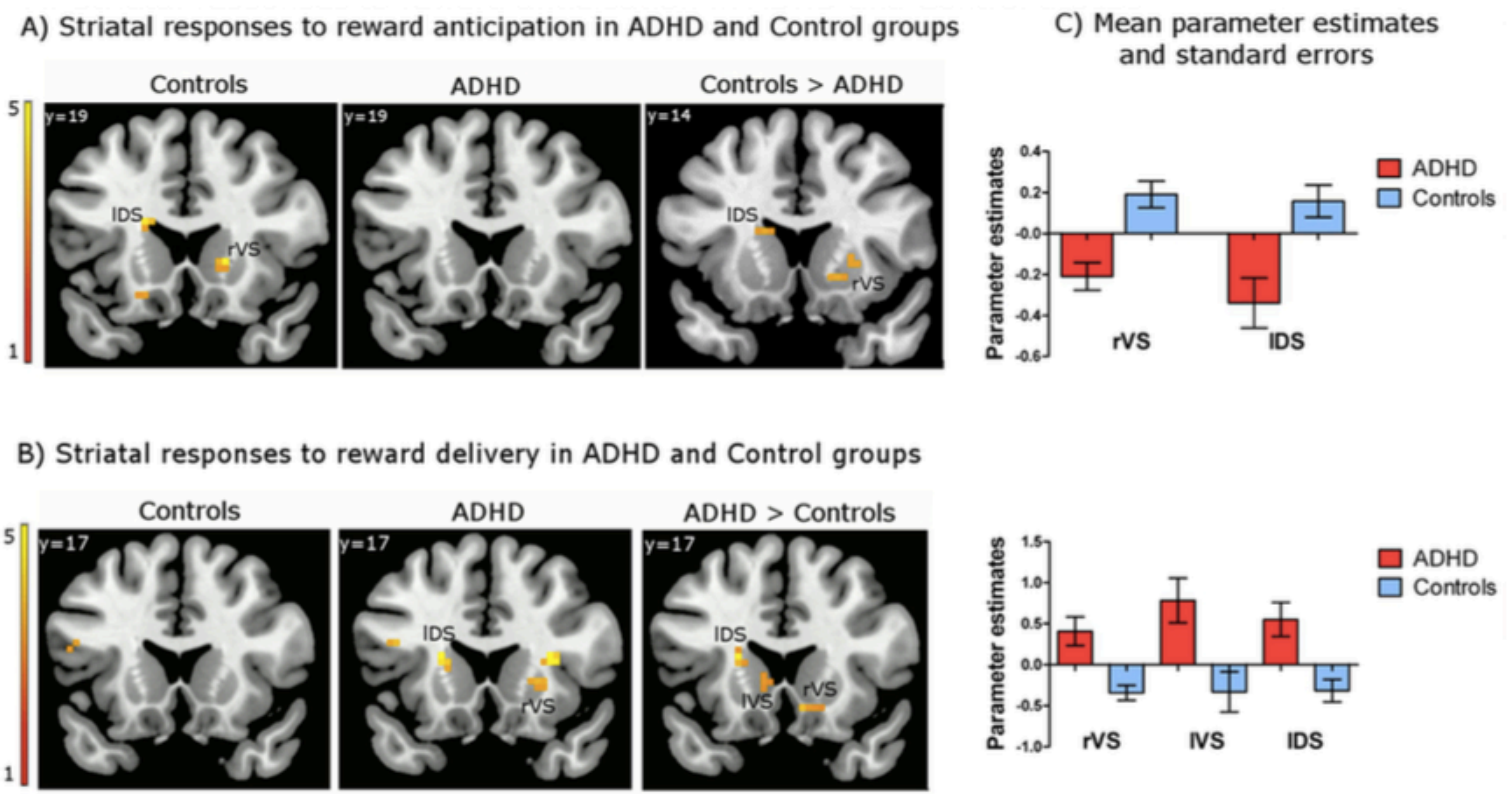
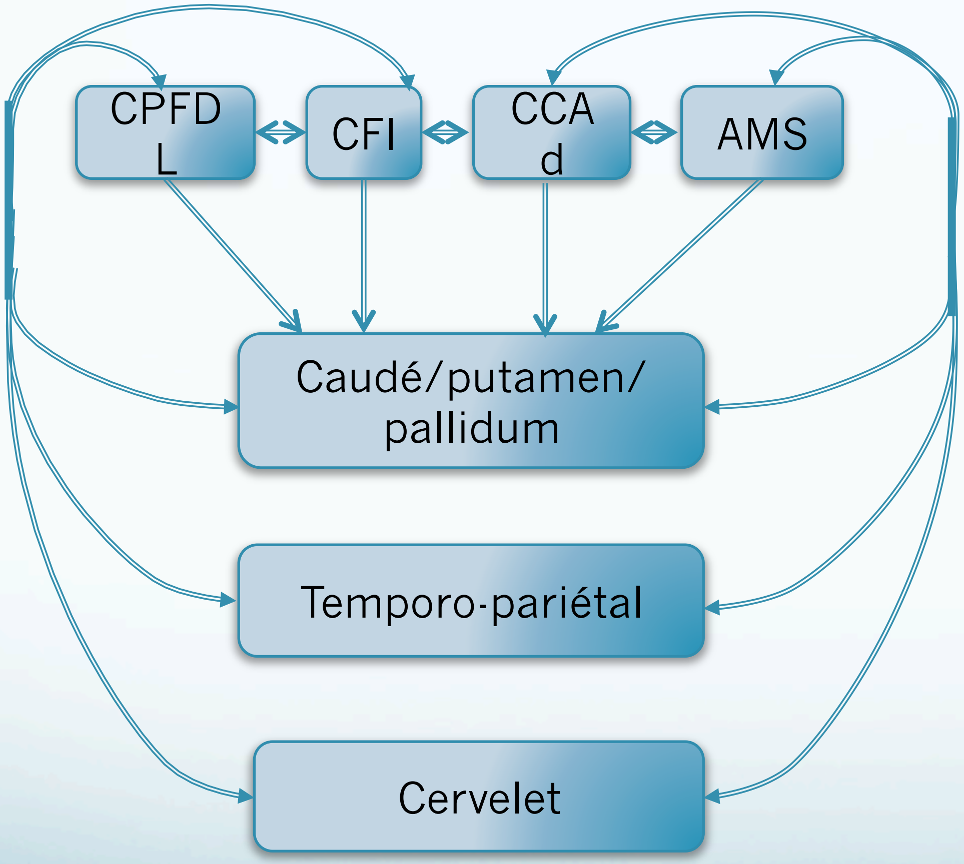


Figure 1. Classical conditioning fMRI paradigm. One of two neutral stimuli (Cue A or Cue B) was fol

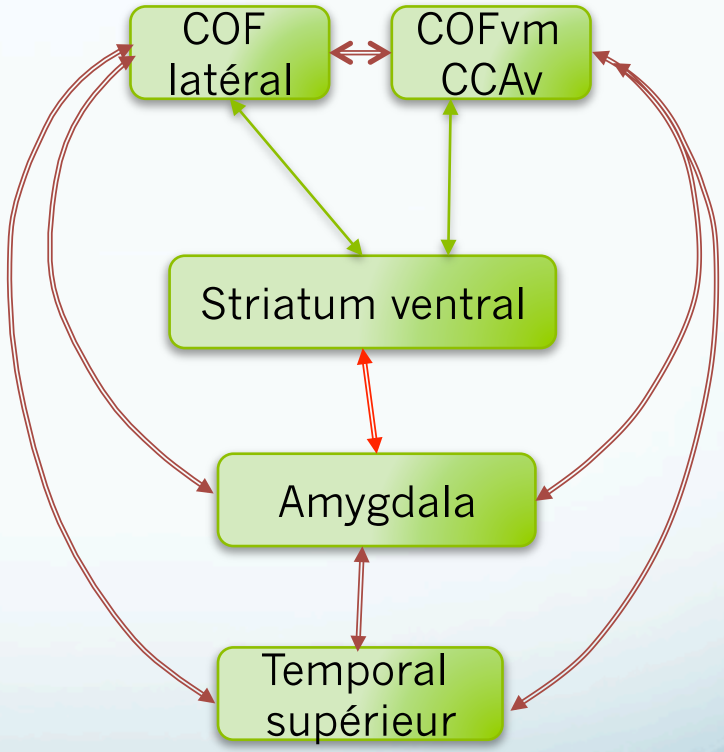


A) Striatal responses to reward anticipation in ADHD and Control groups
Controls
ADHD
Controls > ADHD
5
1
y=19
y=19
y=14
lDS
rVS
lDS
rVS
C) Mean parameter estimates and standard errors
Parameter estimates
0.4
0.2
0.0
-0.2
-0.4
-0.6
rVS
lDS
ADHD
Controls
B) Striatal responses to reward delivery in ADHD and Control groups
Controls
ADHD
ADHD > Controls
5
1
y=17
y=17
y=17
lDS
rVS
lDS
lVS
rVS
Parameter estimates
1.5
1.0
0.5
0.0
-0.5
-1.0
rVS
lVS
lDS
ADHD
Controls

Fonctions exécutives « froides »



Fonctions exécutives « chaudes »



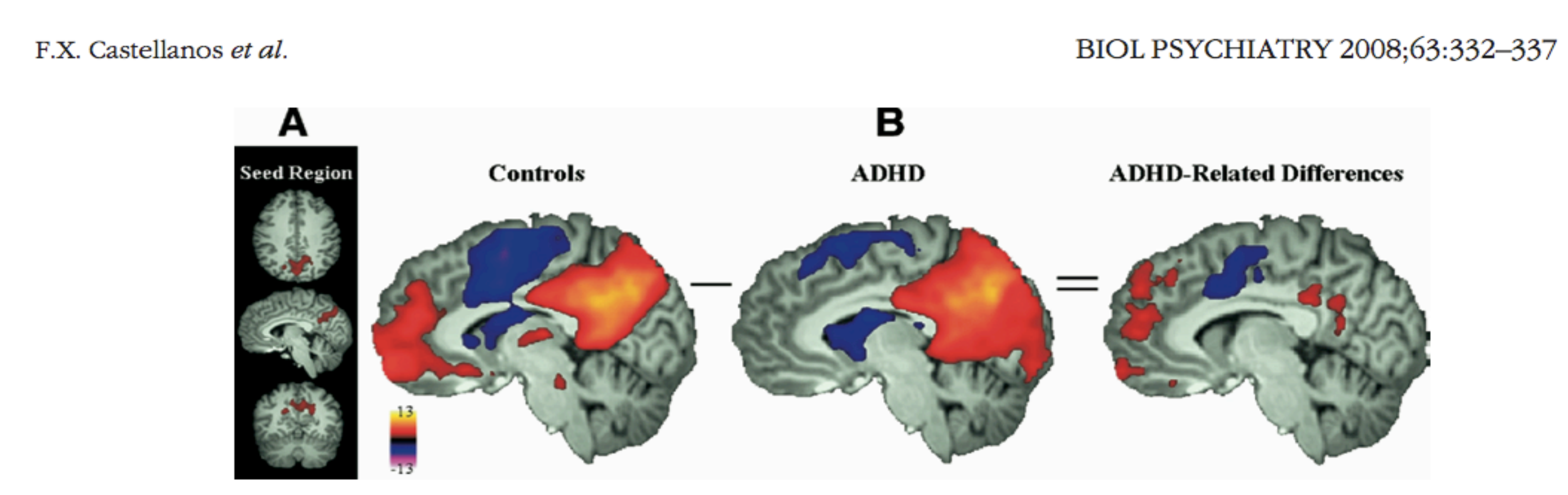
Conclusion

- La dysfonction des systèmes exécutifs « froids », sous-tendus par le cortex frontal latéral, reste une explication valide de la limitation des capacités attentionnelles, en particulier l'attention soutenue
- L'impulsivité et l'aversion au délai (« hot-executive »), sous-tendus par les circuits à origine orbito-frontale, seraient plutôt liés à un défaut d'ajustement des systèmes de la récompense, en particulier lors de comorbidité avec des troubles des conduites
- Il y a de forts arguments, en particulier anatomiques, pour présumer que le primum movens est une dysfonction au niveau des circuits de la récompense et que les autres systèmes sont secondairement dysfonctionnels

III/ *défaut de connectivité et mécanismes du trouble de l'attention.*

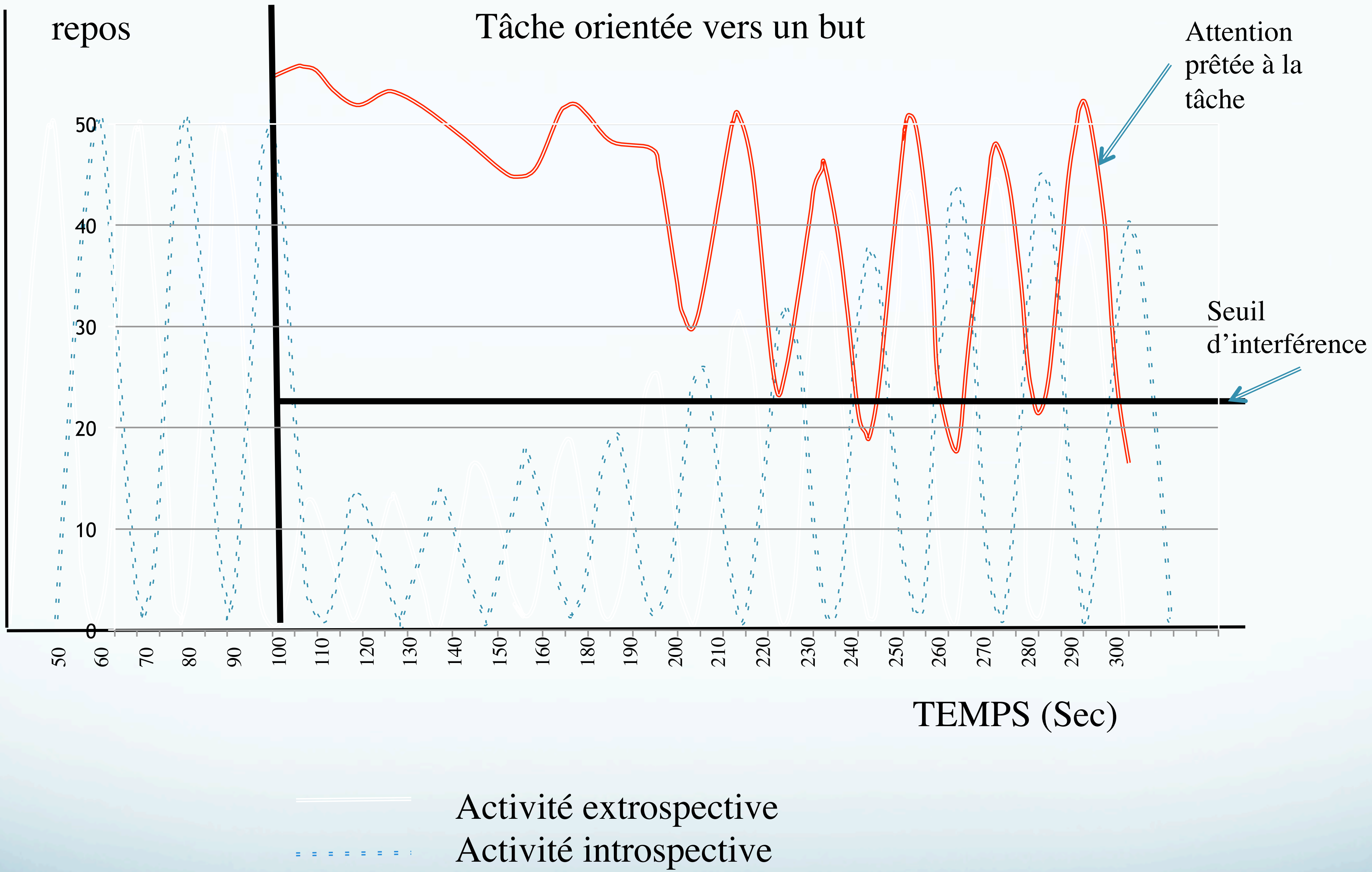
= défaut de connectivité de repos (« default mode)
+ tractographie : étude des circuits cortico-sous-corticaux

→ Dysfonctionnement des connexions cortico-corticales et cortico-sous-corticales

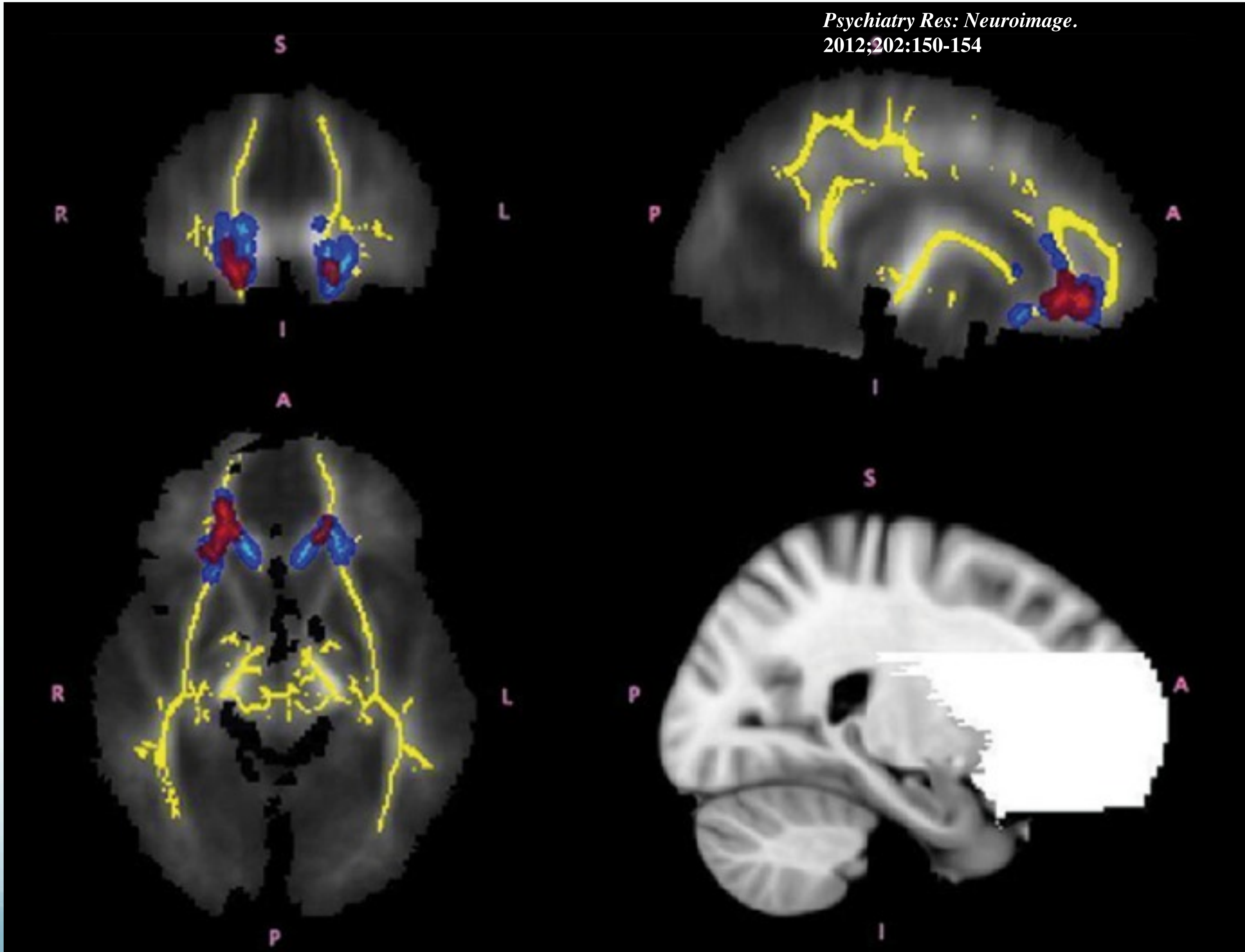


État de repos (resting state) enregistré en IRMf BOLD chez 20 adultes TDAH et 20 témoins appariés : anticorrélation entre DMN (précuneus et ventromedial prefrontal cortex) et cingulaire antérieur. La moindre activité chez les TDAH suggère un défaut de connectivité entre ces deux structures et un défaut de suppression de l'activité spontanée (non dirigée vers un but)

(Castellanos et al., Biol. Psych., 2008).



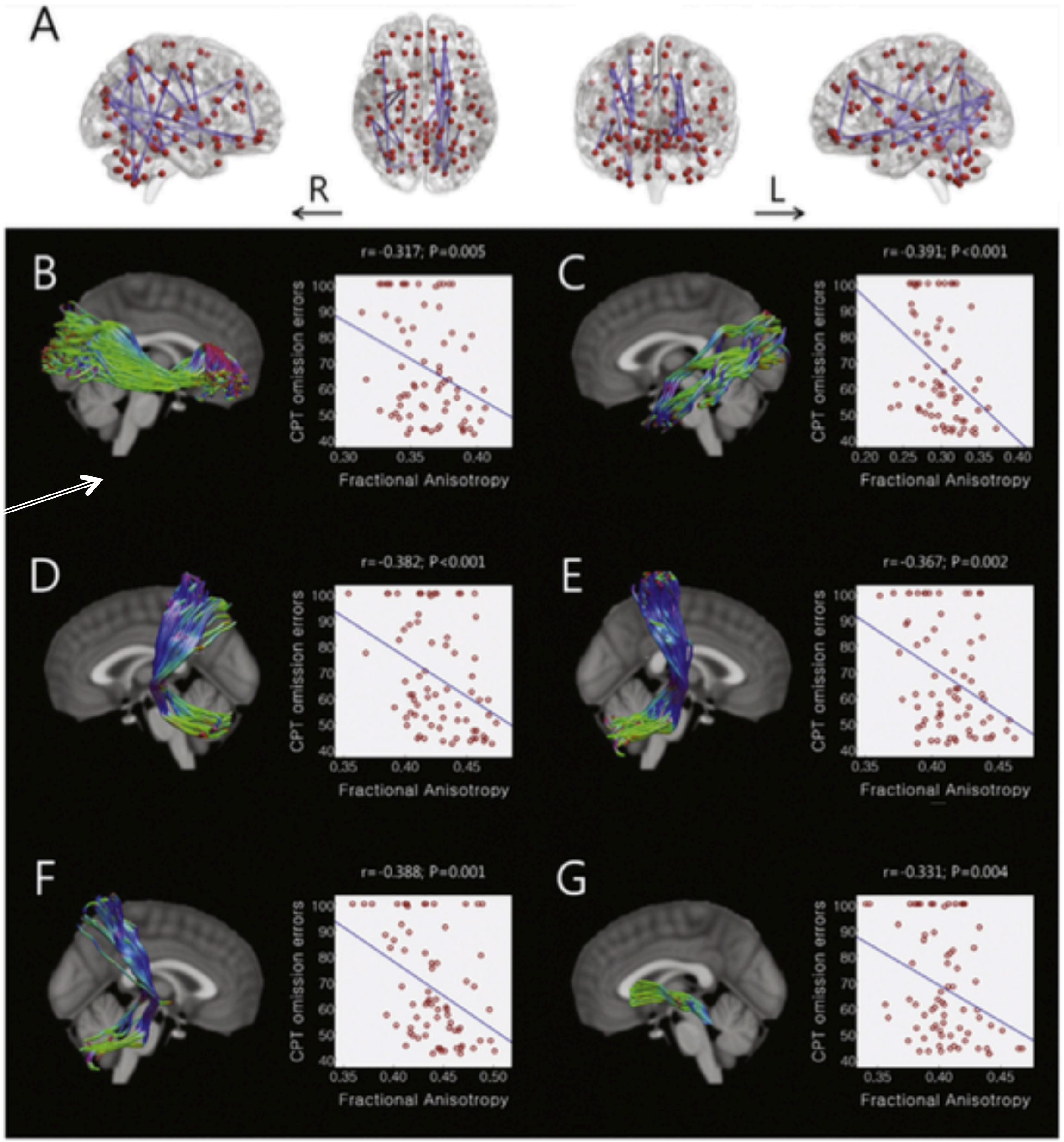
Chez l'hyperactif, une activité mentale spontanée excessive au repos empêcherait la cessation de ces fluctuations qui continueraient après le début de l'action, parasitant ainsi son bon déroulement, ce qui se traduirait par l'observation des troubles de l'attention



DTI : **Regions of significant differences between adolescents with ADHD and controls**

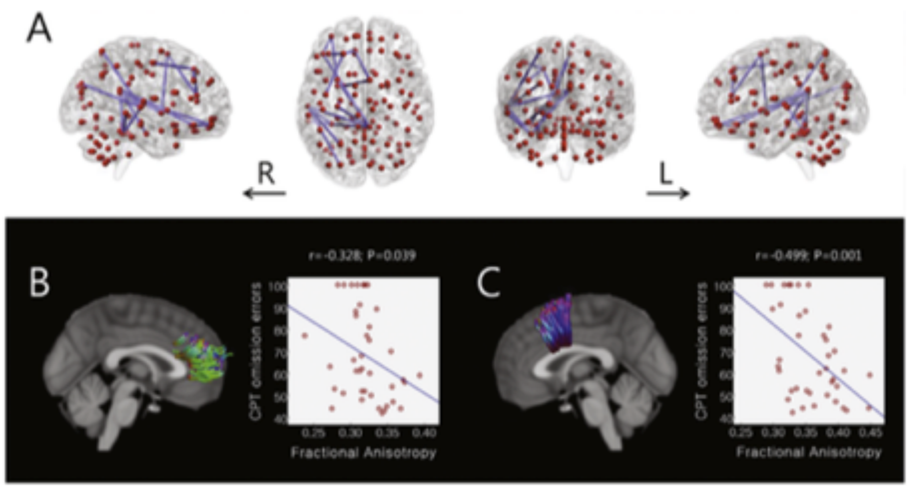
Connectomic Disturbances in Attention-Deficit/ Hyperactivity Disorder: A Whole-Brain Tractography Analysis

Soon-Beom Hong, Andrew Zalesky, Alex Fornito, Subin Park, Young-Hui Y
In-Chan Song, Chul-Ho Sohn, Min-Sup Shin, Bung-Nyun Kim, Soo-Churl C
Jae Hoon Cheong, and Jae-Won Kim



Corrélation entre défaut de connectivité dans divers faisceaux d'association et nombre d'erreurs d'omission au CPT2

ADHD, combined (n=39)
ADHD, inattentive (n=26)



BIOL PSYCHIATRY 2014;76:656–663

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Review

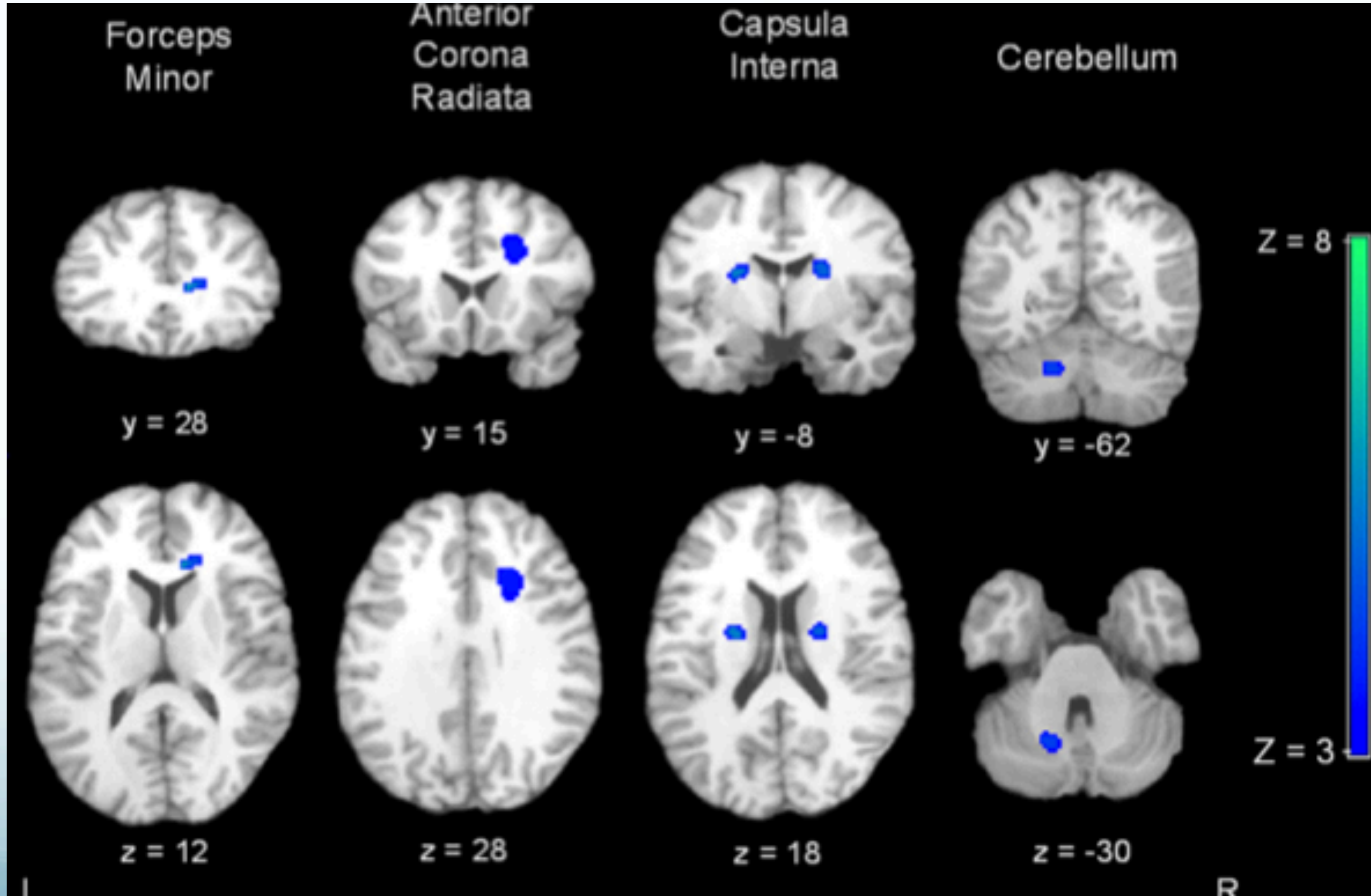
Diffusion tensor imaging in attention deficit/hyperactivity disorder: A systematic review and meta-analysis

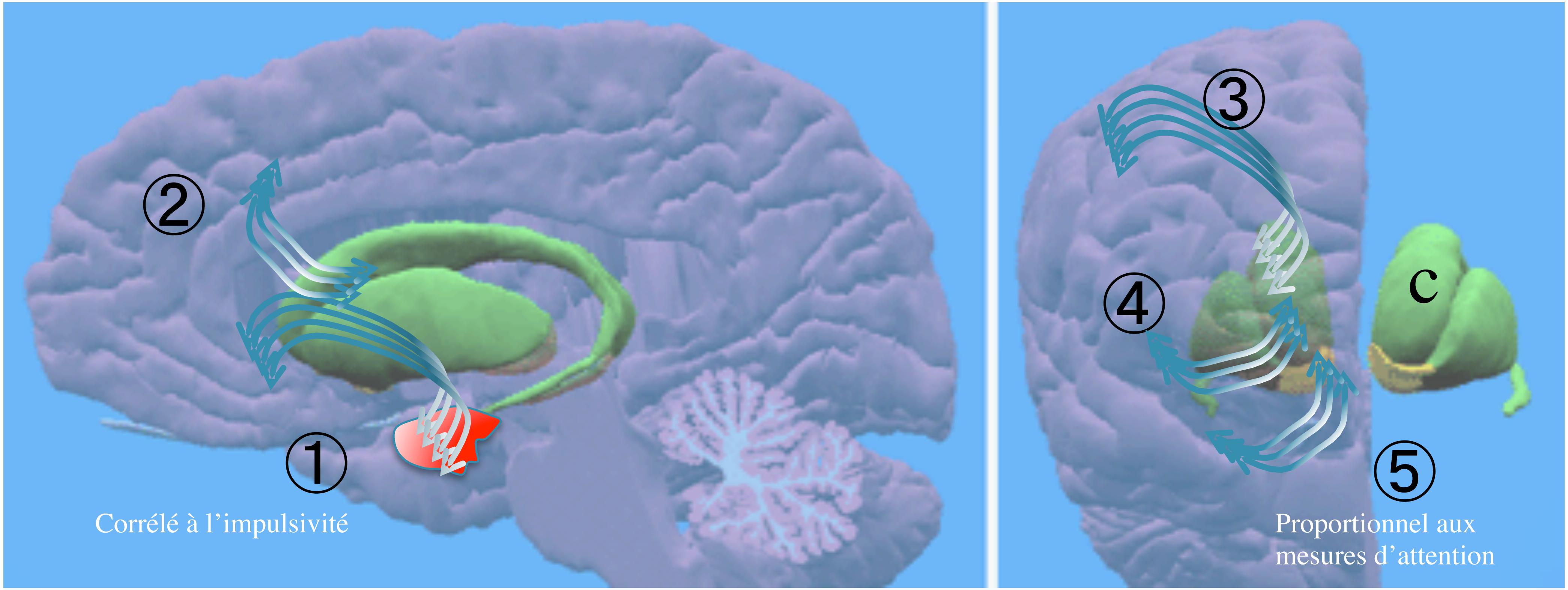
Hanneke van Ewijk[a,*], Dirk J. Heslenfeld[a,b], Marcel P. Zwiers[c], Jan K. Buitelaar[c,d], Jaap Oosterlaan[a]

[a] Department of Clinical Neuropsychology, VU University Amsterdam, The Netherlands
[b] Department of Cognitive Psychology, VU University Amsterdam, The Netherlands
[c] Department of Cognitive Neuroscience, Donders Institute for Brain, Cognition and Behavior, Radboud University Nijmegen Medical Center, Nijmegen, The Netherlands
[d] Karakter, Child and Adolescent Psychiatry University Center Nijmegen, Nijmegen, The Netherlands

Méta-analyse « ALE » de 15 études DTI publiées à 2011:173 ADHD patients and 169 healthy control subjects

Diminution d’anisotropie
- -faisceau long. sup
- - f. cortico-spinal
- connexions fronto-striées
- Cervelet gauche





- TDAH :schématisation des principaux faisceaux d'association issus du cortex frontal tels qu'ils peuvent être individualisés en tractographie IRM.
- **anomalie d'anisotropie en tractographie** proportionnelle à diverses mesures des fonctions exécutives (mémoire de travail, attention soutenue, flexibilité...)

4, 5 : fronto-strié ventro-latéral et orbito-caudé : corrélés au déficit attentionnel
1 : unciné : corrélé à l'impulsivité
D'après Chang et al. (2012); Wu et al. (2012)

Conclusion (2)

- Les méthodes de tractographie ont récemment été largement utilisées dans le TDAH, pour évaluer la thèse d'un défaut de connectivité.
- Un défaut de connectivité de divers circuits cortico-corticaux et cortico-sous-corticaux pourrait rendre compte de ces déficits, et aussi de l'activité mentale spontanée matéralisée par l'activité de repos dans le circuit « default-mode ».
- De nombreux faisceaux de substance blanche ont été analysés comme anormalement constitués ou organisés dans le TDAH (enfant et adulte), à divers niveaux : cortico-cortical, cortico-strié, cortico-cérébelleux.
- Les travaux les plus récents pointent vers un défaut multifocal de connectivité avec des variations individuelles pouvant correspondre à la présence des différents symptômes : inattention, agitation-impulsivité, signes moteurs, troubles des conduites