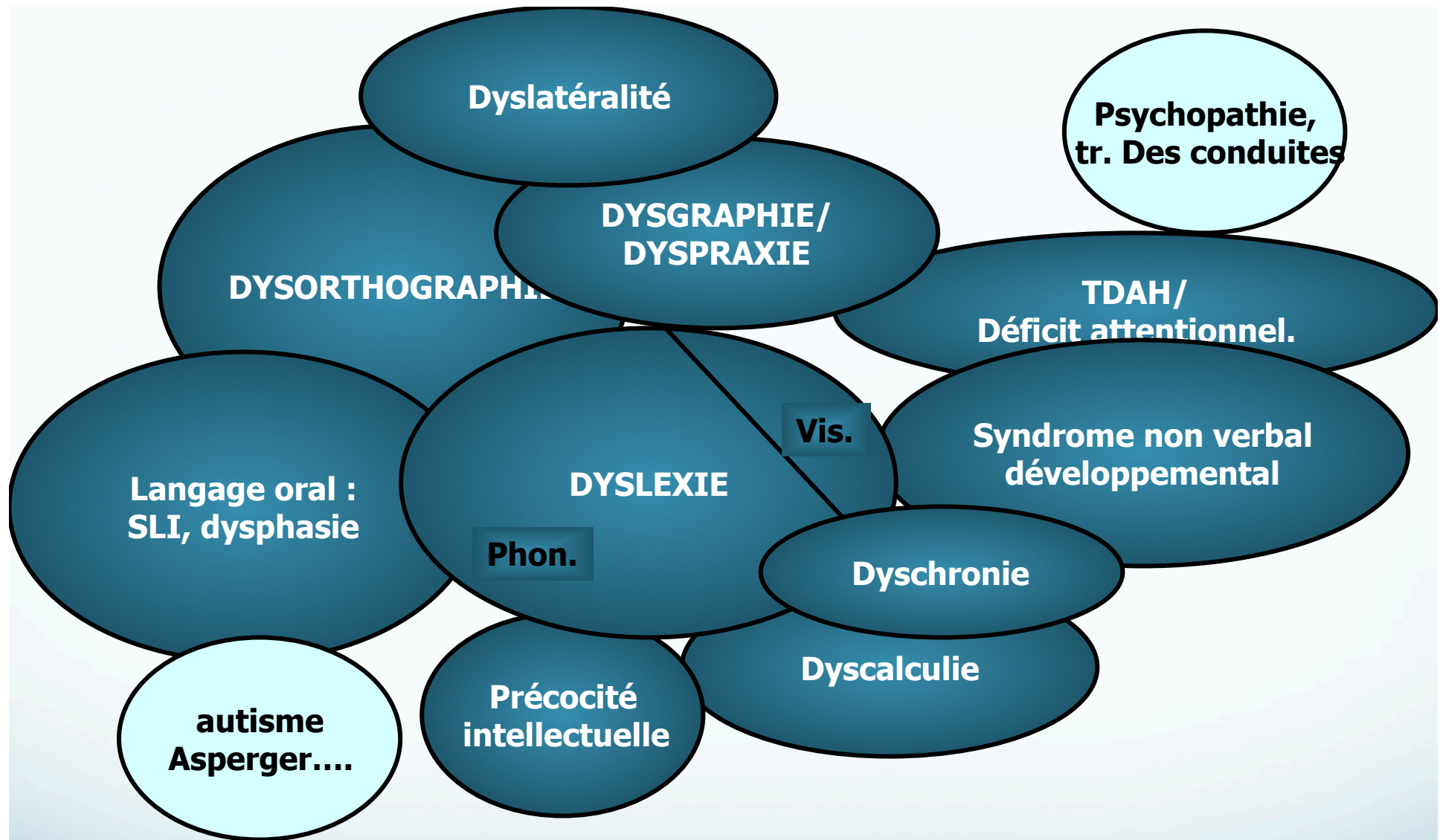


Troubles spécifiques d'apprentissage:

quelques avancées de la recherche et leurs
applications potentielles

Michel Habib
Résodys, Marseille

Perpignan, 2 avril



La « constellation dys » : un point de vue de cliniciens

DSM-5 : trouble spécifique d'apprentissage

- A. Difficulté à apprendre et à utiliser les aptitudes académiques, comme indiqué par la présence **d'au moins un des symptômes** suivants, qui ont **persisté** depuis au moins 6 mois en dépit d'interventions ciblées:
- 1- lecture de mots inexacte, lente ou laborieuse
 - 2- difficulté à comprendre la signification de ce qui est lu (même si lu correctement)
 - 3- difficultés d'orthographe (spelling) : p.e. : ajout ou omission de lettres
 - 4- difficultés dans l'expression écrite (p.e. erreurs de ponctuation ou grammaticales, défaut d'organisation des paragraphes, manque de clarté de l'expression des idées)
 - 5- difficulté à maîtriser le sens des nombres, les faits numériques, ou le calcul
 - 6- difficulté dans le raisonnement mathématique (appliquer des concepts ou des faits dans la résolution de problèmes)
- B. Significativement en-dessous de ceux attendus pour l'âge et interfère significativement avec les performances académiques ou les occupations
- C. Commence durant les années d'école mais peut n'être manifeste que dès lors que les demandes excèdent les capacités limitées de l'individu
- D. Pas mieux expliquées par déficience intellectuelle, acuité auditive ou visuelle non corrigée, autres troubles neurologiques ou mentaux, adversité psycho-sociale...

DSM-5: TROUBLES du neurodéveloppement (neurodevelopmental disorders)

Troubles de la communication

Troubles du langage (dysphasie)

Trouble (pragmatique) de la communication sociale

Trouble de production du langage (speech sound disorder)

Troubles du spectre autistique

Troubles spécifiques d'apprentissage

Lecture – écriture – calcul

Troubles moteurs

Trouble déficitaire d'attention (TDAH)

Forme inattentive

Forme mixte

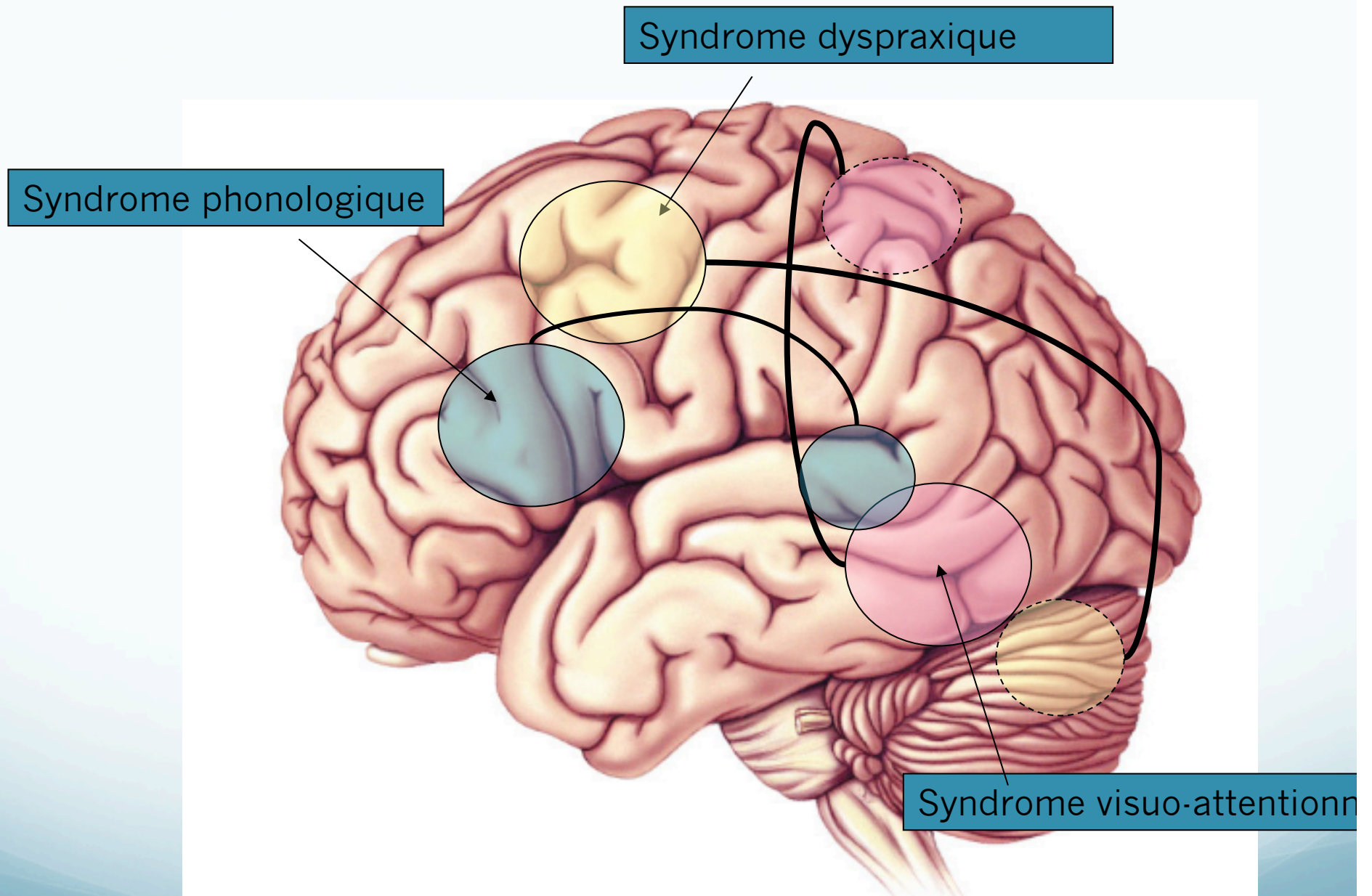
Trois profils de troubles spécifiques d'apprentissage

- **Le syndrome phonologique** : le plus fréquent, le plus classique, repose sur l'hypothèse du déficit phonologique exclusif
- **Le syndrome visuo-attentionnel**: généralement considéré comme un déficit des processus d'ajustement de la fenêtre attentionnelle (S. Valdois)
- **Le syndrome dyspraxique** : moins connu, peut être associé aux précédents, mais aussi survenir seul

Peuvent s'associer entre eux!

Chaque profil relève sans doute de mécanismes différents

- Linguistique/phonologique : défaut d'installation des circuits du langage oral : aires péri-sylviennes gauches
- Visuo-attentionnel : défaut d'installation des circuits attentionnels et de contrôle de l'entrée visuelle : aires pariétales bilatérales et temporale inférieure
- Dyspraxique : défaut d'installation des circuits fronto-pariéto-cérébelleux



Substrat hypothétique des 3 principaux syndromes

L'apport des neurosciences : trois époques successives

- Époque 1 (80-90): travaux fondateurs de Galaburda:
 - microscopique : défaut organogenèse
 - macroscopique : notion de dyslatéralité
- Époque 2 (95-2005): avènement de l'imagerie fonctionnelle (PET, Pot évoqués, IRMf, MEG...)
 - Activation fonctionnelle : caractériser et localiser l'anomalie fonctionnelle
 - En comprendre les mécanismes
 - Effets de la rééducation et de l'environnement socio-culturel
- Époque 3 (2005-2013) : différencier les sous-types, orienter la thérapeutique
 - Combinaison activation fonctionnelle/morphométrie (VBM)
 - Tractographie et imagerie à tenseur de diffusion (DTI) : **connectivité**

Le trouble d'apprentissage de type **non verbal**



Le comprendre pour mieux
intervenir en milieu scolaire

LDA Learning Disabilities Association of America

SchoolBehavior

Home Support

Home About Behavior

LD / NLD Specialty Schools

Placem

→ ADD /

→ Adoles
Progra→ Adoles
Progra

→ Colleg

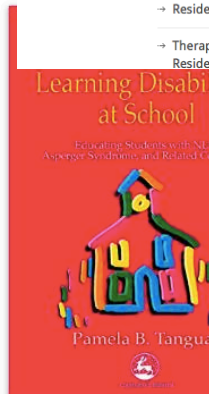
→ Eating

→ GAP Yr

→ LD / N

→ Outdo
Wildr

→ Reside

→ Therap
Reside

**CHILD MIND
INSTITUTE**

TOOLS & RESOURCES

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FIND IT

GET INFORMED

Brainstorm Blog

Ask an Expert

Families Speak Up

Free Workshops

Childmind.org en Español

Topics

ADHD

Adolescents

Anxiety

Autism

Bipolar

Bullying

College

Depression

Disruptive Behavior

Eating Disorders

Executive Function

Kids and Media

TOPICS

What Is Non-Verbal?
Difficulty picking up
visually, socially, and academically



Caroline Miller
Editorial Director
CHILD MIND INSTITUTE

student master long division, and ideas for improving reading and discusses concepts such as frontloading and a code of how they benefit the student with NLD and related conditions.



HOME

HEALTH

NLDA

EVENTS

WEBSITE

Welcome to the NLDA – Nonverbal Learning Disorders Association

Non Verbal learning Disabilities or Disorder (NLD) refers to the condition where individuals possess high verbal ability but face problems with the Social side and always have a verbal-spatial weakness as well. This problem is far un-diagnosed one as most public schools have the reading abilities as the first indicator for performance. Also with non-verbal learning ability posing a serious threat with Social interactivity, NLD has been a highly unique challenge with parents and other adult consumers.

Typical way to find out these individuals is by an IQ test where the normal performance IQ will be slightly below their verbal IQ pertaining to the visual and spatial weakness.

First Signs of NLD at young age:



MOST POPULAR

1. How to Help Kids With ADHD Drive Safely
2. Tips for Beating Test Anxiety
3. Five Ways to Support Siblings in Special Needs Families
4. Disruptive Behavior: Why It's Often Misdiagnosed
5. Helping Resistant Teens into Treatment
6. Children's Mental Health Report

nonverbal learning
indications that he doesn't

get tips to talk to your teen.

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the child with nonverbal learning disorders (NLD) these demands can prove to be totally overwhelming and may appear insurmountable at times. Unless the entire school staff is

Prevalence



- NLD estimated at 5-10% of LD clinical sample (Rourke, 1989)
- Population prevalence of LD around 10% (Pennington, 1991)

Overall NLD population prevalence= 0.1-1.0%



Historique

- Première description par Johnson et Myklebust (1967), comme une forme particulière de trouble d'apprentissage, nécessitant une approche rééducative très spécifique.
- Au sein de la constellation des « DYS », ce syndrome méconnu, mais loin d'être rare, se caractérise par une altération des fonctions généralement dévolues à l'hémisphère droit.
- Prévalence: 4 à 5 % des enfants d'âge scolaire en Amérique du Nord et Sex ratio homogène (Rourke et al.)
- Le diagnostic de NLD (Nonverbal learning Disability) est controversé et officiellement non reconnu dans le DSM-IV et DSM V.

Différentes appellations pour un même syndrome

- **Nonverbal Learning Disorder (NLD)**
- Nonverbal Learning Disability (NVLD)
- Syndrome de Dysfonctions Non Verbales (SDNV)
- Trouble d'Apprentissage Non Verbal (TANV)
- Incapacités d'Apprentissage Non Verbal (IANV)
- Syndrome hémisphérique Droit développemental
- Syndrome de l'hémisphère droit
- Syndrome de l'Hémisphère mineur
- Syndrome non-verbal développemental

Différentes manifestations en fonction de l'âge

Rourke (1995): étude longitudinale approfondie de ce syndrome qui a abouti à une description de l'évolution des manifestations au cours de l'âge.

Alors que certains déficits vont diminuer dans la petite enfance, les déficits caractéristiques s'accroissent au fur et à mesure que l'enfant grandit.

Diagnostic fiable assez tardif.

SAVME: Common Characteristics of Nonverbal Learning Disorders

Social	Lack of ability to comprehend nonverbal communication
	Significant deficiencies in social judgment and social interaction
Academic	Problems in math, reading comprehension, handwriting
	Problems with organization, problem-solving, higher reasoning
	Strengths include strong verbal and auditory attention and memory
Visual-Spatial	Lack of image, poor visual recall
	Faulty spatial perception and spatial relations
Motor	Lack of coordination
	Severe balance problems
	Difficulties with fine motor skills
Emotional	Frequent tantrums, difficulties soothing, easily overwhelmed
	Fears of new places and changes in routines
	Prone to depression and anxiety as they get older

Nom _____
Sexe _____
Etablissement _____
Psychologue _____

Date d'administration _____
Date de naissance _____
Age _____

14 ans, ♀
Difficultés scolaires
croissantes,
mathématiques,
écriture,
concentration

Conversion des notes brutes en notes standard

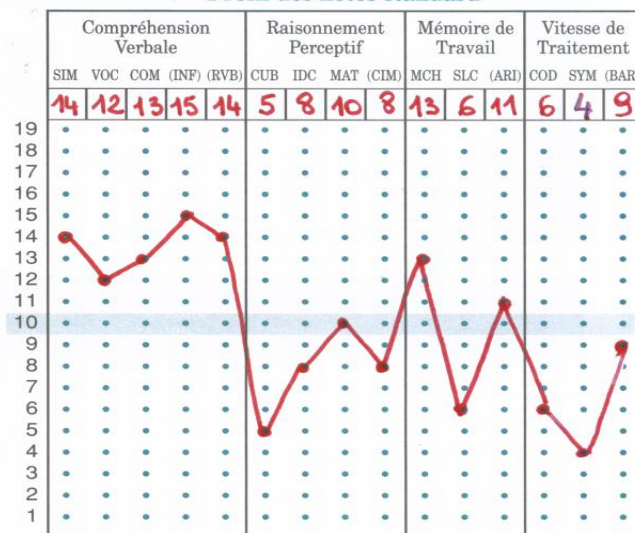
Subtests	Notes brutes	Notes standard				
Cubes	22	5		5		5
Similitudes	29	14	14			14
Mémoire des chiffres	18	13		13		13
Identif. de concepts	17	8		8		8
Code	33	6			6	6
Vocabulaire	39	12	12			12
Séq. Lettres-Chiffres	15	6		6		6
Matrices	23	10		10		10
Compréhension	26	13	13			13
Symboles	13	4			4	4
(Complét. d'images)	22	8		(8)		(8)
(Barrage)	72	9			(9)	(9)
(Information)	23	15	(15)			(15)
(Arithmétique)	24	11		(11)		(11)
(Raisonnement verbal)	19	14	(14)			(14)
Sommes des notes standard		39	23	19	11	82
		Comp. Verb.	Rais. Perc.	Mém. Trav.	Vit. Trait.	Totale

Conversion des sommes des notes standard en notes composites

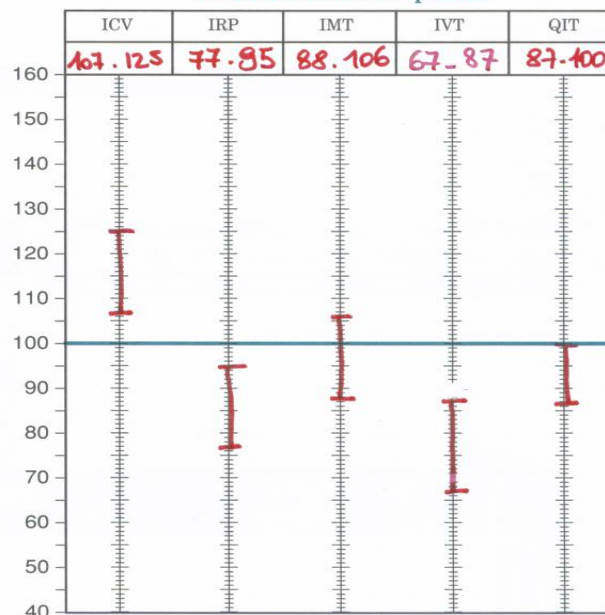
Echelle	Somme des notes standard	Note composite	Rang percentile	95% Intervalle de confiance
Compréhension Verbale	39	ICV 118	88	107 - 125
Raisonnement Perceptif	23	IRP 84	14	77 - 95
Mémoire de Travail	19	IMT 97	42	88 - 106
Vitesse de Traitement	10	IVT 73	4	67 - 87
Totale	9	QIT 83	32	87 - 100

Cahier de passation

Profil des notes standard



Profil des notes composites



10. Expressions

Cherche quel sens tu peux donner à chacune des phrases suivantes et entoure la petite lettre qui va avec la bonne réponse.

2/5 = 5^e
percentile

- 1) Tu m'as enlevé une épine du pied.
- a) J'ai une écharde dans le pied.
 - b) Tu as résolu mon problème.
 - c) Tu m'as fait du tort.
 - d) Je n'avais pas raison.
-
- 2) Il ne faut pas vendre la peau de l'ours avant de l'avoir tué.
- a) Avant de se réjouir d'un succès, il faut en être tout à fait sûr.
 - b) Pour tuer un ours, il faut un fusil.
 - c) Il faut se lever tôt pour réussir dans la vie.
 - d) Il ne faut pas se perdre dans la forêt à cause des ours.
-
- 3) Tu arrives comme un chien dans un jeu de quilles.
- a) Tu as bien fait de venir.
 - b) Quand le chien est arrivé, on a arrêté le jeu.
 - c) Tu viens déranger nos plans.
 - d) Tu arrives trop tard.
-
- 4) Petit à petit l'oiseau fait son nid.
- a) Chaque année l'oiseau doit recommencer son nid.
 - b) La persévérance vient à bout des difficultés.
 - c) Il faut un nid pour avoir des petits.
 - d) Il faut faire tout en même temps pour ne rien oublier.
-
- 5) Quand le chat est parti, les souris dansent.
- a) Quand on a travaillé, on peut danser.
 - b) Dans les maisons où il n'y a pas de chat, on trouve des souris.
 - c) Qui veut la fin, prend les moyens.
 - d) Les écoliers profitent de leur liberté en l'absence du professeur.
-

ASSQ

Ehlers S., Gillberg, C. Wing, L (1999) traduction française M.H. Plumet

		non	un peu	oui
1	Est "vieux jeu" ou précoce	☒	☐	☐
2	est considéré par les autres enfants comme un "professeur excentrique"	☒	☐	☐
3	vit un peu dans son propre monde autour d'intérêts intellectuels restreints et particuliers (idiosyncratiques)	☒	☐	☐
4	accumule des informations ou connaissances sur certains sujets (bonne mémoire de stockage) mais sans en comprendre réellement la signification	☒	☐	☐
5	a une compréhension littérale (au premier degré) des énoncés métaphoriques ou ambigus	☐	☐	☒
6	présente un style verbal déviant, avec un langage formel, précieux ou comme un "robot" ou ordinateur	☐	☒	☐
7	invente des mots ou des expressions idiosyncratiques	☒	☐	☐
8	a une voix ou une élocution particulière	☐	☒	☐
9	produit des sons involontaires tels que raclements de gorge, grognements, claquement de langue, cris...	☒	☐	☐
10	est étonnamment performant dans certains domaines et étonnamment mauvais dans d'autres	☐	☒	☐
11	utilise un langage fluide, mais a du mal à l'ajuster en fonction des différents contextes sociaux ou des besoins des interlocuteurs	☐	☒	☐
12	manque d'empathie	☒	☐	☐
13	fait des remarques naïves et embarrassantes	☒	☐	☐
14	a un mode déviant d'utilisation du regard	☒	☐	☐
15	souhaite être sociable mais a du mal à nouer des relations avec ses pairs	☐	☒	☐
16	peut être avec d'autres enfants, mais seulement s'ils suivent ses conditions, ses règles d'interaction	☒	☐	☐
17	n'a pas réellement de meilleur ami	☐	☐	☒
18	manque de sens commun, de bon sens	☐	☒	☐
19	est peu compétent dans les jeux à plusieurs, n'a pas le sens de la coopération en équipe, poursuit ses propres buts	☐	☒	☐
20	a des mouvements ou des gestes maladroits, gauches, mal coordonnés ou embarrassés	☐	☐	☒

21	a des mouvements involontaires du corps ou du visage	☒	☐	☐
22	a du mal à accomplir certaines activités quotidiennes simples à cause de la répétition compulsive de certaines actions ou pensées	☒	☐	☐
23	a des routines spéciales: insiste pour que rien ne change	☒	☐	☐
24	montre des attachements idiosyncratiques à des objets	☒	☐	☐
25	se fait brutaliser ou intimidé par les autres enfants	☐	☒	☐
26	a des mimiques expressives nettement inhabituelles	☐	☒	☐
27	montre des postures nettement inhabituelles	☒	☐	☐

Score 15/54 – cutoff = 19

Arguments en faveur de deux syndromes indépendants

	SDNV	Asperger
Traitement des émotions	émotions normales mais difficultés à les exprimer et à les reconnaître chez les autres,	Difficultés de traitement des émotions mais pas de difficulté de traitement visuel obligatoirement.
Rigidité, besoin de routine	Intérêts restreints en lien avec l'isolement social mais pas d'intérêt obsessionnel	Fixation sur un sujet, un objet, voire une partie d'objet (fascination pour les horaires de trains) Adhésion inflexible à des habitudes ou à des rituels spécifiques et non fonctionnels

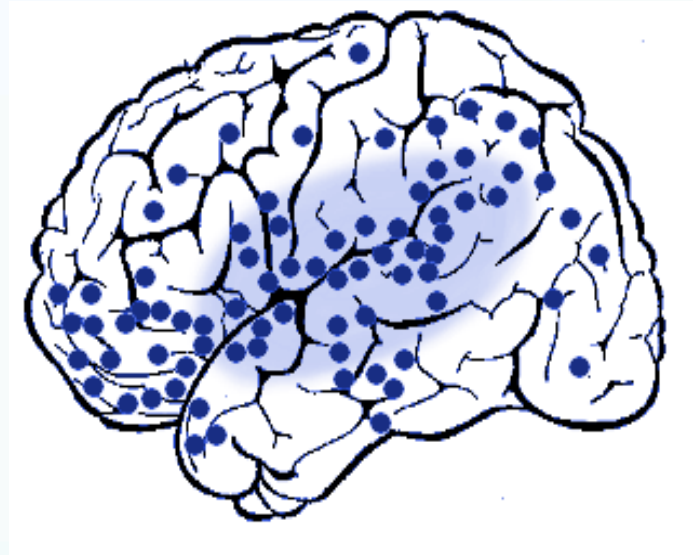
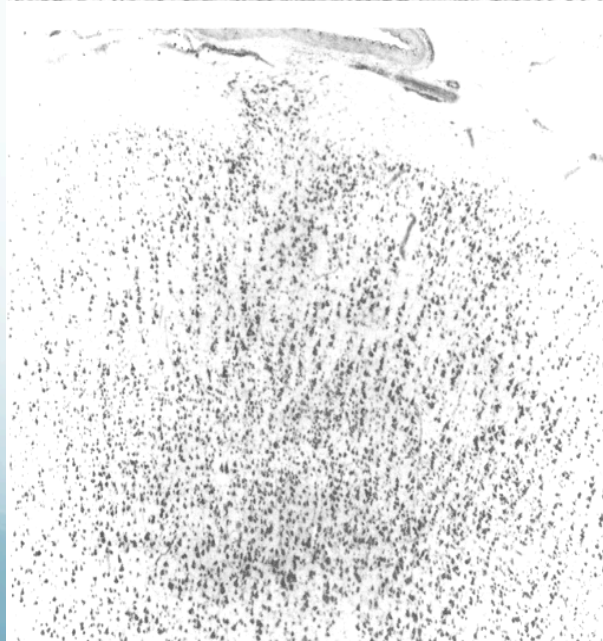
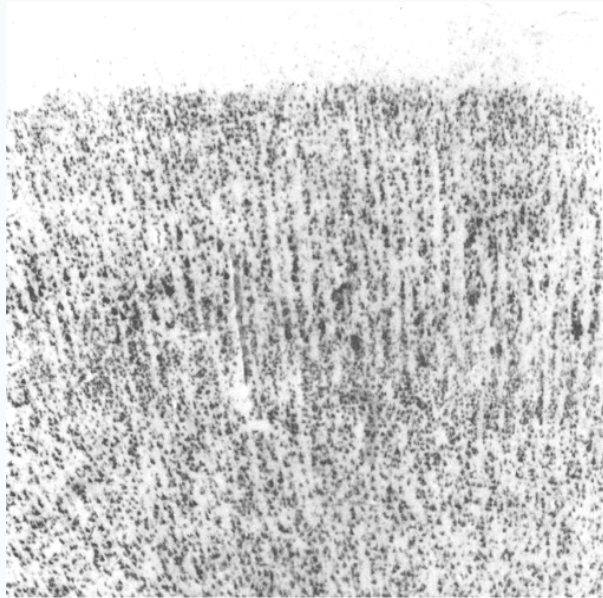
Arguments en faveur de deux syndromes indépendants

	SDNV	Asperger
Comportement sociaux	Contexte dépendant..	Quel que soit le contexte
Perception tactile	Déficit	Hypersensibilité
Motricité	Maniérisme moteur stéréotypie non présent	Peu de maladresses motrices
	Maladresse dans les coordinations motrices	Des maniérismes moteur

Arguments en faveur de deux syndromes indépendants

	SDNV	Asperger
Compétences en Mathématiques	Critères de diagnostic	Pas de troubles spécifiques
Langage		Troubles de la pragmatique plus caractéristiques

Epoque 1: les précurseurs

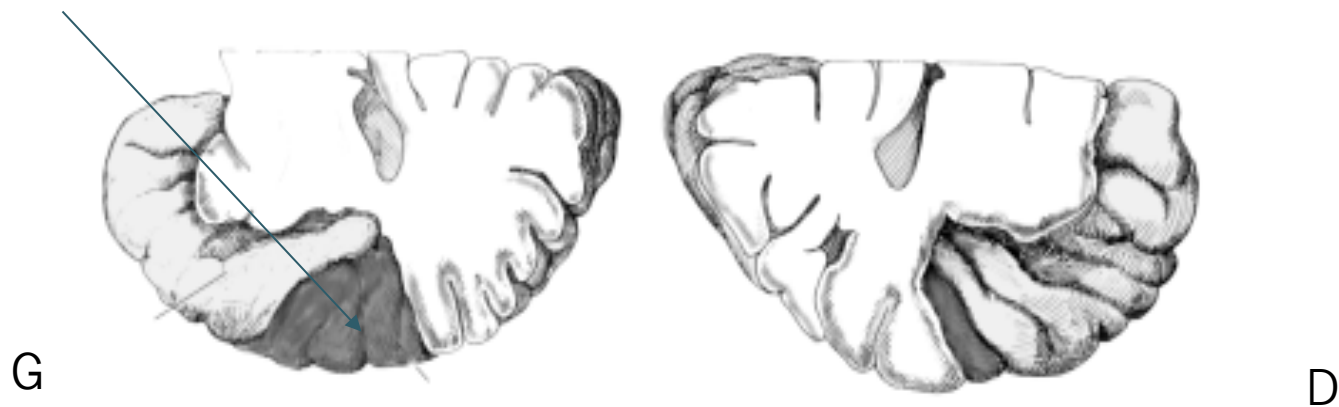


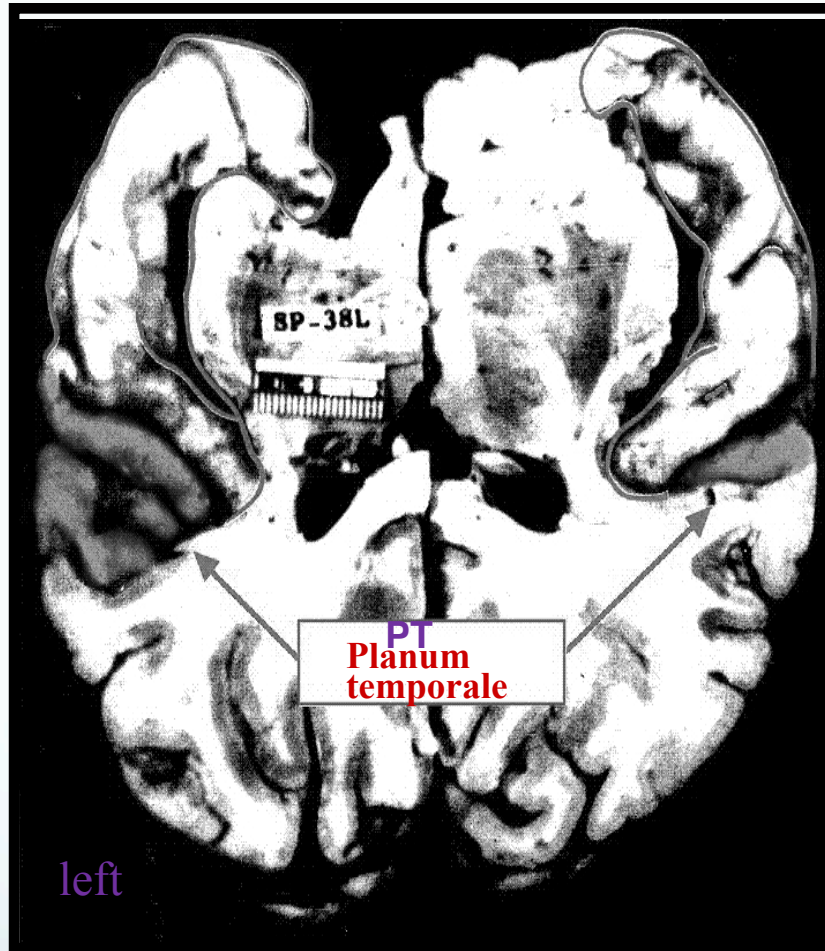
Ectopies sur le cerveau
dyslexique
(Galaburda et al., 1979, 1985)

Aire de Wernicke

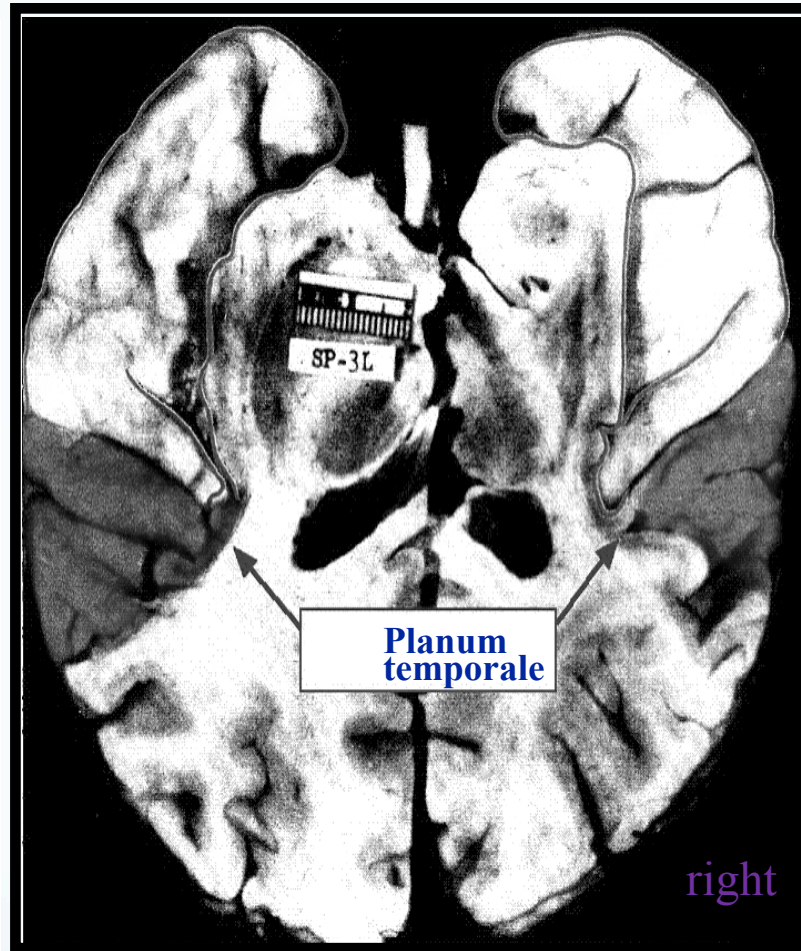


Planum temporale





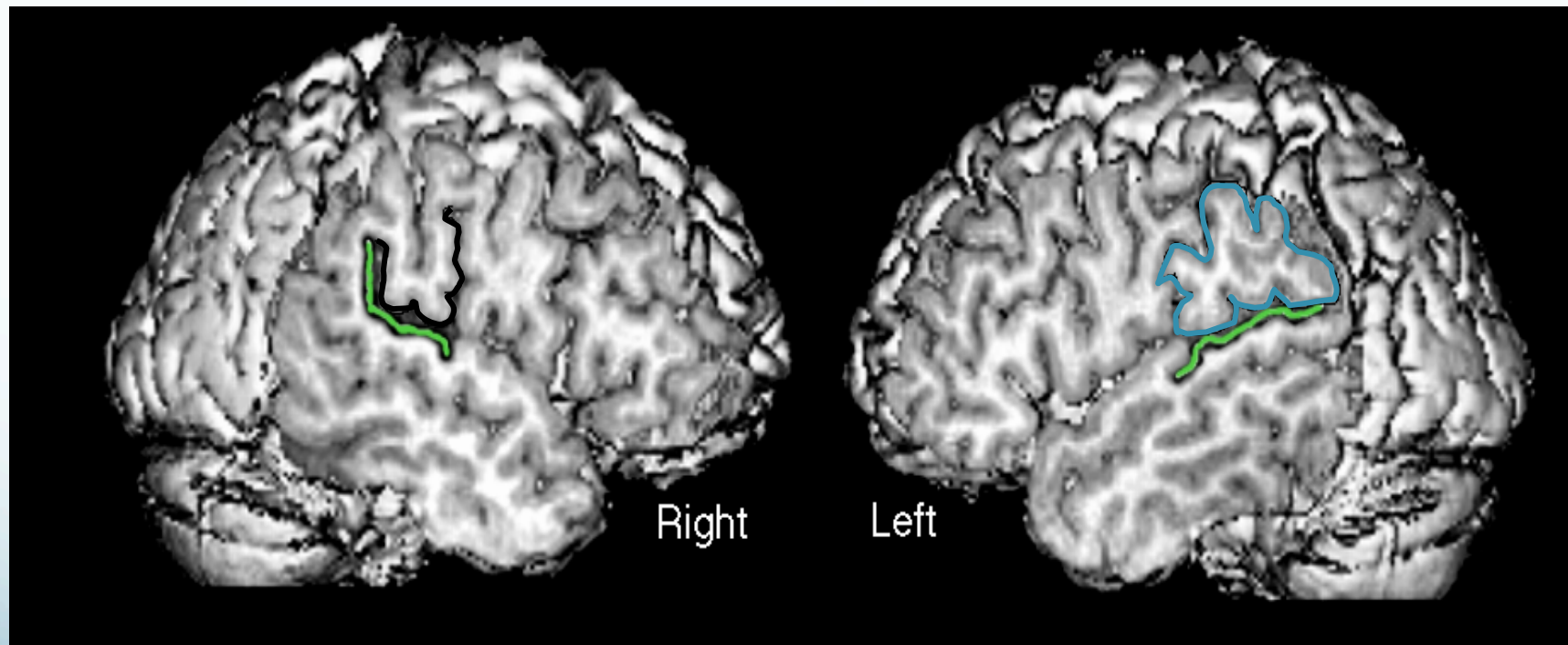
NON DYSLEXIC

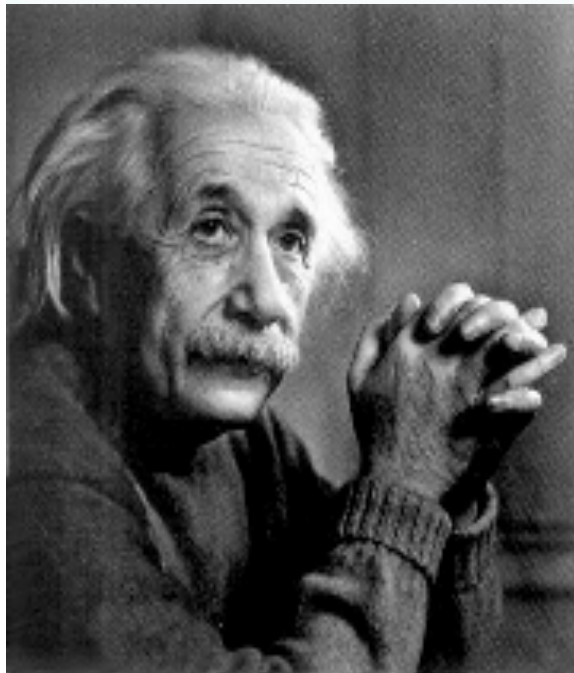
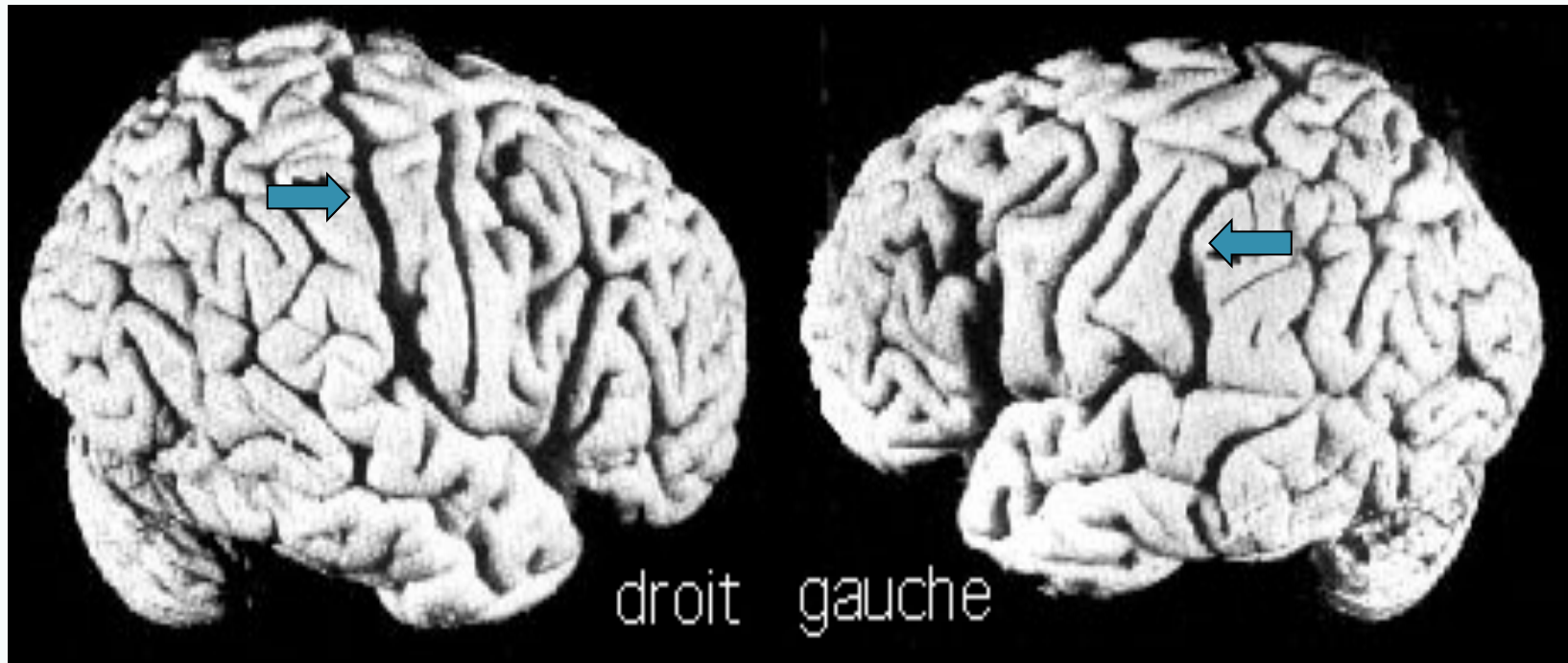


DYSLEXIC

Absence of planum asymmetry in the dyslexic brain
 From Galaburda et al., 1979; 1985

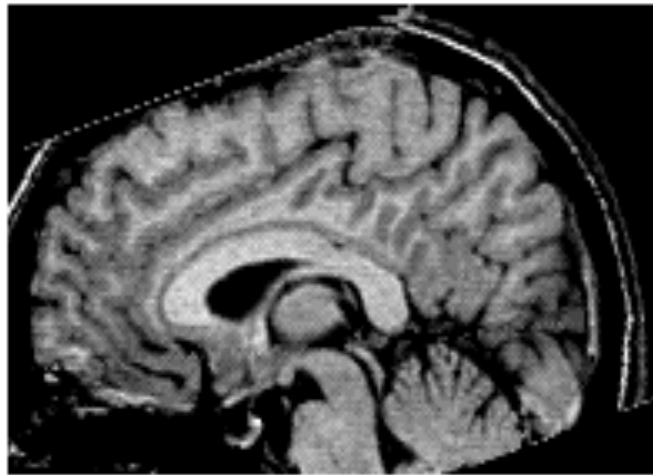
Dyslexie : opercule pariétal gauche plus vaste



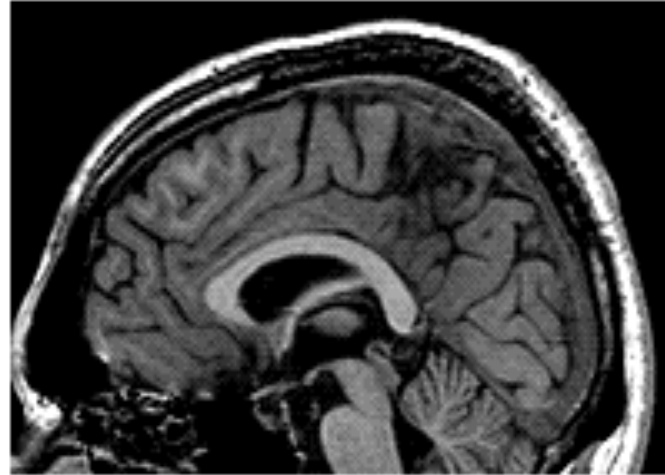


**Einstein's brain : no parietal opercula
(from Witelson et al., 1999)**

Hypertrophie du corps calleux



dyslexique (2136)



témoin



PERGAMON

Neuropsychologia 40 (2002) 1035–1044

NEUROPSYCHOLOGIA

www.elsevier.com/locate/neuropsychologia

Less developed corpus callosum in dyslexic subjects—a structural MRI study

Kerstin von Plessen^{a,*}, Arvid Lundervold^b, Nicolae Duta^c, Einar Heiervang^a,
Frederick Klauschen^b, Alf Inge Smievoll^d, Lars Ersland^e, Kenneth Hugdahl^f

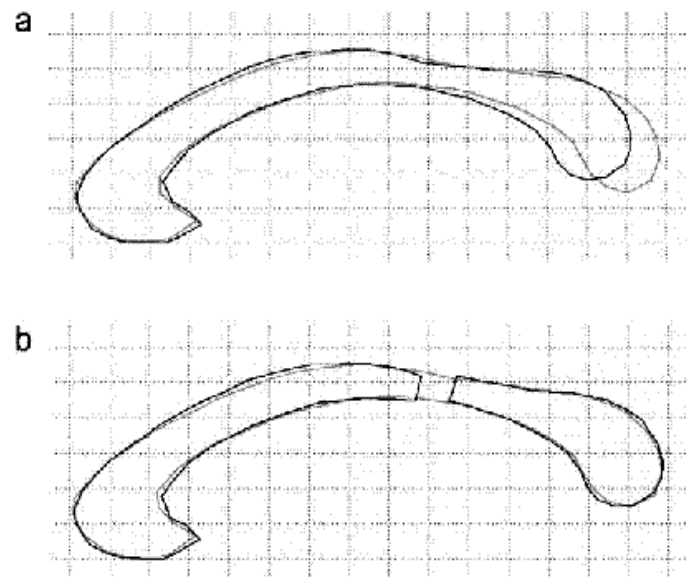


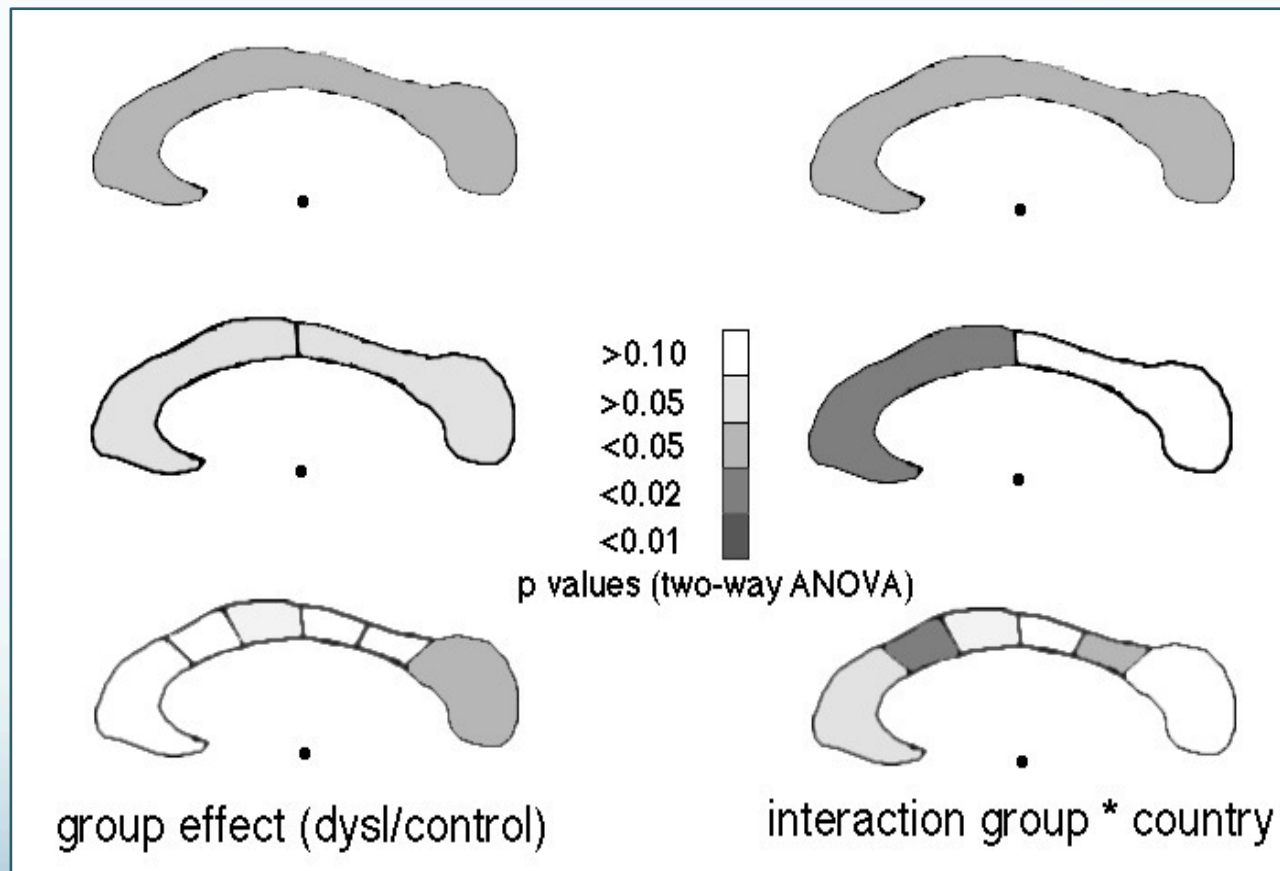
Fig. 4. Comparing the control (shown in grey) and dyslexic (shown in black) average CC shapes (prototypes) (a). The dyslexic prototype is cut into two pieces that are aligned separately at rostrum and splenium (b). The posterior midbody region in the dyslexic subjects is significantly shorter than in the control subjects.

Areas analysis : No areal differences
Shape analysis : shorter posterior midbody

Table 2
Mean values (SD) for CC area measurements

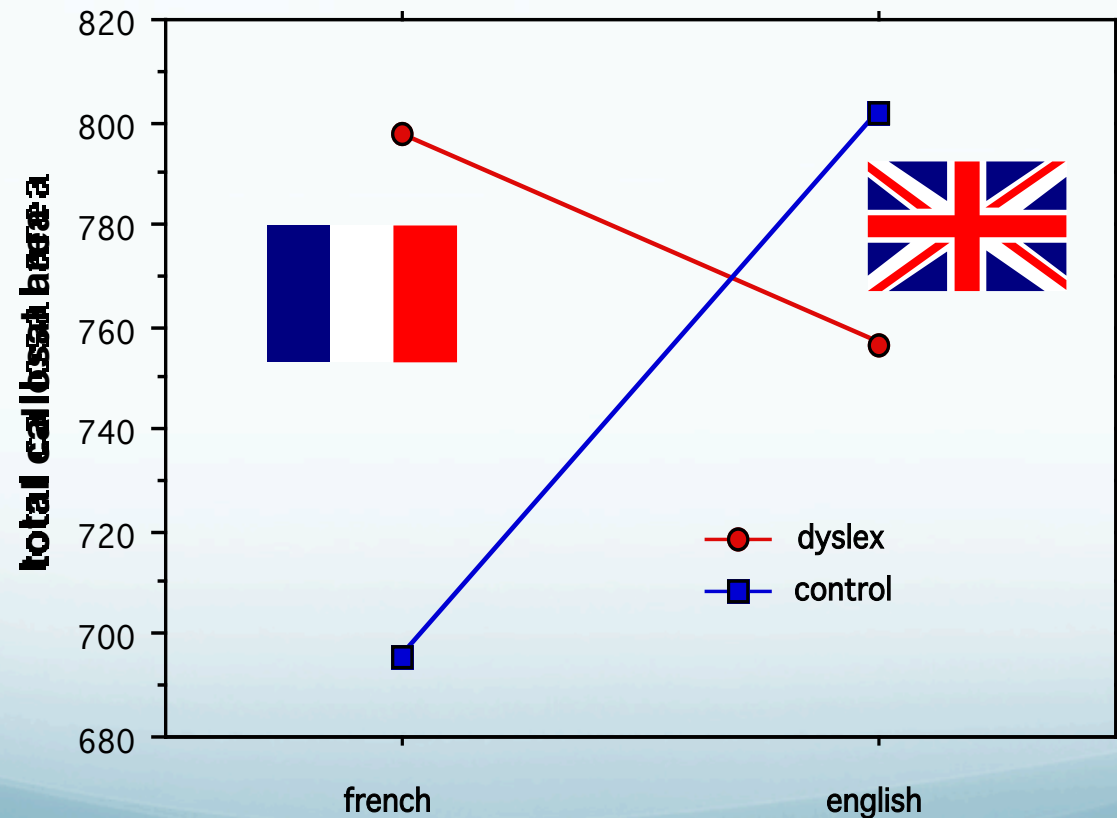
	Dyslexic group, <i>n</i> = 20 (mm ²)	Control group, <i>n</i> = 20 (mm ²)
Total CC area	662.6 (79.9)	659.85 (99.9)
Midsagittal cortical brain area	10582 (781)	10999 (838)
Anterior third	294.9 (41.9)	288.3 (49.1)
Mid-third	135.2 (20.1)	138.8 (23.7)
Posterior third	225.6 (34.5)	232.9 (38.5)

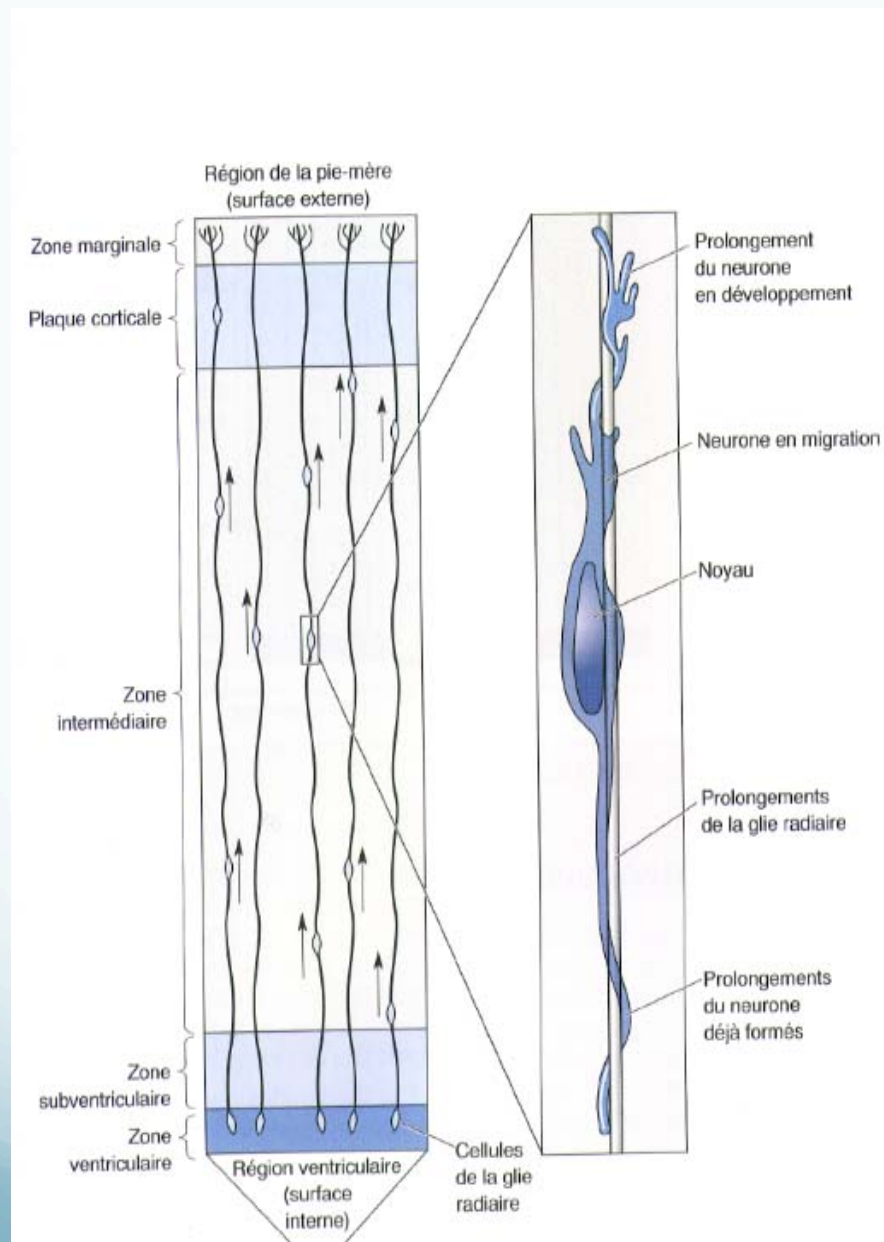
Effect of group (DYS/CONT) and country (FR/ENGL) on callosal size



Total callosal area : group x country interaction

$F(1,60)=9.337; p=0.033$



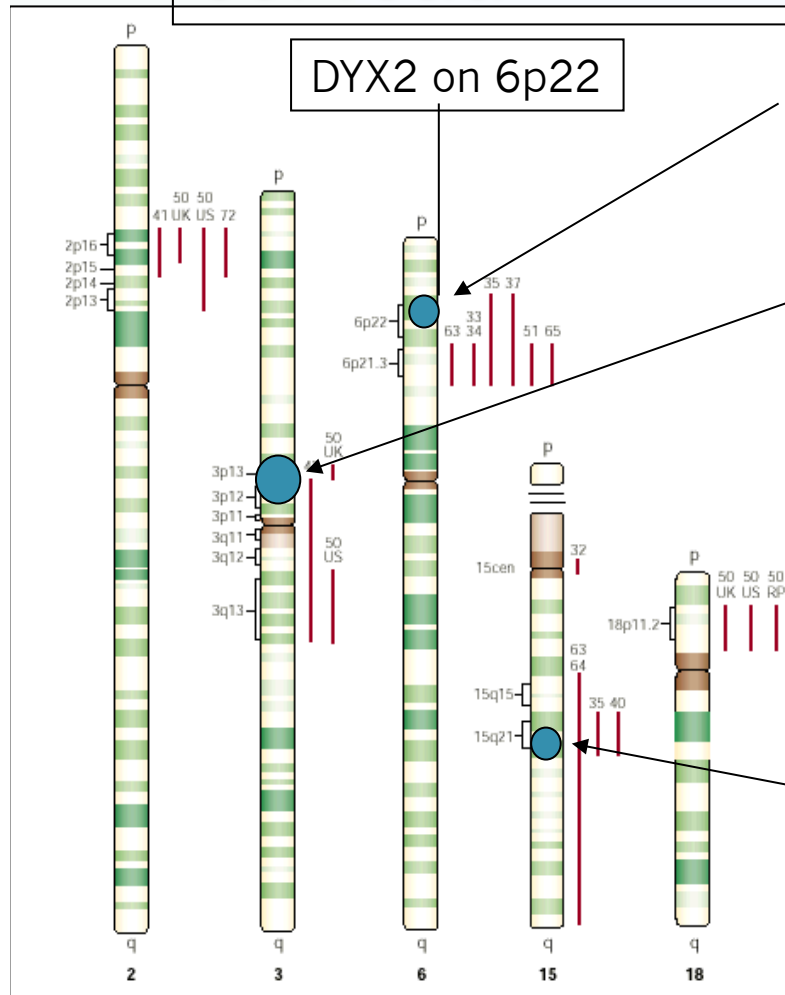


MIGRATION

NEURONALE :

chaque neurone semble "choisir" son rail glial en fonction de la présence à la surface de ce dernier de certaines molécules, dites molécules d'adhésion

Plusieurs gènes identifiés par les analyses de liaisons ont également un rôle connu dans le développement du cerveau

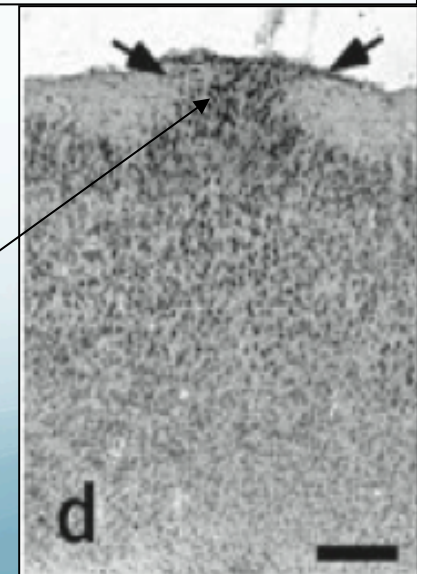


DYX2 on 6p22

DCDC2 : un gène associé chez l'animal et chez l'homme à une migration neuronale anormale

ROBO1 : joue un rôle dans la régulation du passage de la ligne médiane par les axones calleux

Une manipulation in utero de DYX1C1 provoque des ectopies similaires à celles des humains dyslexiques



Résumé époque 1

- Les travaux initiaux de Galaburda et al. sur la morphologie corticale micro-et macroscopique ont eu le mérite d'attirer l'attention vers un défaut de maturation survenu dans les phases précoces du développement cérébral
- Les premières études en imagerie se sont focalisées sur des caractéristiques anatomiques macroscopiques du cerveau sans apporter d'information décisive sur les mécanismes
- Les études de génétique moléculaire ont identifié plusieurs gènes candidats dont l'intervention implique les phases très précoces du développement cérébral

Epoque 2 : imagerie fonctionnelle

<http://www.resodys.org>

Developmental dyslexia

Jean-François Démonet, Margot J Taylor, Yves Chaix

Lancet 2004; **363**: 1451–60

INSERM U455, Hôpital Purpan, IFR 96, Toulouse, France
(J-F Démonet MD); **CNRS UMR 5549, Faculté de Médecine de**
Toulouse-Rangueil, IFR 96, Toulouse, France (M J Taylor PhD); and
Unité de Neuro-Pédiatrie, Hôpital des Enfants, Toulouse, France
(Y Chaix MD)

Correspondence to: Dr J-F Démonet
(e-mail: demonet@toulouse.inserm.fr)

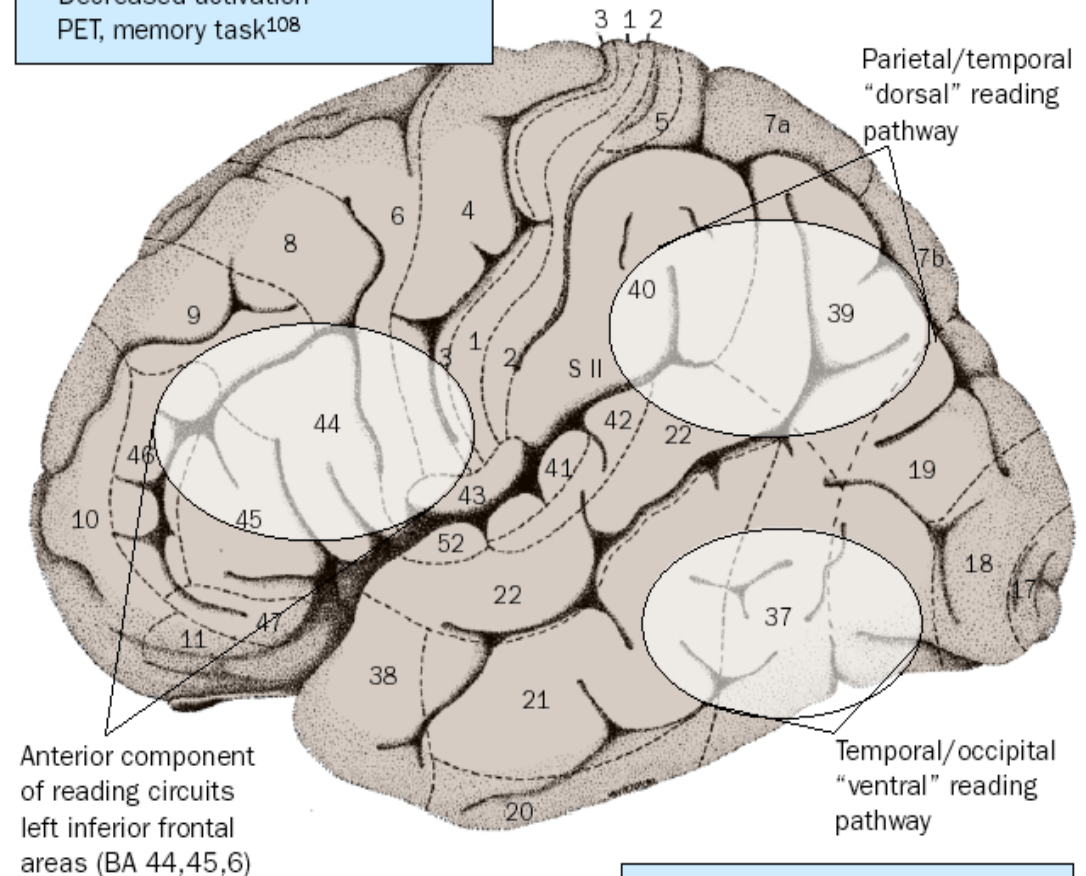
Dysfunction of left inferior frontal area

Increased activation:
fMRI, hierarchically organised
tasks with phonological process;¹⁰⁶
PET, implicit and explicit word
and pseudoword reading¹⁰⁷

Decreased activation
PET, memory task¹⁰⁸

Reduced activity in left parietal/ temporal regions

PET, rhyming task;^{108,109}
PET, pronunciation and decision
making tasks;¹¹⁰
fMRI, hierarchically organised tasks
with phonological process¹⁰⁶
PET, reading¹¹¹



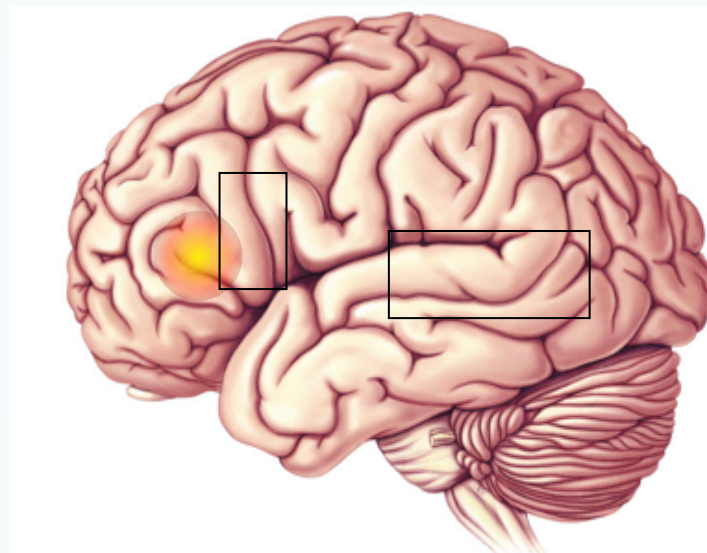
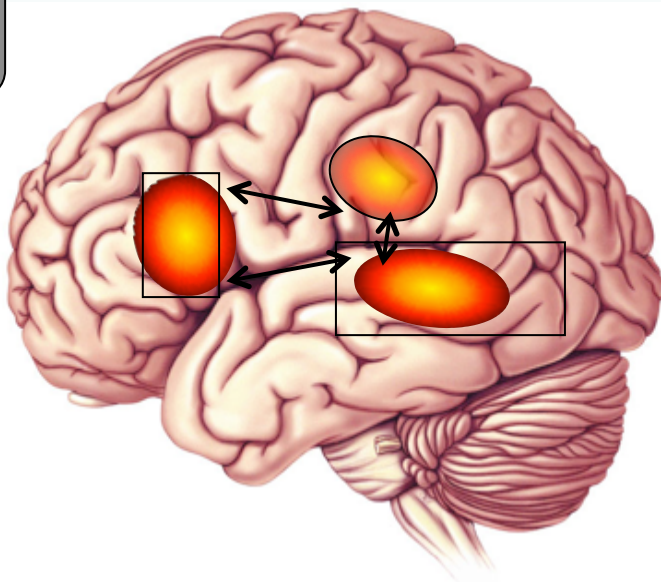
Reduced activity in left inferior temporal/occipital area

MEG, letter perception¹⁰¹
PET, implicit and explicit word and
pseudoword reading^{107,112}

G

H

Lettres
riment?



Dyslexique avant traitement



(1) Réactivation de zones
« éteintes »



(2) Activation de zones
normalement non actives



Après traitement phonologique (Fastforward®). D'après Temple et al., 2003

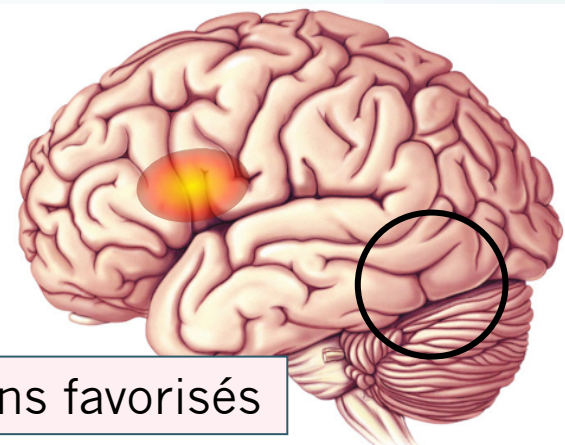
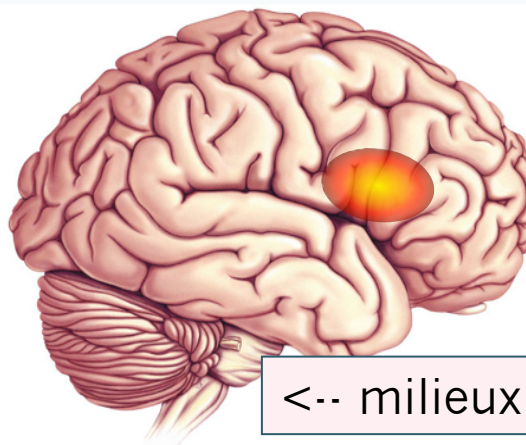
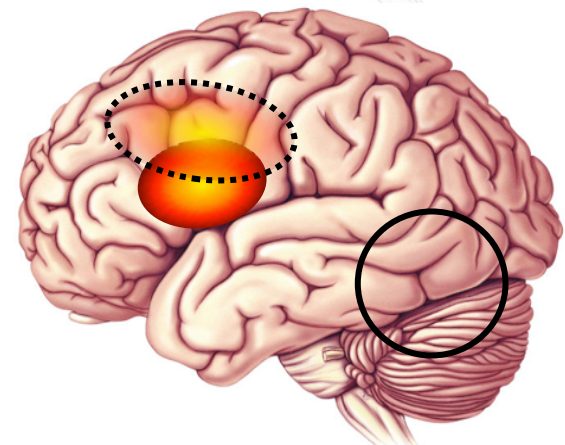
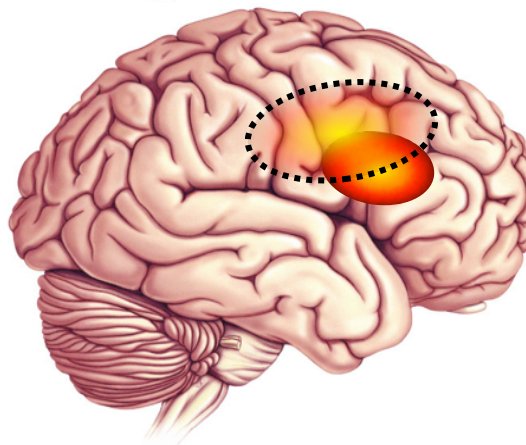
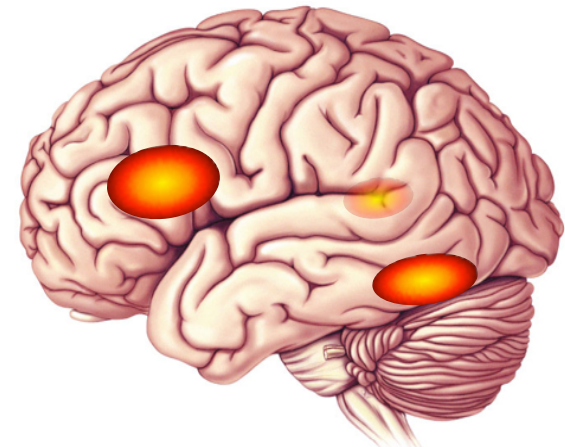
LEAT JETE

Témoins
non dys

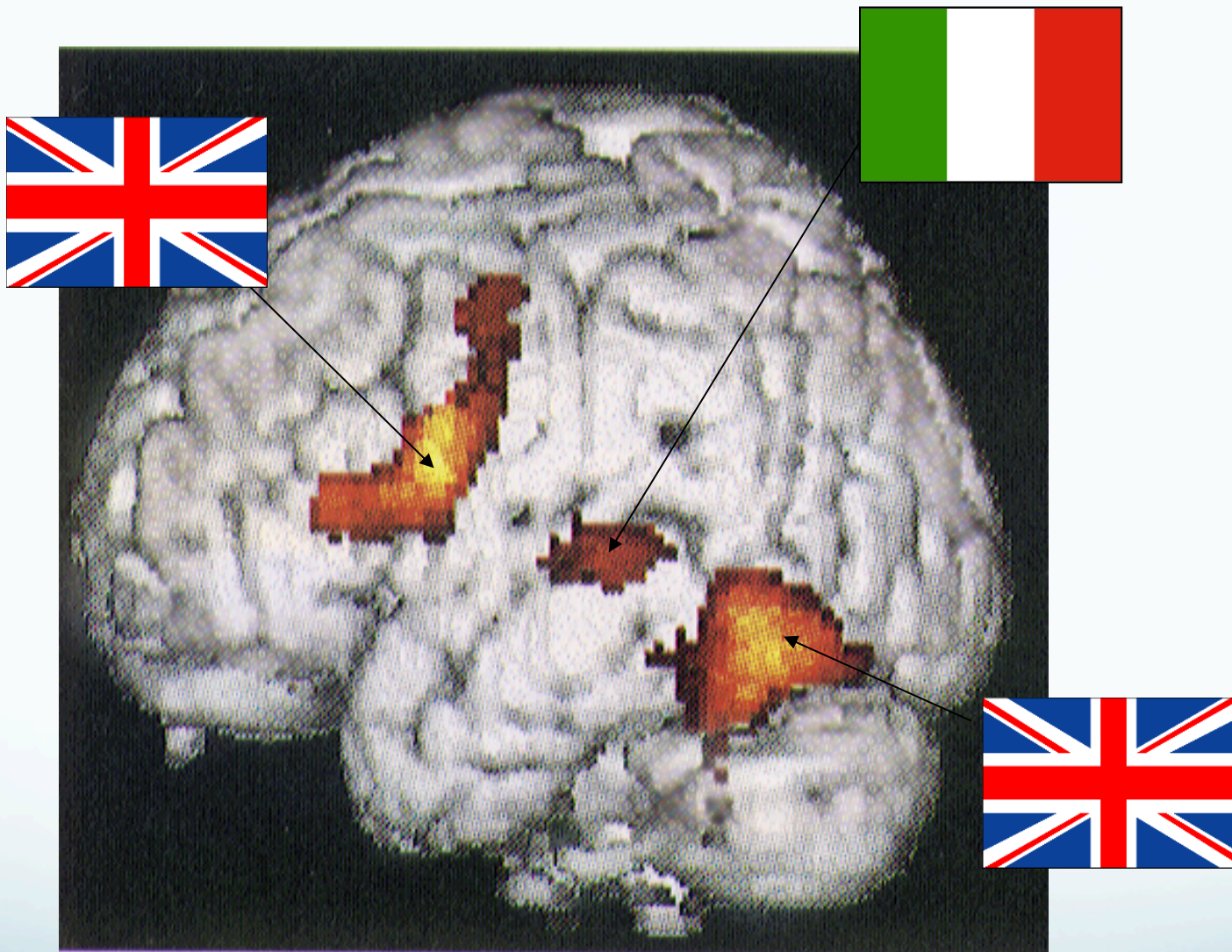
Riment?

Dyslexiques
"compensés"

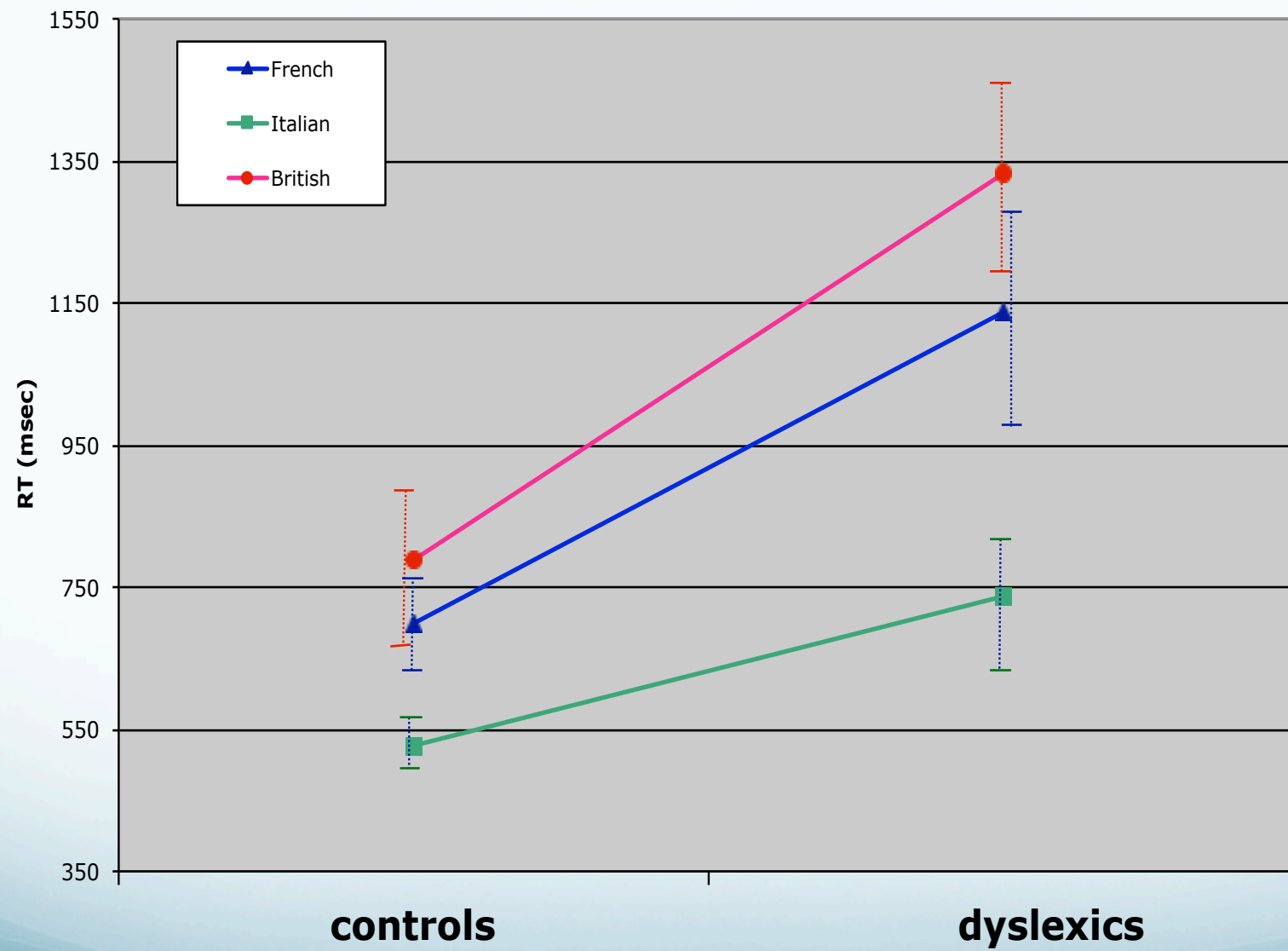
Dyslexiques
"persistants"

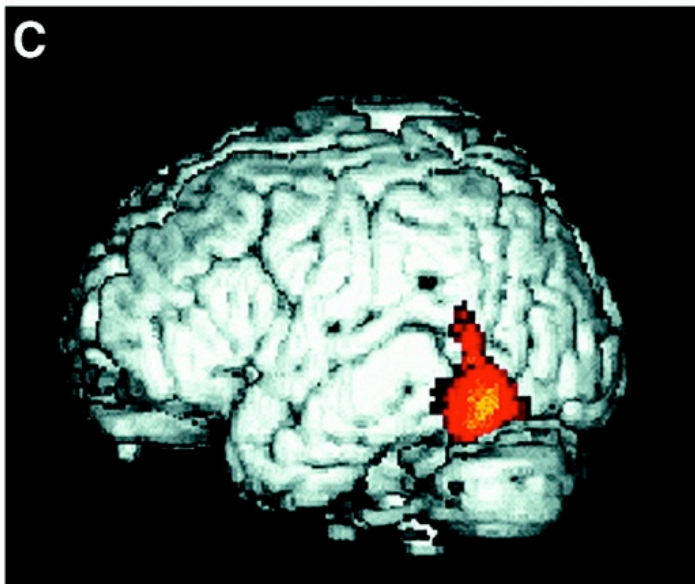


<- milieux moins favorisés



Paulesu et al. (2000)
A cultural effect on brain function



C

Controls - dyslexics

Dyslexia: Cultural Diversity and Biological Unity

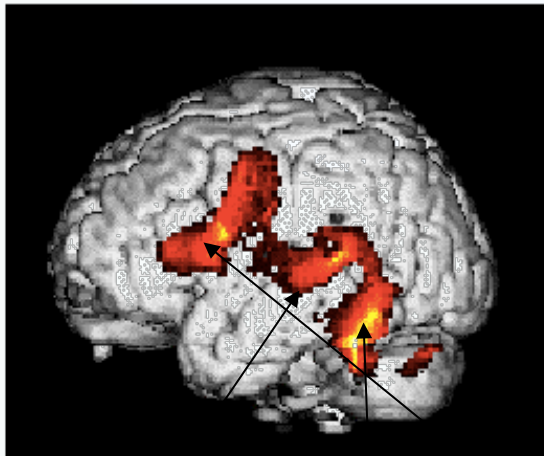
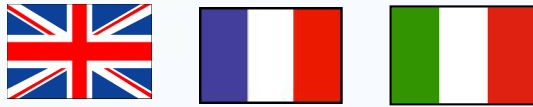
E. Paulesu,^{1,2*} J.-F. Démonet,³ F. Fazio,^{2,4} E. McCrory,⁵
V. Chanoine,³ N. Brunswick,⁶ S. F. Cappa,⁷ G. Cossu,⁸ M. Habib,⁹
C. D. Frith,⁶ U. Frith⁵

The recognition of dyslexia as a neurodevelopmental disorder has been hampered by the belief that it is not a specific diagnostic entity because it has variable and culture-specific manifestations. In line with this belief, we found that Italian dyslexics, using a shallow orthography which facilitates reading, performed better on reading tasks than did English and French dyslexics. However, all dyslexics were equally impaired relative to their controls on reading and phonological tasks. Positron emission tomography scans during explicit and implicit reading showed the same reduced activity in a region of the left hemisphere in dyslexics from all three countries, with the maximum peak in the middle temporal gyrus and additional peaks in the inferior and superior temporal gyri and middle occipital gyrus. We conclude that there is a universal neurocognitive basis for dyslexia and that differences in reading performance among dyslexics of different countries are due to different orthographies.

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*To whom correspondence should be addressed at University of Milan Bicocca. E-mail: eraldo.paulesu@unimib.it

A

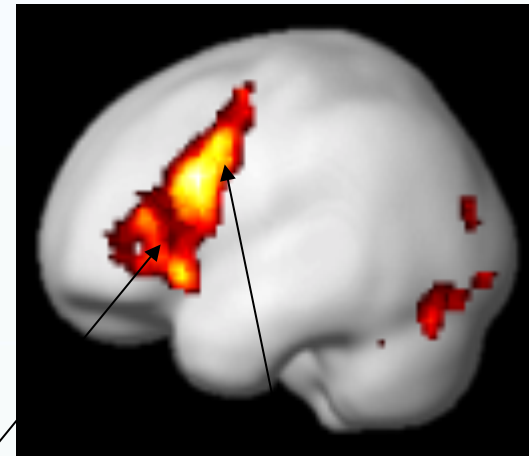


Wernicke's area

Posterior temporal lobe

Broca's area (BA45)

B



电
+
店

Middle frontal gyrus (BA9)

Ziegler & Habib (2005) TICS

A structural–functional basis for dyslexia in the cortex of Chinese readers

Wai Ting Siok^{†‡}, Zhendong Niu[§], Zhen Jin[¶], Charles A. Perfetti^{||}, and Li Hai Tan^{††‡‡}

In and Cognitive Sciences, University of Hong Kong, Pokfulam Road, Hong Kong; ^{||}Institute of Technology, Beijing 100081, China; [¶]Beijing 306 Hospital, ^{||}Department Center, University of Pittsburgh, Pittsburgh, PA 15260

of Technology, Cambridge, MA, February 25, 2008 (received for review January 1, 2008)

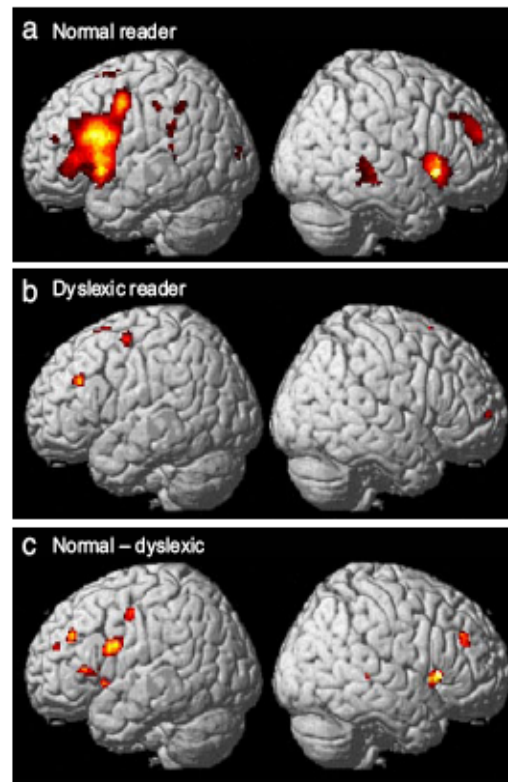


Fig. 2. Brain regions with significant activation during rhyme judgment. (a and b) Cortical activation associated with rhyme judgment contrasted with font-size decision in normal and dyslexic Chinese readers. (c) Brain regions showing group differences during rhyme judgment.

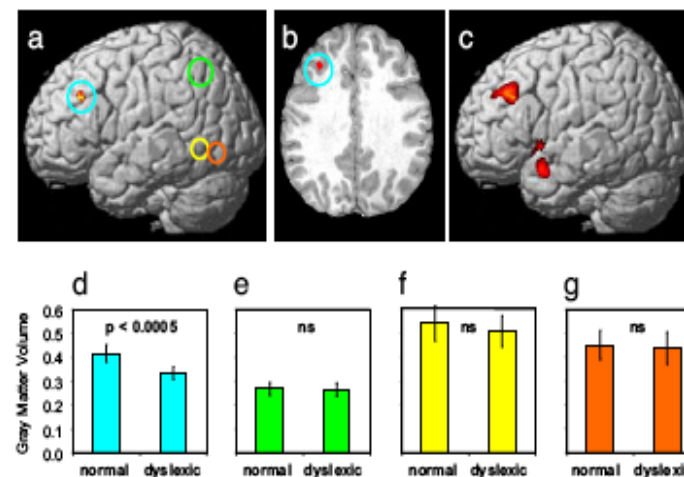


Fig. 1. Group differences in gray matter volume. (a, b, and d) A region in the left middle frontal gyrus (BA 9; $x = -32, y = 31, z = 28$) exhibited reduced volume in the dyslexic group, $P < 0.05$ corrected using the FWE correction for the whole brain. (c) At a less stringent uncorrected threshold of $P < 0.001$, reduced gray matter volume was seen in the left anterior temporal gyrus (BA 38/21) and the left Sylvian fissure, in addition to the left middle frontal gyrus. (e–g) ROI analysis of gray matter volume difference in the left posterior temporoparietal region (in green), the left middle temporal gyrus (in yellow), and the left inferior occipito-temporal cortex (in orange). No significant alteration was observed in these regions.

Parmi les aires sous-activées en IRMf, une région du GFMoy Gche présente une diminution significative du volume de substance grise

Grey Matter Alterations Co-Localize with Functional Abnormalities in Developmental Dyslexia: An ALE Meta-Analysis

Janosch Linkersdörfer^{1,2*}, Jan Lonnemann^{2,3}, Sven Lindberg^{1,2}, Marcus Hasselhorn^{1,2,3}, Christian J. Fiebach^{1,3,4}

¹ Center for Individual Development and Adaptive Education of Children at Risk, Frankfurt, Germany, ² German Institute for International Educational Research, Frankfurt, Germany, ³ Institute for Psychology, Goethe-University Frankfurt, Germany, ⁴ Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, The Netherlands

Abstract

The neural correlates of developmental dyslexia have been investigated intensively over the last two decades and reliable evidence for a dysfunction of left-hemispheric reading systems in dyslexic readers has been found in functional neuroimaging studies. In addition, structural imaging studies using voxel-based morphometry (VBM) demonstrated grey matter reductions in dyslexics in several brain regions. To objectively assess the consistency of these findings, we performed activation likelihood estimation (ALE) meta-analysis on nine published VBM studies reporting 62 foci of grey matter reduction in dyslexic readers. We found six significant clusters of convergence in bilateral temporo-parietal and left occipito-temporal cortical regions and in the cerebellum bilaterally. To identify possible overlaps between structural and functional deviations in dyslexic readers, we conducted additional ALE meta-analyses of imaging studies reporting functional underactivations (125 foci from 24 studies) or overactivations (95 foci from 11 studies) in dyslexics. Subsequent conjunction analyses revealed overlaps between the results of the VBM meta-analysis and the meta-analysis of functional underactivations in the fusiform and supramarginal gyri of the left hemisphere. An overlap between VBM results and the meta-analysis of functional overactivations was found in the left cerebellum. The results of our study provide evidence for consistent grey matter variations bilaterally in the dyslexic brain and substantial overlap of these structural variations with functional abnormalities in left hemispheric regions.

Double méta-analyse :

- 9 études en VBM=62 foyers de réduction de SG chez dyslexiques
- 24 études en IRMf =125 foyers d'hypoactivation et 11 études=95 foyers de sur-activation

Résultats:

- VBM : clusters de convergence dans G.temp-Par. bilatéral, GTInf Gche et cervelet bilatéral
- superposition entre hypoactivation fonctionnelle et foyer de réduction VBM temporal inférieur gauche
- superposition entre hyperactivation et foyer de réduction VBM cervelet

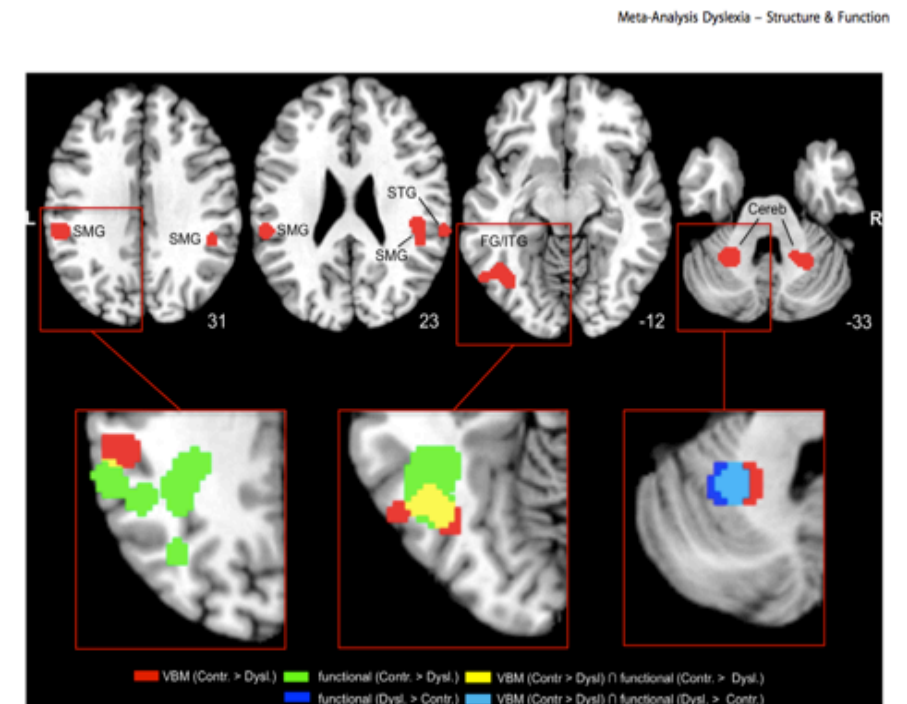
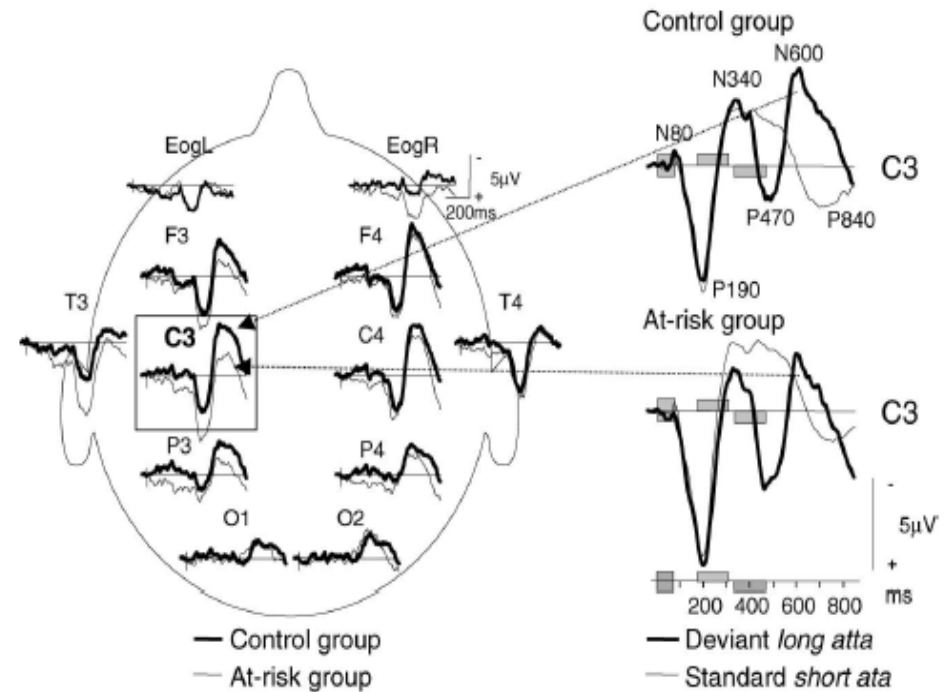


Figure 1. Results of the ALE meta-analysis of VBM studies and the conjunction analyses. Upper row-2D axial slices depicting the thresholded and binarized ALE map for the VBM meta-analysis (red) projected onto the Colin T1-template in MNI space. Images are presented in neurological convention (i.e., left=left) and MNI coordinates in the inferior-superior (Z) plane are provided with each slice. Lower row – cut-outs of the axial slices display overlaps (yellow) of the VBM meta-analysis (red) with the thresholded and binarized ALE map for the meta-analysis of functional underactivations (green) and overlaps (light blue) with the thresholded and binarized ALE map for the meta-analysis of functional overactivations (dark blue). SMG=supramarginal gyrus; STG=superior temporal gyrus; FG/ITG=fusiform gyrus/inferior temporal gyrus; Cereb=cerebellum. doi:10.1371/journal.pone.0043122.g001

Brain Responses to Changes in Speech Sound Durations Differ Between Infants With and Without Familial Risk for Dyslexia

Paavo H. T. Leppänen
*Department of Psychology
University of Jyväskylä*

Ulla Richardson



Enfants de 6 mois à risque familial de dyslexie : défaut d'activation cérébrale par un stimulus déviant quant à ses caractéristiques temporelles (/ata/ vs /atta/)

Altered Neuronal Response During Rapid Auditory Processing and Its Relation to Phonological Processing in Prereading Children at Familial Risk for Dyslexia

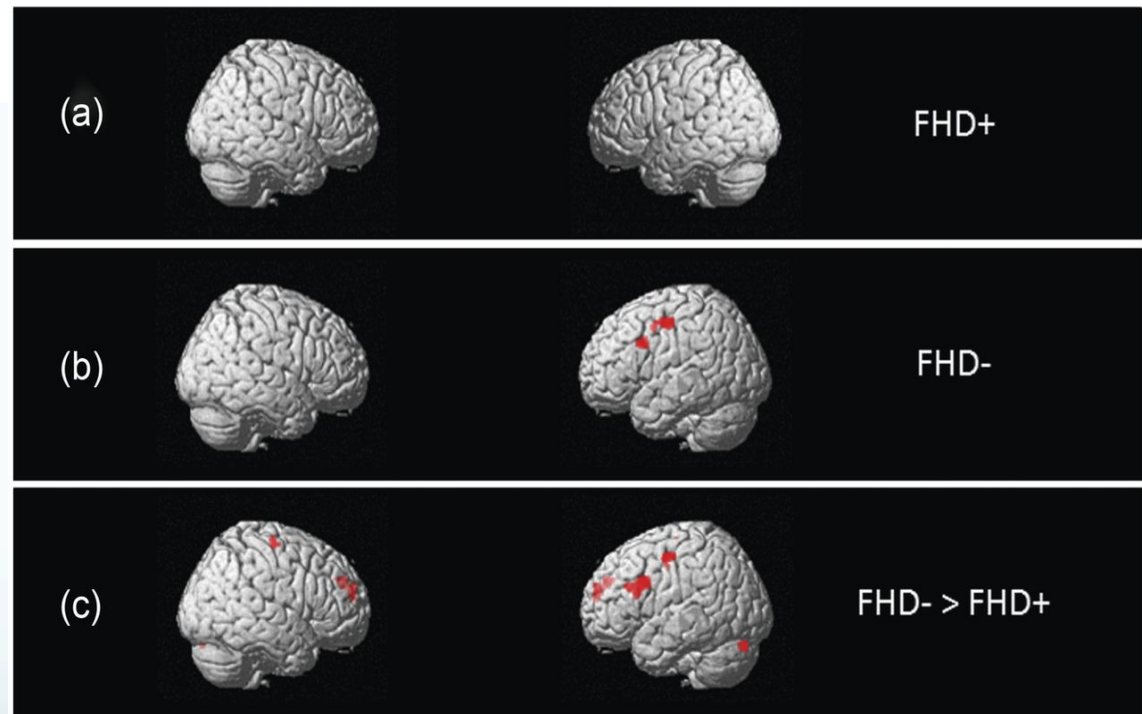
Nora M. Raschle^{1,2}, Patrice L. Stering¹, Sarah N. Meissner¹ and Nadine Gaab^{1,2,3} 

We investigate functional networks during RAP in 28 children with ($n = 14$) and without ($n = 14$) a familial risk for DD before reading onset (mean: 5.6 years).

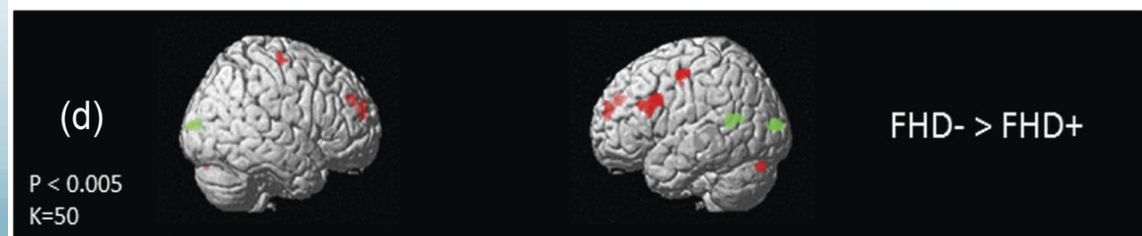
Results reveal functional alterations in left-hemispheric prefrontal regions during RAP in prereading children at risk for DD, similar to findings in individuals with DD.

Furthermore, activation during RAP in left prefrontal regions positively correlates with prereading measures of DD

Rapid Auditory Processing



Rapid Auditory & Phonological Processing



LETTER TO THE EDITOR

Cortical differences in preliterate children at familiar risk of dyslexia are similar to those observed in dyslexic readers

Indra Kraft,¹ Riccardo Caferio,¹ Gesa Schaadt,^{1,2} Jens Brauer,¹ Nicole E. Neef,¹ Bent Müller,³ Holger Kirsten,³ Arndt Wilcke,³ Johannes Boltze,^{3,4} Angela D. Friederici¹ and Michael A. Skeide¹

¹ Department of Neuropsychology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

Crucially, Clark and colleagues had only 57% power in their sample at MRI time point 1 to detect the clusters in the left supramarginal gyrus and the left occipito-temporal cortex identified in our analyses (effect size = 0.93; effect size in Clark et al. = 0.53; effect size is defined as the mean difference divided by common standard deviation). Despite the significant value of the longitudinal study by Clark and colleagues for the field, larger and statistically more powerful studies may be required to reveal ultimately which of the contrary hypotheses best approximates reality.

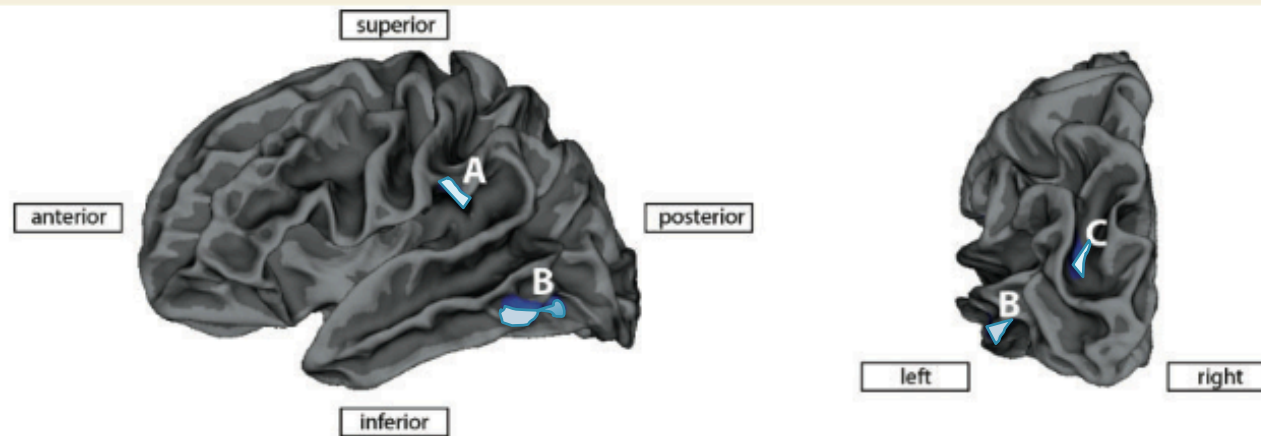


Figure 1 Cortical thickness differences between 5-year-old preliterate children at familial risk of developmental dyslexia and non-risk controls. Compared to children without a family history of developmental dyslexia, individuals with a family history of developmental dyslexia showed a significantly reduced cortical thickness ($P < 0.05$, false discovery rate corrected) in the left supramarginal gyrus (A), the left inferior temporal gyrus (B), and the left superior and transversal occipital sulci (C), but not in right-hemispheric regions. The opposite contrast (non-risk children versus at-risk children) did not reveal any significant results. Depicted are z-transformed cortical thickness values on the white matter surface of the group-averaged left hemisphere.

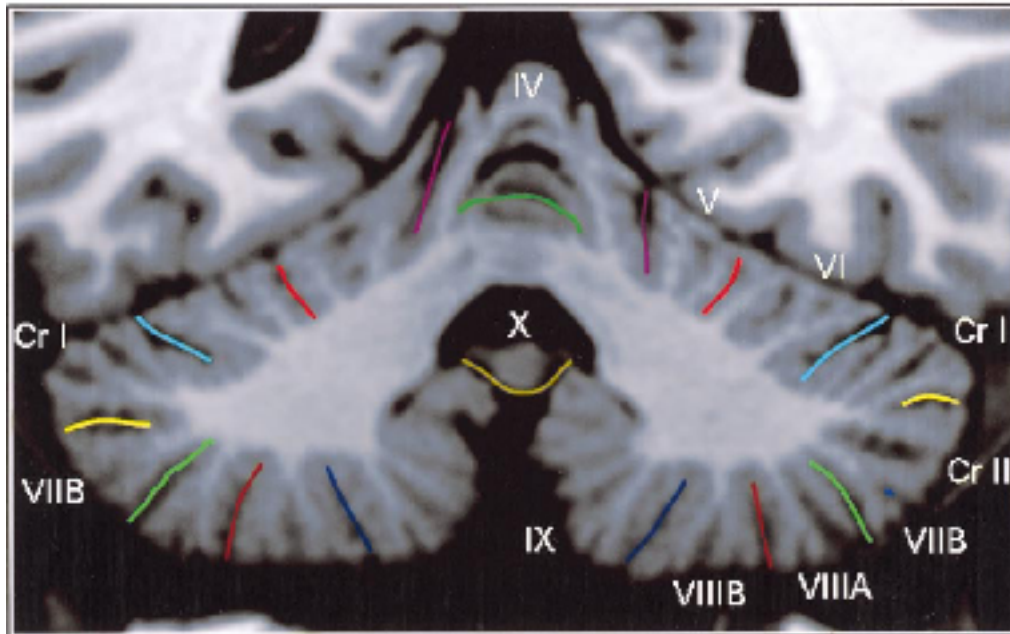
Résumé période 2

- Les aires du langage sont insuffisamment activées chez le dyslexique lors d'exercices phonologiques
- Un entraînement intensif de quelques semaines, focalisé sur le système déficient, non seulement réactive les zones affaiblies mais sollicite des zones "muettes" des deux hémisphères. Donc l'entraînement (une intervention extérieure) a modifié l'organisation cérébrale dans le sens d'une probable meilleure connectivité entre des zones habituellement inutilisées
- Cette capacité de réorganisation est très variable selon des facteurs généraux tels que l'intelligence et le niveau socio-économique des familles
- Certaines caractéristiques de la langue maternelle influent sur l'organisation du cerveau pour la lecture et modifient même la façon dont dysfonctionne le cerveau du dyslexique.
- Pour autant, des anomalies fonctionnelles et même morphologiques seraient présentes avant même tout apprentissage, donc toute intervention thérapeutique ou éducative

Epoque 3:

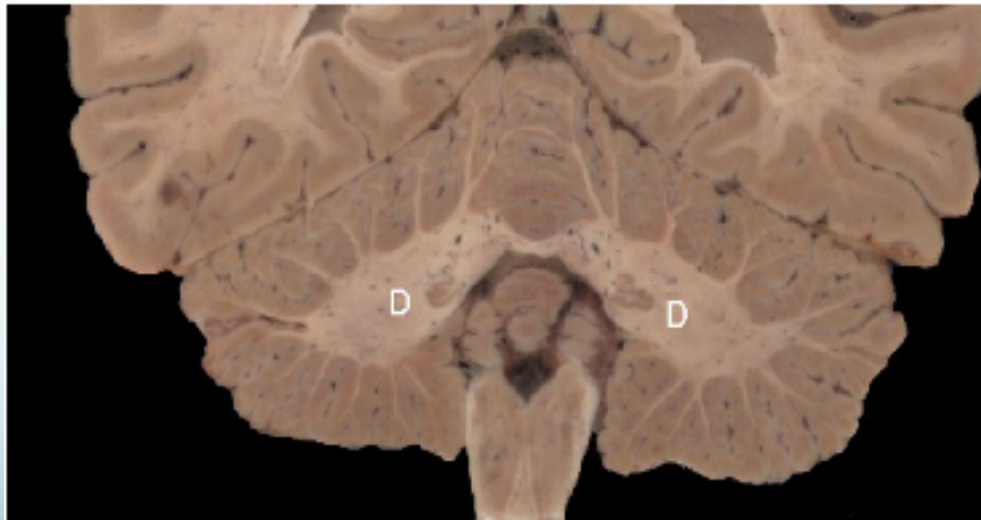
au-delà de la dyslexie: vers une explication
unitaire des troubles d'apprentissage

Le cervelet : un premier candidat très contesté



Le cervelet : un organe aux fonctions multiples et émergentes

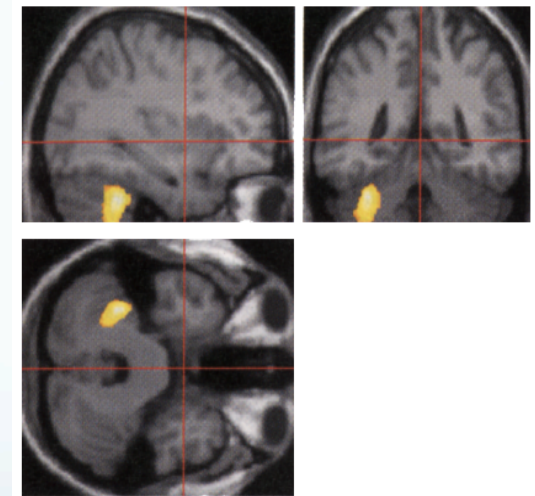
- motricité, coordination, posture
- Modulateur des apprentissages procéduraux et des automatismes (sensori-moteurs et cognitifs)
- Pace-maker des structures sus-jacentes?



Developmental dyslexia: the cerebellar deficit hypothesis

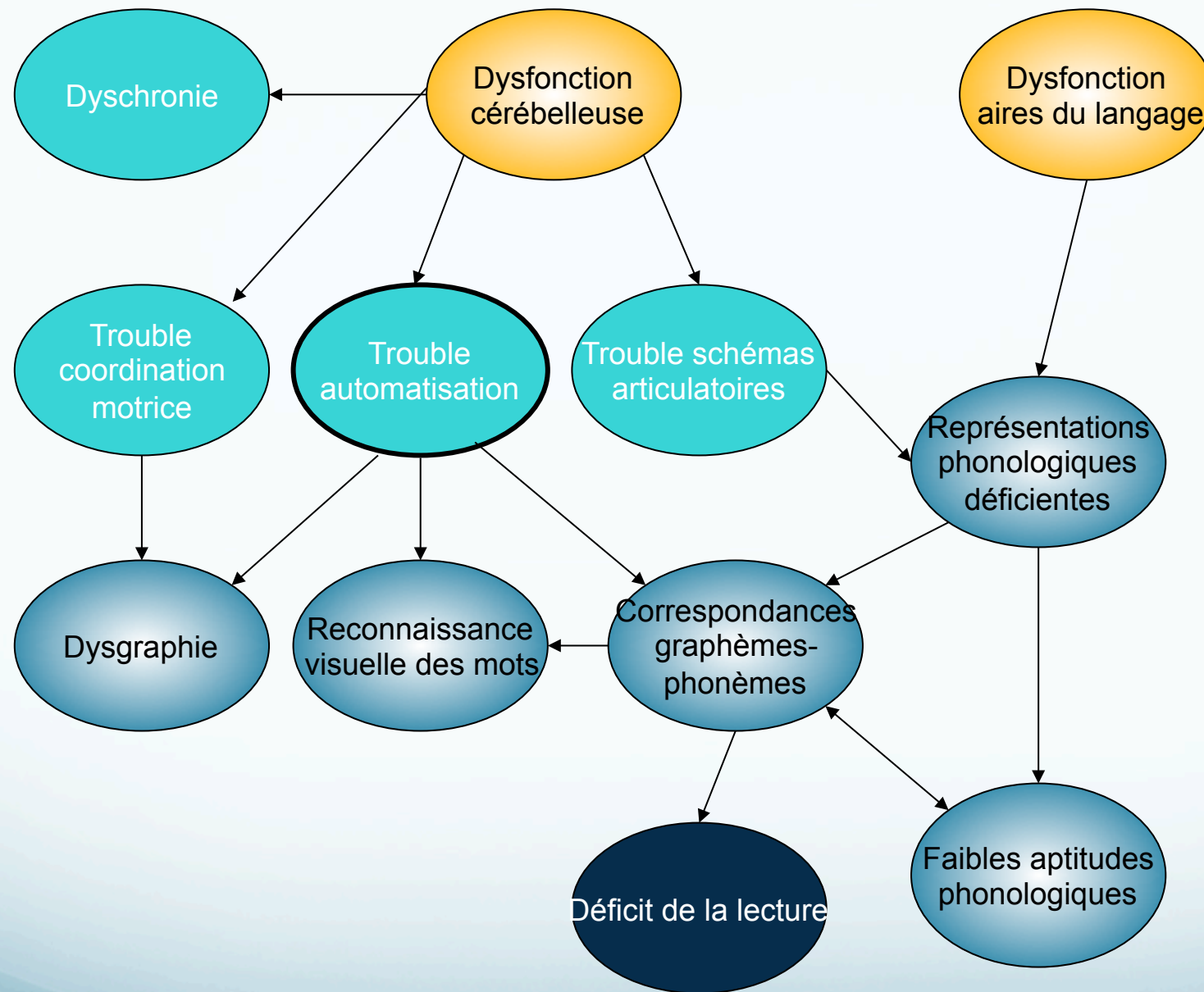
Roderick I. Nicolson, Angela J. Fawcett and Paul Dean

Surprisingly, the problems faced by many dyslexic children are by no means confined to reading and spelling. There appears to be a general impairment in the ability to perform skills automatically, an ability thought to be dependent upon the cerebellum. Specific behavioural and neuroimaging tests reviewed here indicate that dyslexia is indeed associated with cerebellar impairment in about 80% of cases. We propose that disorders of cerebellar development can in fact cause the impairments in reading and writing characteristic of dyslexia, a view consistent with the recently appreciated role of the cerebellum in language-related skills. This proposal has implications for early remedial treatment.

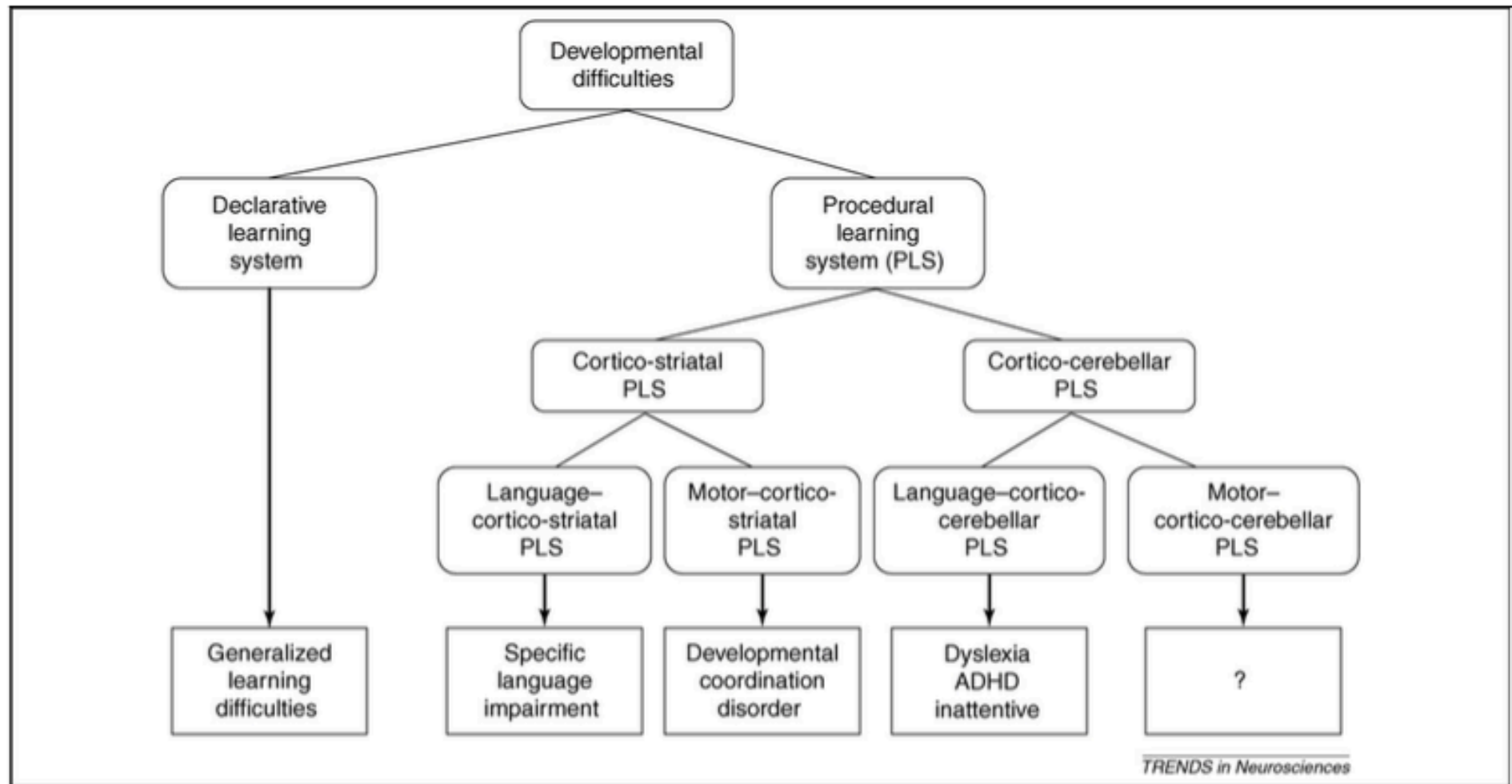


Nicolson et al., 1999

Nicolson et al., T.I.N.S., 2001



dysfonction cérébelleuse (Nicolson)



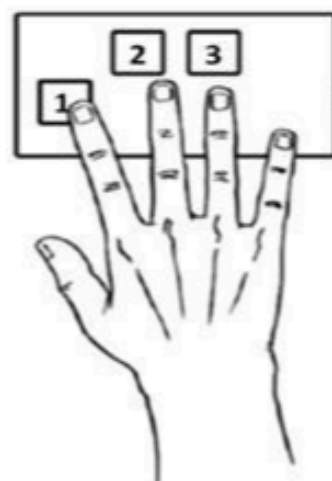
Théorie procédurale de Nicolson et Fawcett (2007)

OS = Séquence Automatisée

1-2-1-2-3

5min/jour pendant 15 jours

Consolidée et Automatisée



NS = Séquence Nouvelle

2-3-1-3-1

Nouvellement apprise

le jour même

Tableau 5 : Caractéristiques démographiques et cliniques des participants

	TAC	DD	DysTAC	Test
Enfants (N)	16	16	16	
Garçons	12 (75%)	9 (56.3%)	10 (62.5%)	Khi = 1.3. df = 2. p = .53
Filles	4 (25%)	7 (43.8%)	6 (37.5%)	
Age, Moyenne (ET)	9.6 (1.7)	10.3 (1.3)	9.9 (1.1)	F(2.47) = 0.968. p = .388
M-ABC*				
MABC score total	25.7 (5.8)	4.6 (3.7)	25.8 (6.6)	F(2.47) = 78.116. p < .001
MABC dextérité manuelle	12.5 (2.9)	3.0 (2.8)	10.3 (3.9)	F(2.47) = 37.173. p < .001
MABC lancer de balles	5.3 (2.4)	1.0 (1.5)	7.0 (3.9)	F(2.47) = 19.695. p < .001
MABC équilibre	7.8 (4.8)	0.6 (1.1)	8.6 (4.6)	F(2.47) = 20.715. p < .001
Echelle de lecture**				
Score Composite CM/CTL	0.2 (0.5)	-2.1 (0.6)	-1.9 (0.6)	F(2.47) = 68.384. p < .001
WISC-IV				
QIT	103.9 (13.1)	110.3 (14.0)	99.6 (18.7)	F(2.47) = 1.915. p = .159

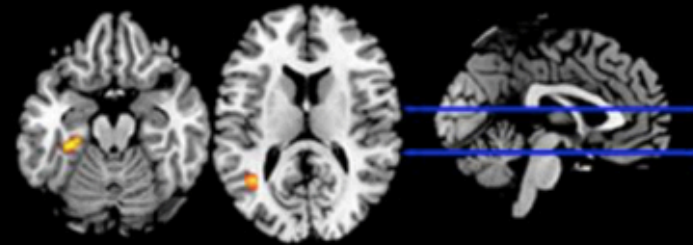
* Différences significatives dans tous les subtests moteurs entre DD et TAC avec ou sans DD

** Différences significatives dans tous les subtests de lecture entre TAC et DD avec ou sans TAC

Thèse Maelle
Biotteau (Toulouse)

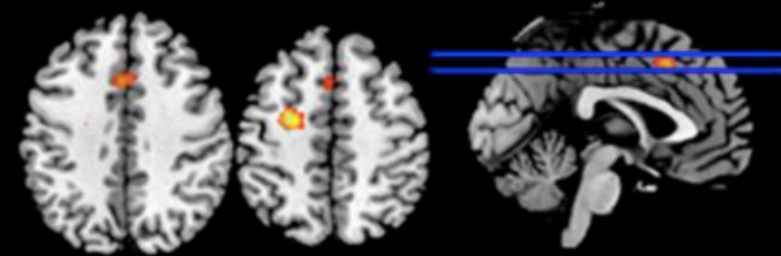
OS-NS

DD

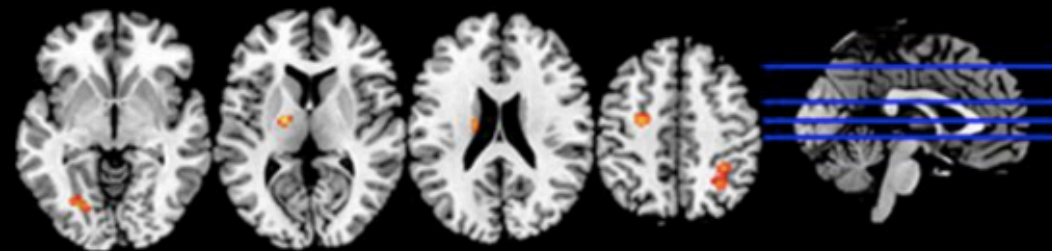


NS-OS

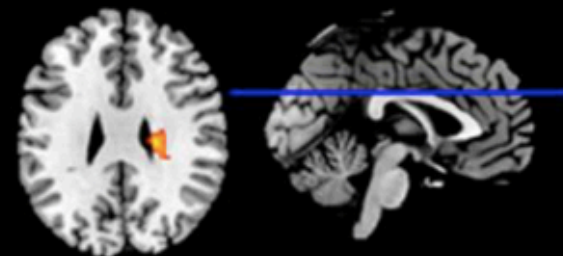
DD



MI



DCD





Timing precision and rhythm in developmental dyslexia

PETER H. WOLFF

Children's Hospital and Harvard Medical School, Boston MA 02115, USA

dyslexic students anticipated the signal of an isochronic pacing metronome by intervals that were two or three times as long as those of age matched normal readers or normal adults. These group differences were significant when participants tapped with the preferred index finger alone or with both fingers in unison. Dyslexic students also took significantly longer than normal readers did to recalibrate their tapping responses when the metronome rate was experimentally changed in the middle of a trial. In addition, dyslexic students, by contrast to normal readers, had inordinate difficulty reproducing simple motor rhythms by finger tapping, and similar difficulty reproducing the appropriate speech rhythm of linguistically neutral nonsense syllables. These difficulties were exaggerated when participants had to synchronize their performance to an external pacing metronome.

Table 2. (A) Anticipation of isochronic intervals (finger tapping) and (B) Recalibration of anticipation mode (mean tracking responses before switch)

Outcome measure	Dyslexic students Mean (SD)	Normal readers Mean (SD)
A. Absolute difference (ms) tap onset and metronome signal		
Stable rate – 2 Hz		
Right finger	130 (53)	41 (10)**
Both finger	86 (41)	28 (14)**
B. Rate change: 1.5 to 2 Hz to 2.5 Hz		
Right finger	6.1 (1.1)	1.3 (14)**

** $p < 0.01$ Mann-Whitney U-Test.

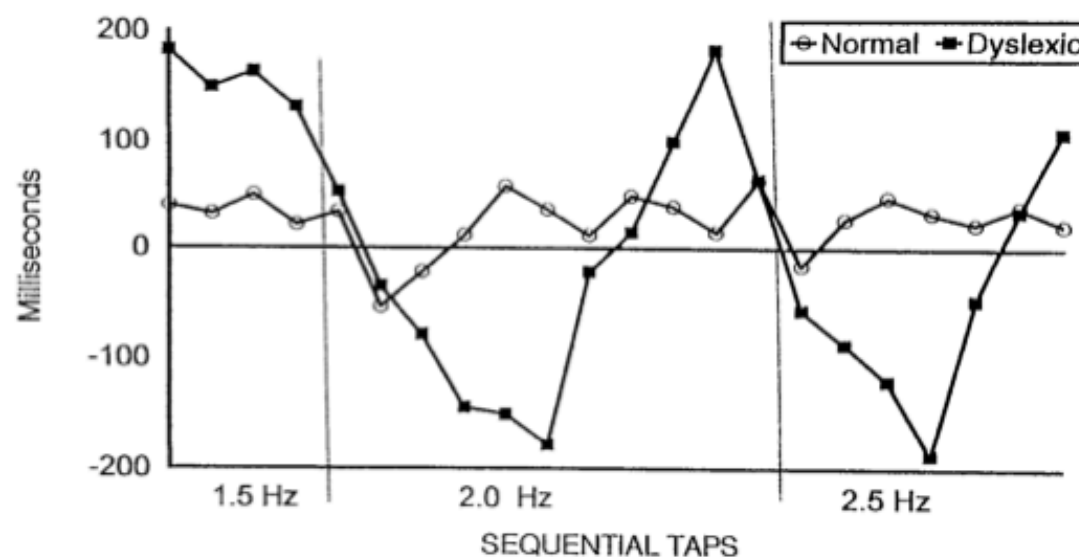


Figure 1. Mean intervals between tapping onset and metronome signal, before and after changes in metronome rate (dotted vertical lines). Points above the 0 line represent anticipations; those below the line represent tracking responses.



Rhythmic processing in children with developmental dyslexia: Auditory and motor rhythms link to reading and spelling

Jennifer M. Thomson¹, Usha Goswami^{*}

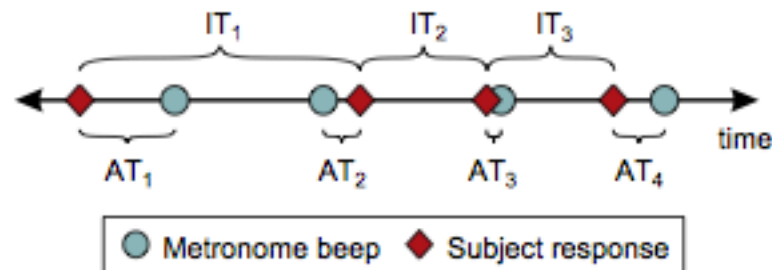


Fig. 1 – Schematic depiction of ITI and AT calculation.

CORTEX 45 (2009) 119–130

Special issue: Research report

Rhythmic motor entrainment in children with speech and language impairments: Tapping to the beat

Kathleen H. Corriveau^{a,b} and Usha Goswami^{a,*}

^aCentre for Neuroscience in Education, University of Cambridge, Cambridge CB2 8PQ, UK

^bHarvard University Graduate School of Education, Cambridge, MA, USA

We measure rhythmic finger tapping (paced by a metronome beat versus unpaced) and motor dexterity, phonological and auditory processing in 10-year old children, some of whom had a diagnosis of developmental dyslexia. We report links between paced motor tapping, auditory rhythmic processing and written language development. Motor dexterity does not explain these relationships. In regression analyses, paced finger tapping explained unique variance in reading and spelling.

Children with SLI were indeed found to be impaired in a range of measures of paced rhythmic tapping, but were not equally impaired in tapping in an unpaced control condition requiring an internally-generated rhythm. The severity of impairment in paced tapping was linked to language and literacy outcomes.

Music Training Increases Phonological Awareness and Reading Skills in Developmental Dyslexia: A Randomized Control Trial

Elena Flaugnacco^{1,2}, Luisa Lopez³, Chiara Terribili³, Marcella Montico⁴, Stefania Zoia¹, Daniele Schön^{5,6*}

Music training. focus on rhythm and temporal processing (e.g. use of percussive instruments, use of rhythm syllables [ta, ti-ti, . . .], rhythmic body movements accompanying music, sensorimotor synchronization games). **Painting training.** This program emphasized visual-spatial and hand skills as well as creativity.

Training sessions involved groups of 5–6 children, one hour, twice a week, for 30 weeks (excluding holidays)

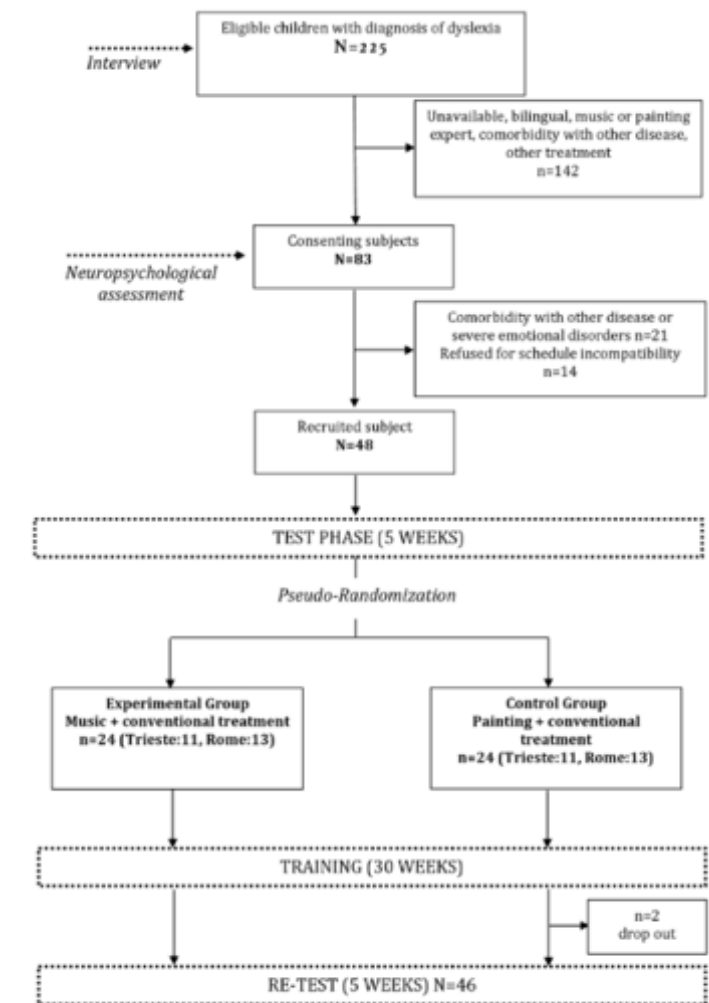
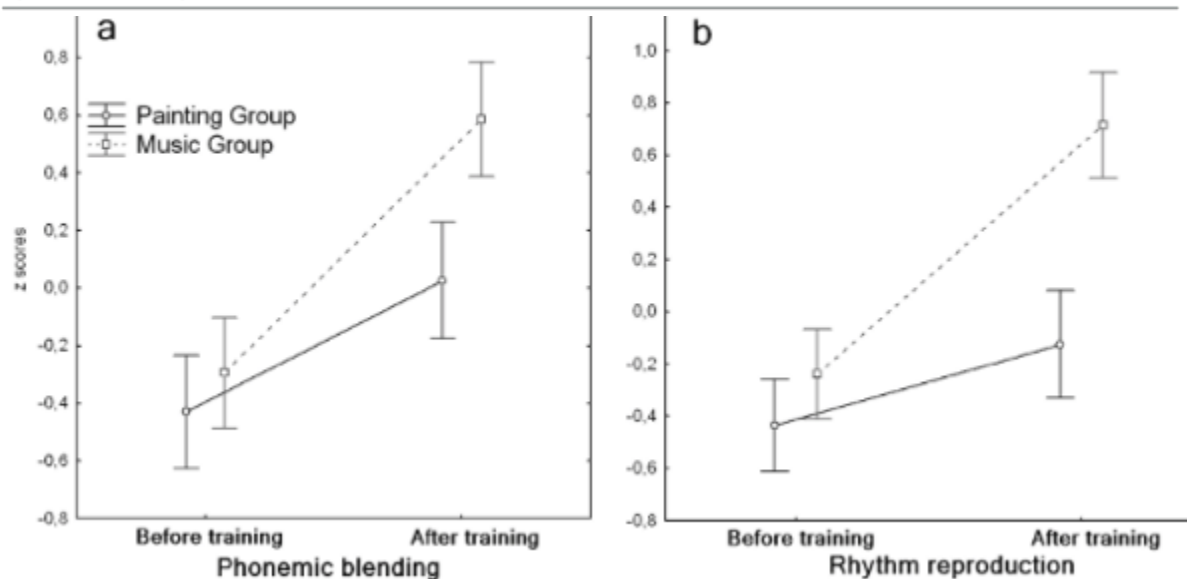


Fig 1. Flow chart illustrating participants' recruitment and experimental design.

Table 2. Summary of reading and phonological awareness results before and after training.

Test	Outcomes Variables	Measure	Before training		After training		Larger effect of music training	Effect size
			Painting Group n = 24	Music Group n = 22	Painting Group n = 24	Music Group n = 22		
DDE-2 Pseudo word reading test	Accuracy (Primary Outcome)	N of severely impaired children (<5)	15	17	12	5	0.016	OR = 3.7
	Time	Mean of z score of seconds	4.1 (3.0)	3.6 (2.6)	2.89 (2.6)	2.42 (2.2)	0.57 (***)	
MT Text reading	Accuracy	N of severely impaired children (<15)	21	20	15	8	0.038	OR = 1.9
	Speed	Mean of z score syll/s	-2.15 (0.84)	-1.83 (0.62)	-1.88 (0.81)	-1.68 (0.61)	0.51 (**)	
DDE-2 Word reading test	Accuracy	N of severely impaired children (<5)	18	15	8	7	0.76	
	Time	Mean of z score of seconds	6.2 (5.5)	5.6 (4.4)	4.18 (4.7)	3.38 (2.9)	0.67 (***)	
Pseudo-word reproduction Promea Battery	Accuracy (40 items)	Mean of correct Pseudo-words	32.45 (4.95)	31.33 (3.71)	33.77 (4.3)	34.87 (2.6)	0.03	0.3
Phonemic segmentation task	Accuracy (38 items)	Mean of correct words	13.5 (9.48)	17.1 (9.50)	20.36 (8.78)	23.52 (7.72)	0.7 (***)	
	Speed	Mean of seconds	437 (186)	429 (132)	401 (123)	397 (94)	0.17	
Phonemic blending	Accuracy (38 items)	Mean of correct words	9.4 (9.45)	11 (10.96)	14.05 (9.38)	19.83 (9.54)	0.004	0.4
	Speed	Mean of seconds	614 (153)	630 (153)	620 (207)	557 (148)	0.10	

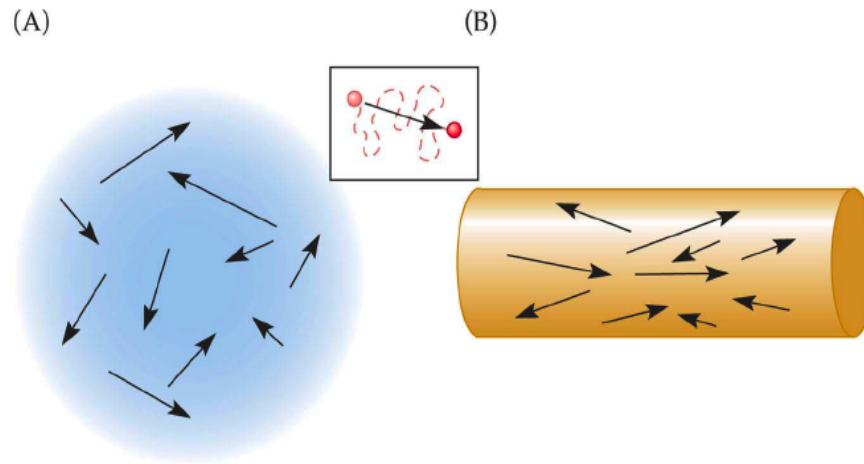
The column "Larger effect of music training" reports whether or not there is a larger improvement in the music training group compared to the painting group (p value<0.05). When this is not the case (ns, p>0.05), significant main effects of session are reported (* = p<0.05; ** = p<0.01; *** = p<0.001), pointing to an equal improvement of both groups. The standard deviation from the mean is reported in parenthesis. The effect size is reported for significant effects (categorical data: Odd Ratio; interval data: z/√N).



A larger effect of music training was also found when testing **auditory attention** and in several perception and production abilities as tested by psychoacoustic and musical tasks (Table 3). This was particularly evident for tasks requiring precise temporal processing, such as the temporal anisochrony detection task (a psychophysical measure of temporal regularity perception) and **the rhythm reproduction task** (Fig 2b), wherein children had to tap a previously heard rhythmic sequence. The outcome in the rhythm production task turned out to be **the best predictor of phonological awareness** as measured by the phonemic blending and phonemic segmentation tasks

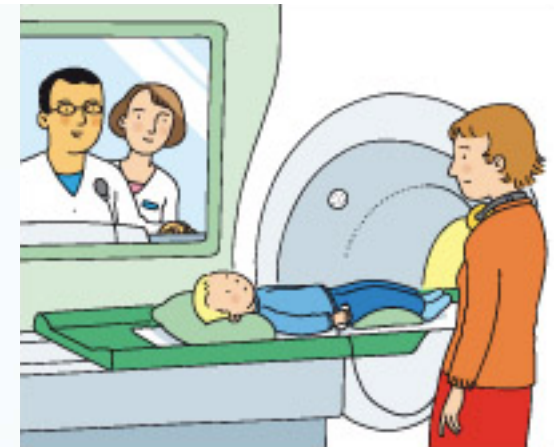
Le faisceau arqué : un élément clé dans l'élucidation des mécanismes

5.18 Isotropic and anisotropic diffusion.

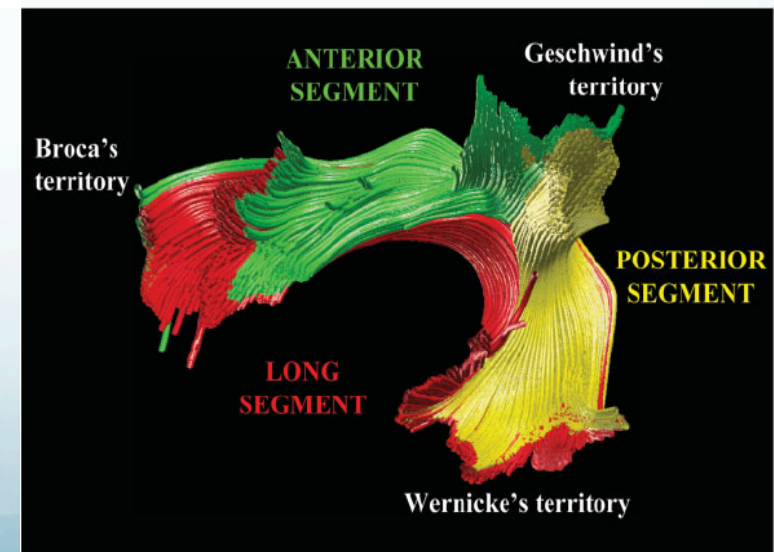


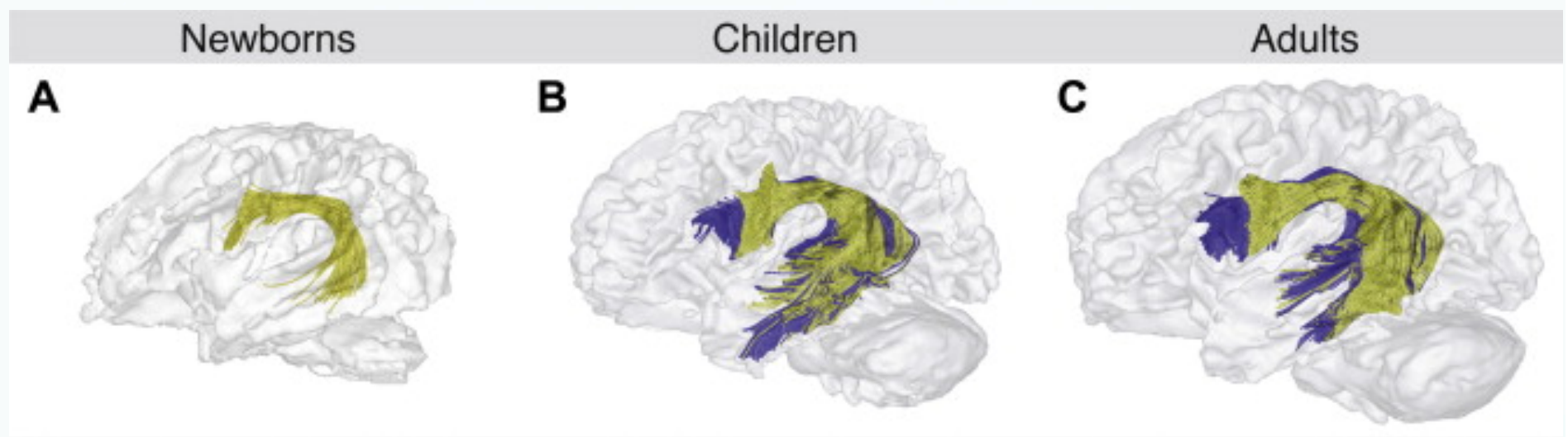
Diffusion tensor imaging (D.T.I.)

FUNCTIONAL MAGNETIC RESONANCE IMAGING, Figure 5.18 © 2004 Sinauer Associates, Inc.



Le faisceau arqué : principal marqueur anatomique de la dyslexie





Le faisceau arqué, qui connecte les aires de Broca et de Wernicke est constitué de deux contingents : l'un ventral, présent dès la naissance, qui serait responsable du développement linguistique initial (fonctionnerait comme un extracteur de règles d'invariance dans la phonologie et la syntaxe). L'autre dorsal, n'apparaissant que vers 7ans, responsable de fonctions linguistiques plus complexes (sous l'influence de la lecture?).

[Brauer J, Anwander A, Perani D, Friederici AD. Dorsal and ventral pathways in language development. *Brain Lang.* 2013 May 1.](#)

A tractography study in dyslexia: neuroanatomic correlates of orthographic, phonological and speech processing

Maaïke Vandermosten,^{1,2,3} Bart Boets,^{1,2,4} Hanne Poelmans,^{1,2} Stefan Sunaert,³ Jan Wouters² and Pol Ghesquière¹

¹ Parenting and Special Education Research Unit, Katholieke Universiteit Leuven, A. Vesaliusstraat 2, PO Box 3765, 3000 Leuven, Belgium

Étude en tractographie des déficits phono-auditifs et orthographiques dans la dyslexie : dissociation entre une voie inférieure (orthographe) et supérieure (phonologie et perception de la parole)

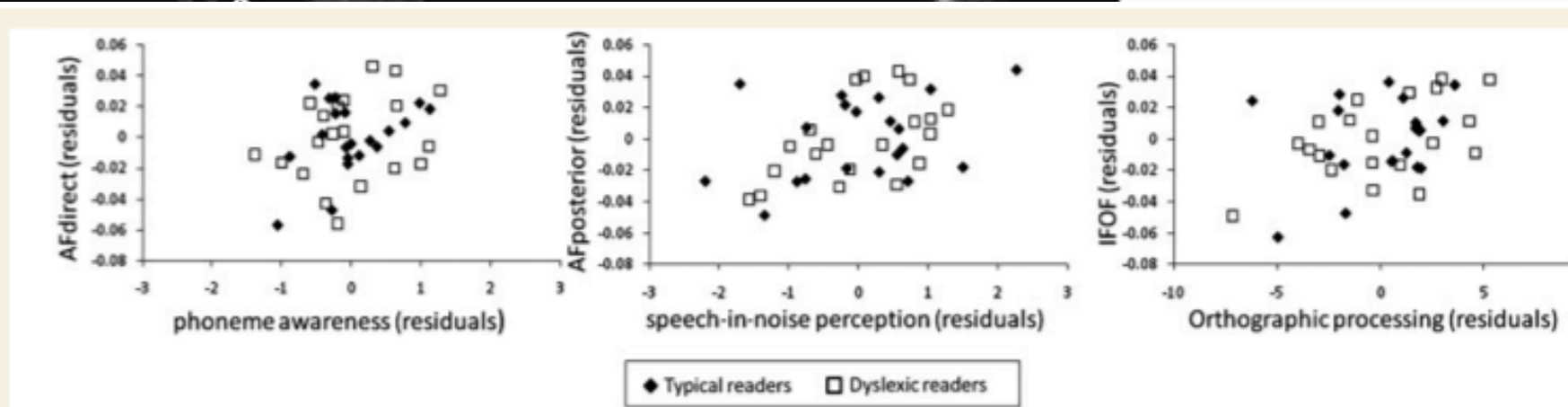
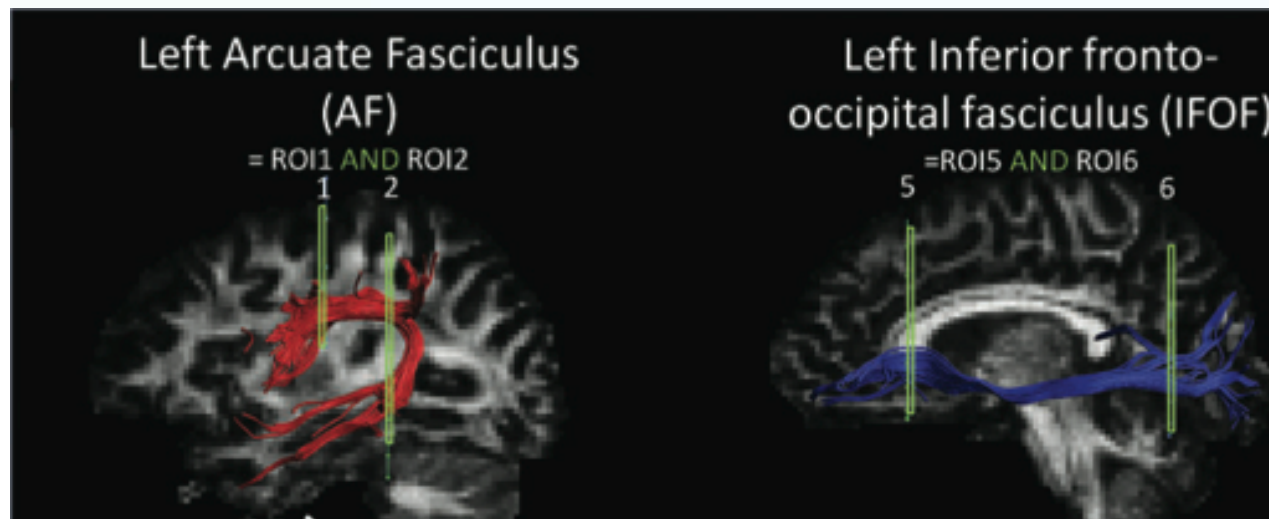
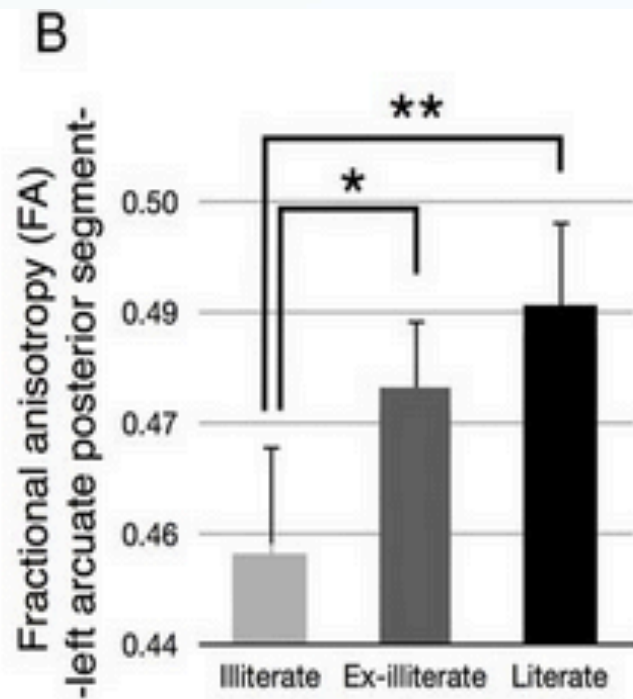


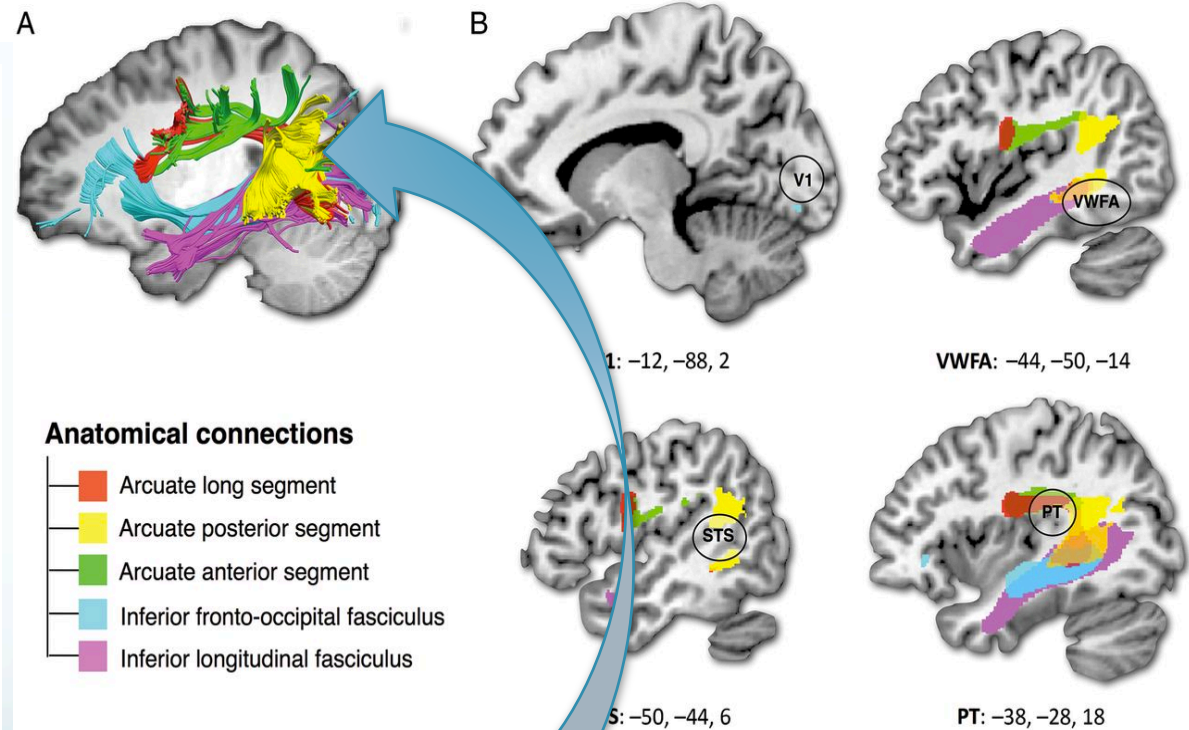
Figure 2 Correlations between (residual) fractional anisotropy values and (residual) reading-related behavioural measures after controlling for group, IQ and quality index of DTI acquisition. AFdirect = arcuate fasciculus-direct; AFposterior = arcuate fasciculus-posterior; IFOF = inferior fronto-occipital fasciculus.

Learning to Read Improves the Structure of the Arcuate Fasciculus

Michel Thiebaut de Schotten^{1,2,3,4}, Laurent Cohen^{3,4,5}, Eduardo Amemiya⁶,
Lucia W. Braga⁶ and Stanislas Dehaene^{7,8,9,10}



- Illettrés (n= 10) : proviennent de la région rurale (5) ou urbaine (5) des environs de Brasilia
- « Participants were illiterates for social reasons, with no history of special difficulty other than the lack of access to schools. »
- Ex-illettrés (n= 10) : parcours similaire à celui des illettrés (parents illettrés de secteur rural) mais ont reçu un enseignement à l'âge adulte.
- Non-illettrés : (n= 11) proviennent de la même communauté sociale que les illettrés mais ont appris à lire pendant l'enfance.



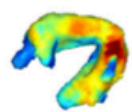
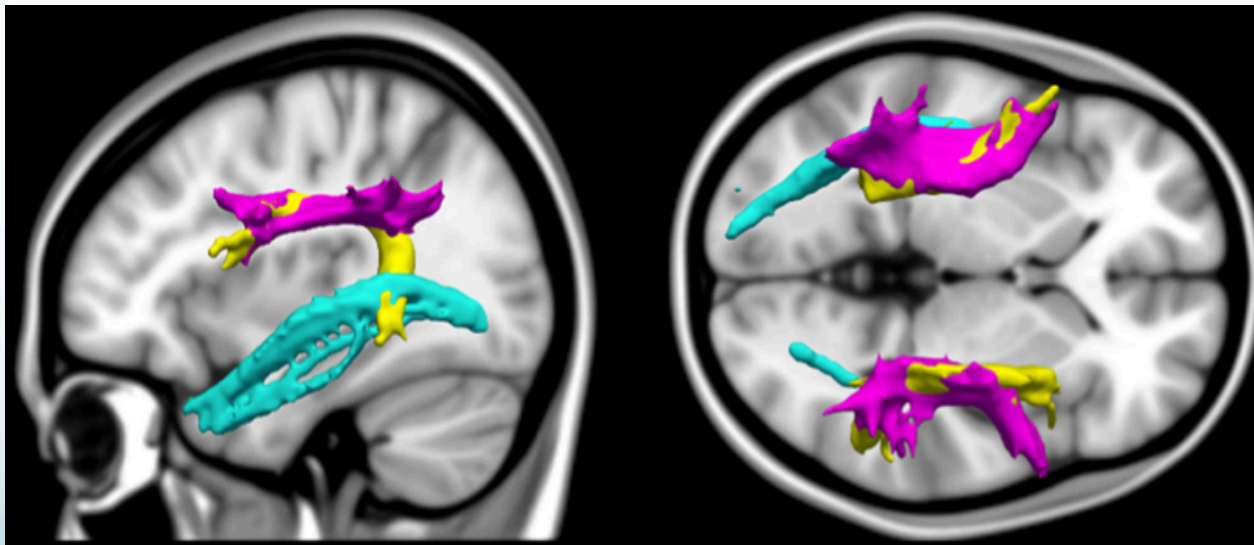
Partie postérieure du faisceau arcué:
Volume inversement proportionnel au degré d'illettrisme

Behavioral/Cognitive

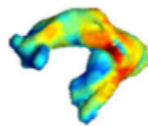
Tracking the Roots of Reading Ability: White Matter Volume and Integrity Correlate with Phonological Awareness in Prereading and Early-Reading Kindergarten Children

Zeynep M. Saygin,^{1*} Elizabeth S. Norton,^{1*} David E. Osher,¹ Sara D. Beach,¹ Abigail B. Cyr,¹ Ola Ozernov-Palchik,³ Anastasia Yendiki,⁴ Bruce Fischl,^{2,4} Nadine Gaab,³ and John D.E. Gabrieli¹

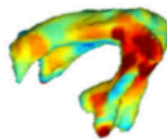
¹McGovern Institute for Brain Research and Department of Brain and Cognitive Sciences and ²Computer Science and Artificial Intelligence Laboratory



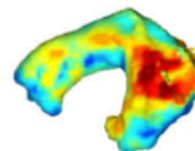
BW score=0



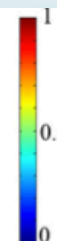
BW score=3



BW score=9



BW score=11



40 enfants de différents niveaux de capacités de conscience phonologique en première moitié de maternelle et 18 pré-lecteurs. Corrélation avec l'organisation (taille et anisotropie) du faisceau arqué dans les deux populations :

- les différences d'organisation du FA ne sont pas la conséquence de l'acquisition de la lecture.
- Pas de telle corrélation avec les autres faisceaux

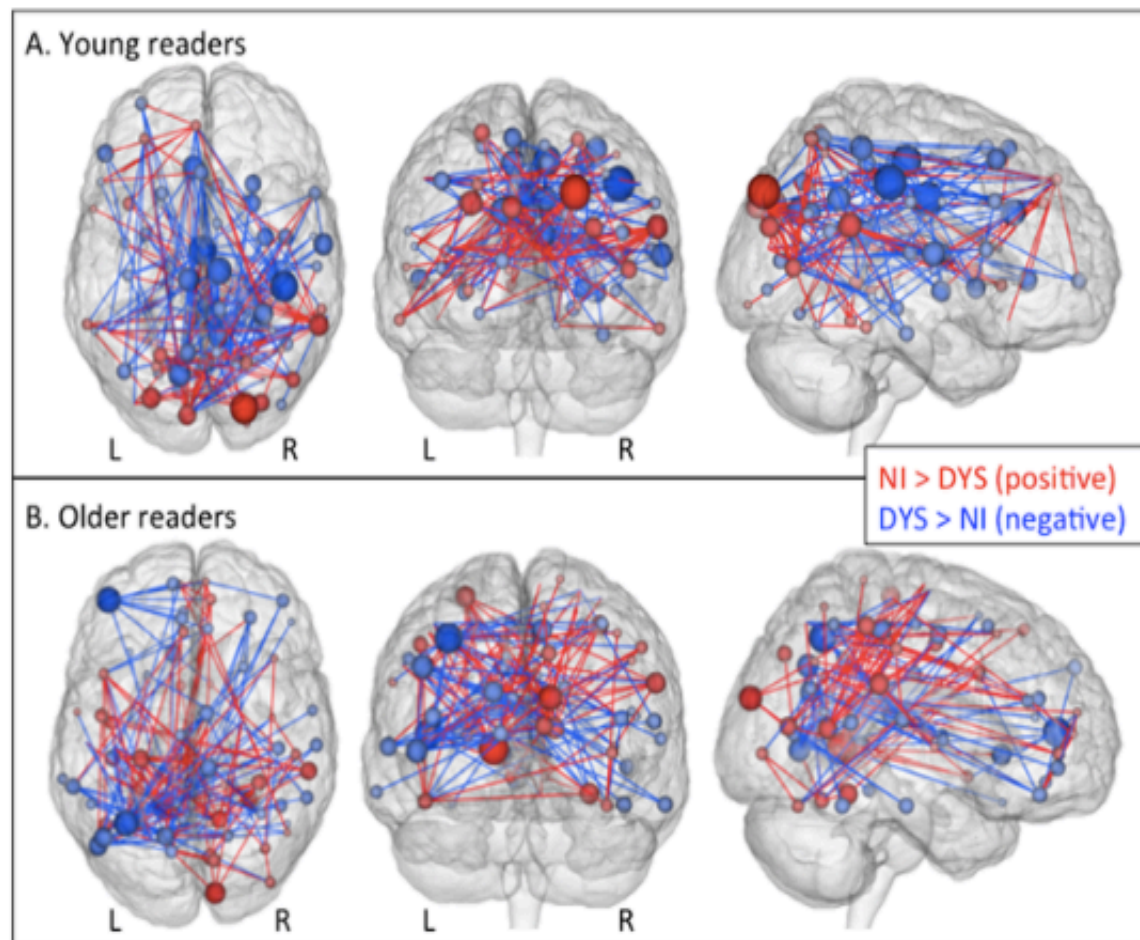
Corrélation entre le score de conscience phonologique en maternelle et la morphologie du faisceau arqué (volume et anisotropie)

ARCHIVAL REPORT

Disruption of Functional Networks in Dyslexia: A Whole-Brain, Data-Driven Analysis of Connectivity

Emily S. Finn, Xilin Shen, John M. Holahan, Dustin Scheinost, Cheryl Lacadie,
Xenophon Panademetris, Sally E. Shavwitz, Bennett A. Shavwitz, and R. Todd Constable

400 BIOL PSYCHIATRY 2014;76:397–404

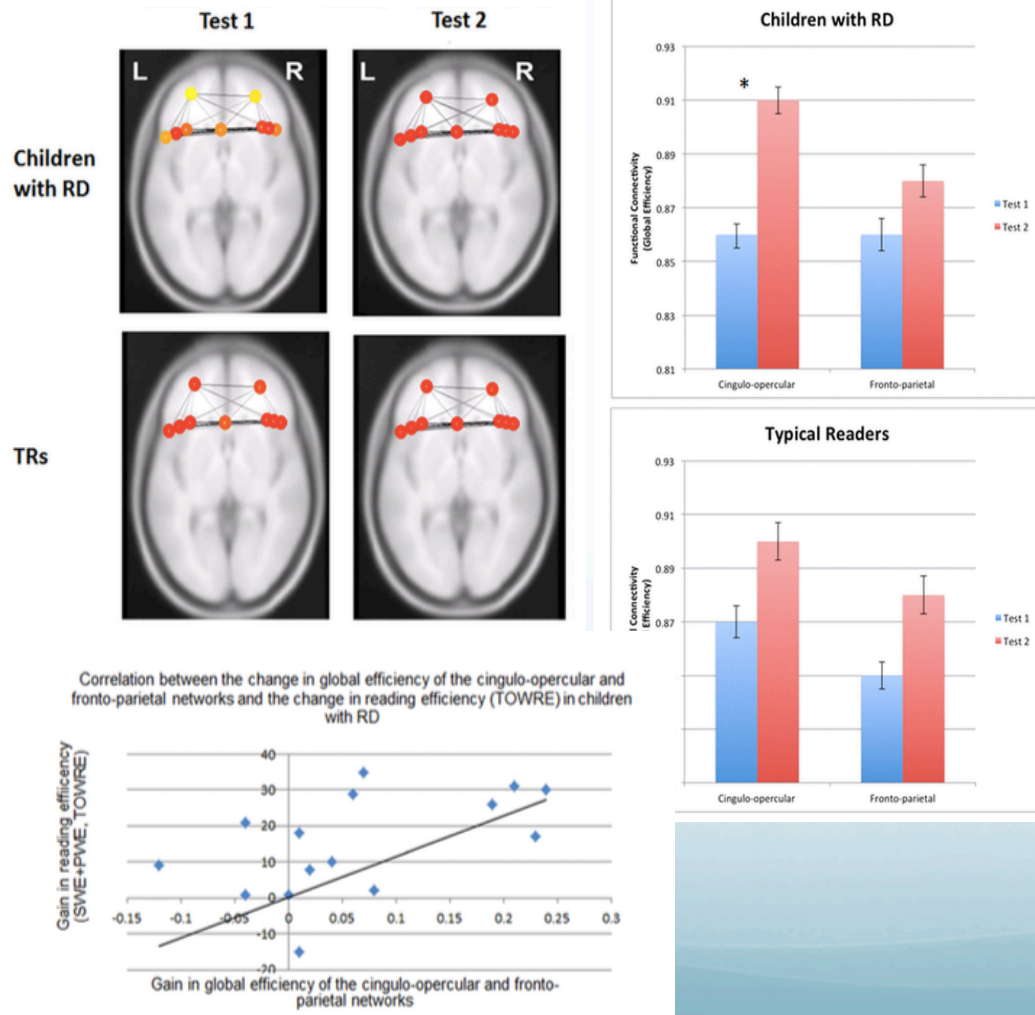


Compared to NI readers, DYS readers showed **divergent connectivity within the visual pathway** and between visual association areas and prefrontal attention areas; **increased right-hemisphere connectivity; reduced connectivity in the visual word-form area** (part of the left fusiform gyrus specialized for printed words); and **persistent connectivity to anterior language regions** around the inferior frontal gyrus.

RESEARCH ARTICLE

Increased Resting-State Functional Connectivity in the Cingulo-Opercular Cognitive-Control Network after Intervention in Children with Reading Difficulties

Tzipi Horowitz-Kraus^{1,2*}, Claudio Toro-Serev², Mark DiFrancesco¹



compared to typical readers, children with reading difficulty had significantly greater functional connectivity in the cingulo-opercular network after training, which may demonstrate the importance of cognitive control during reading in this population. These results support previous findings of increased error-monitoring activation after reading training in children with dyslexia and confirm greater gains with training in this group.

The current study provides evidence for the effect of the RAP training, an EF- based reading intervention, **on functional connectivity of cognitive-control networks** during rest in children with reading difficulties.

En résumé : époque 3

- Le faisceau arqué apparaît comme le principal et le plus robuste marqueur anatomique de la dyslexie
- Sa morphologie varie de façon notable chez l'adulte en fonction du degré d'illettrisme
- Chez l'enfant, son développement est en partie contemporain de l'acquisition de la lecture
- Les différences sont cependant déjà présentes avant l'apprentissage de la lecture et proportionnelles aux aptitudes phonologiques
- Au-delà du seul faisceau arqué, c'est toute la connectivité cortico-corticale qui est altérée chez les dyslexiques, et qui peut se restituer après une thérapie spécifique

Défaut d'intégration multimodale : une explication unitaire des troubles dys

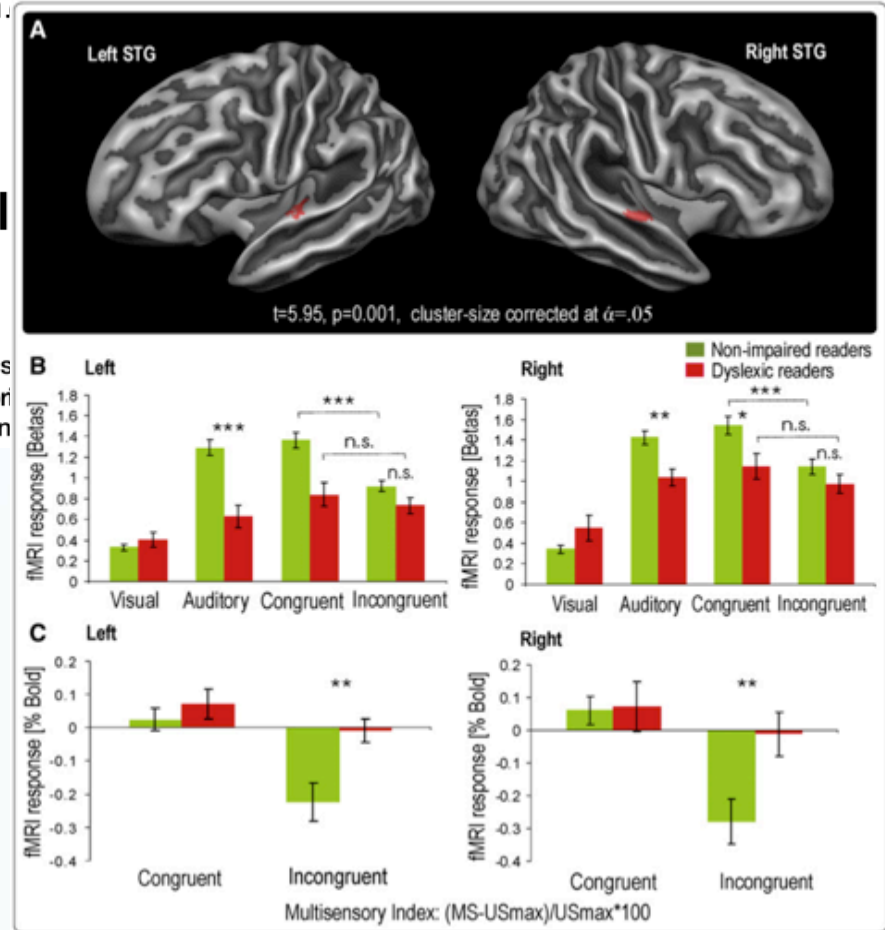
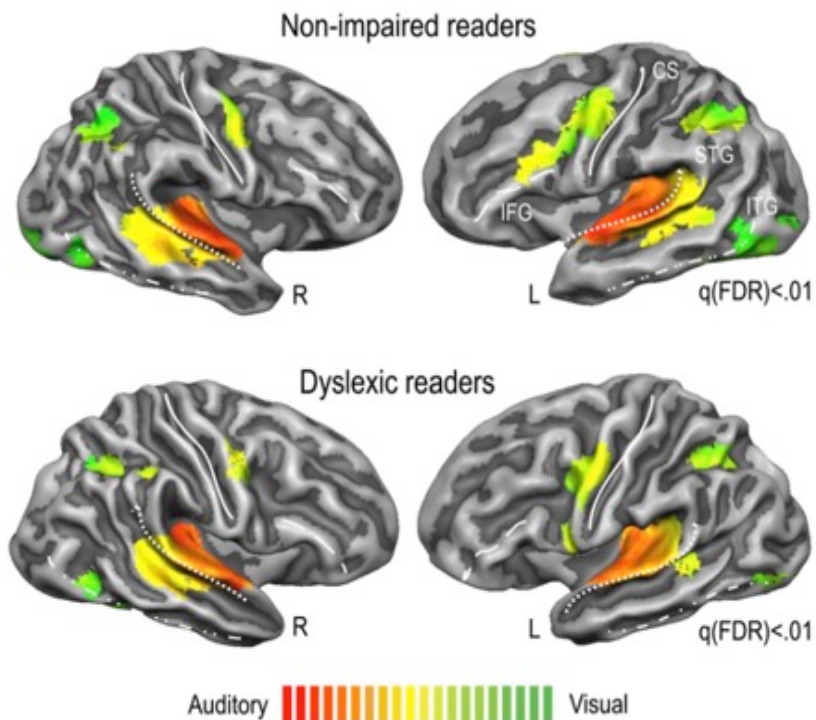


McGurk effect : an auditory /ba/ presented with a visual /ga/ is typically “heard” as /da/ (the reverse, i.e., auditory /ga/ and visual /ba/, tends to yield /bga/).

Reduced Neural Integration of Letters and Speech Sounds Links Phonological and Reading Deficits in Adult Dyslexia

Vera Blau,^{1,2,*} Nienke van Atteveldt,^{1,2} Michel Ekkebus,³
Rainer Goebel,^{1,2} and Leo Blomert^{1,2}
¹University of Maastricht

for letters and speech s
dyslexia have been pr
adequately representin

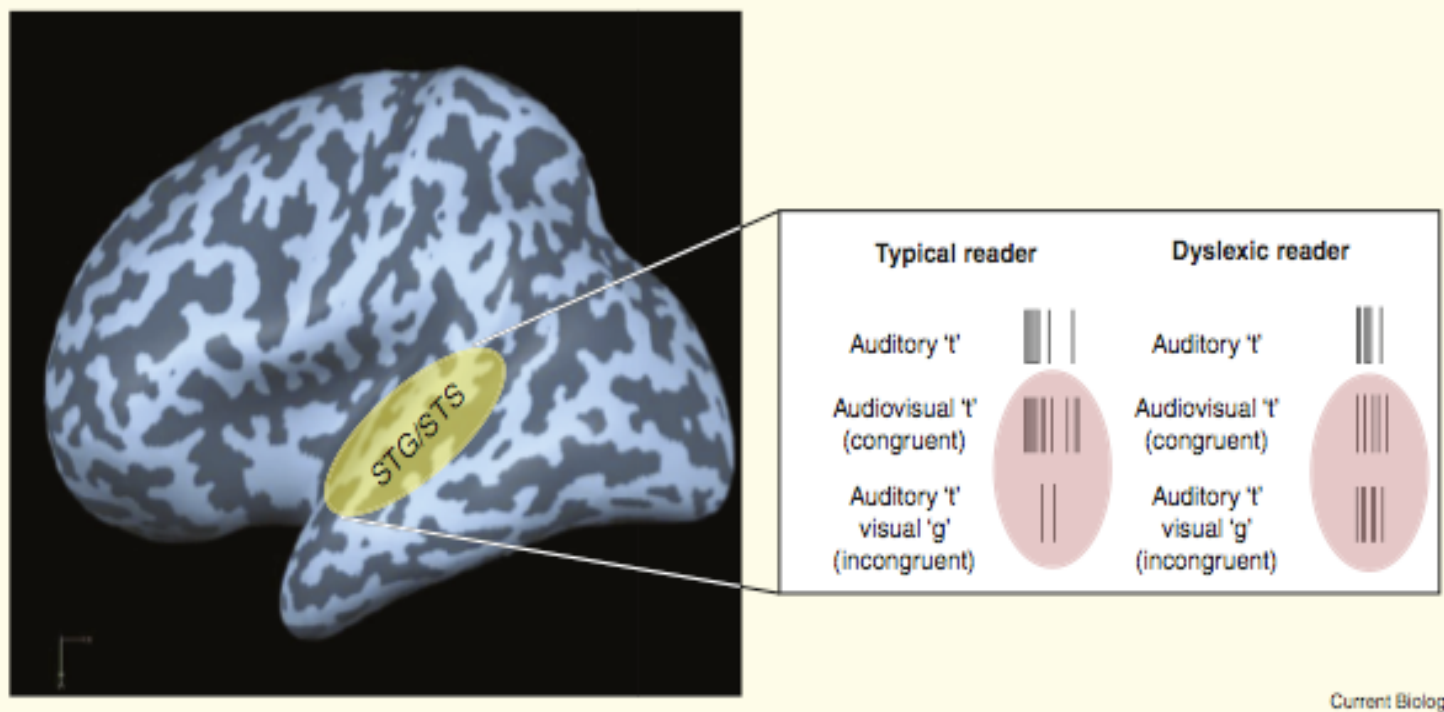


Zones activées par des stimuli unimodaux
(parole=rouge, lettres=vert,
commun=jaune)

4 conditions : unimodal visuel, unimodal
auditif, multimodal congruent et multimodal
incongruent

A/ l'interaction groupe condition est
significative dans les deux régions auditives
moyennes

B/ dyslexiques activent moins en unimodal et
en multimodal



lorsque le stimulus est congruent (le sujet entend 't' et voit la lettre T), la décharge neuronale est moins bien organisée que chez le témoin; en outre, celle-ci est beaucoup plus importante qu'elle ne devrait l'être pour un stimulus incongruent (le sujet entend 't' et voit la lettre G).

--> pb d'intégration intermodale



Mapping symbols to sounds: electrophysiological correlates of the impaired reading process in dyslexia

Andreas Widmann^{1*}, Erich Schröger¹, Mari Tervaniemi^{2,3}, Satu Pakarinen² and Teija Kujala^{2,4}

¹ Institute of Psychology, University of Leipzig, Leipzig, Germany

² Cognitive Brain Research Unit, Cognitive Science, Institute of Behavioural Sciences, University of Helsinki, Helsinki, Finland

³ Center of Excellence in Interdisciplinary Music Research, University of Jyväskylä, Jyväskylä, Finland

⁴ Cicero Learning, University of Helsinki, Helsinki, Finland

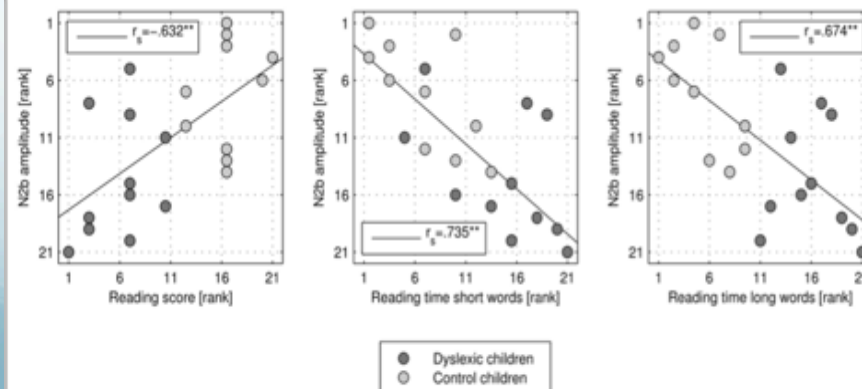
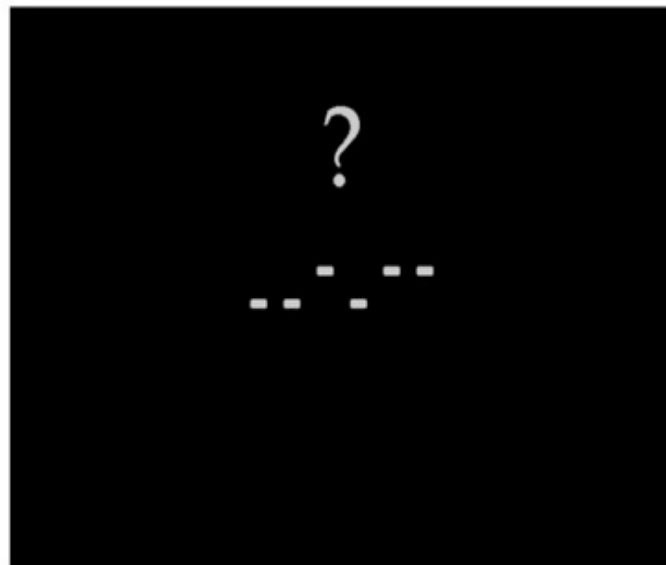
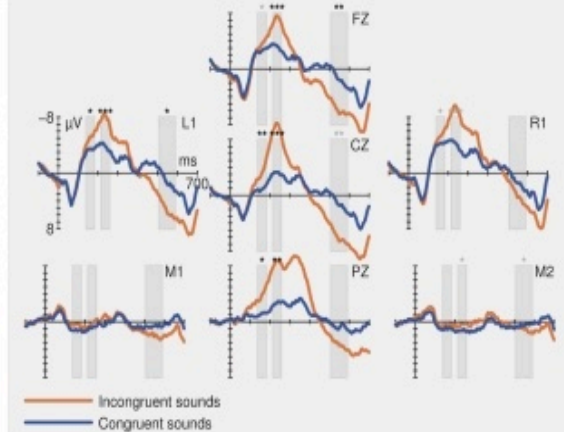


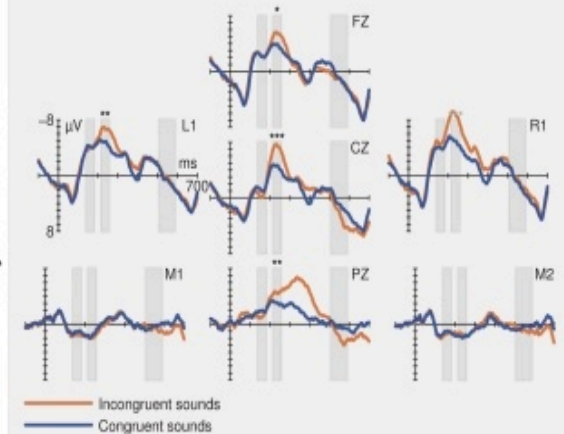
FIGURE 3 | Scatter plot and correlation of N2b amplitude rank (negative up) at electrode location Cz and rank of reading score, and reading time of short and long words, respectively.

A Symbol-to-Sound-Matching Task

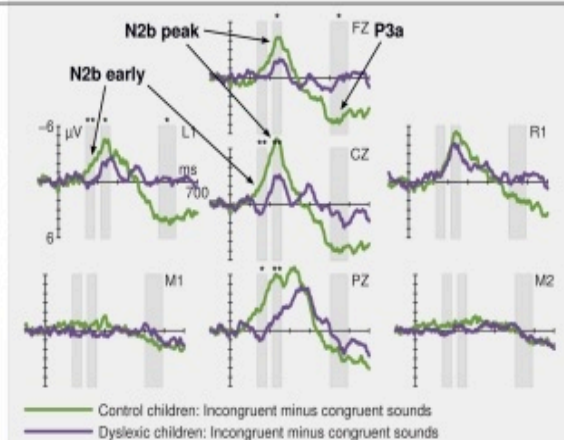
ERPs Control Children



ERPs Dyslexic Children

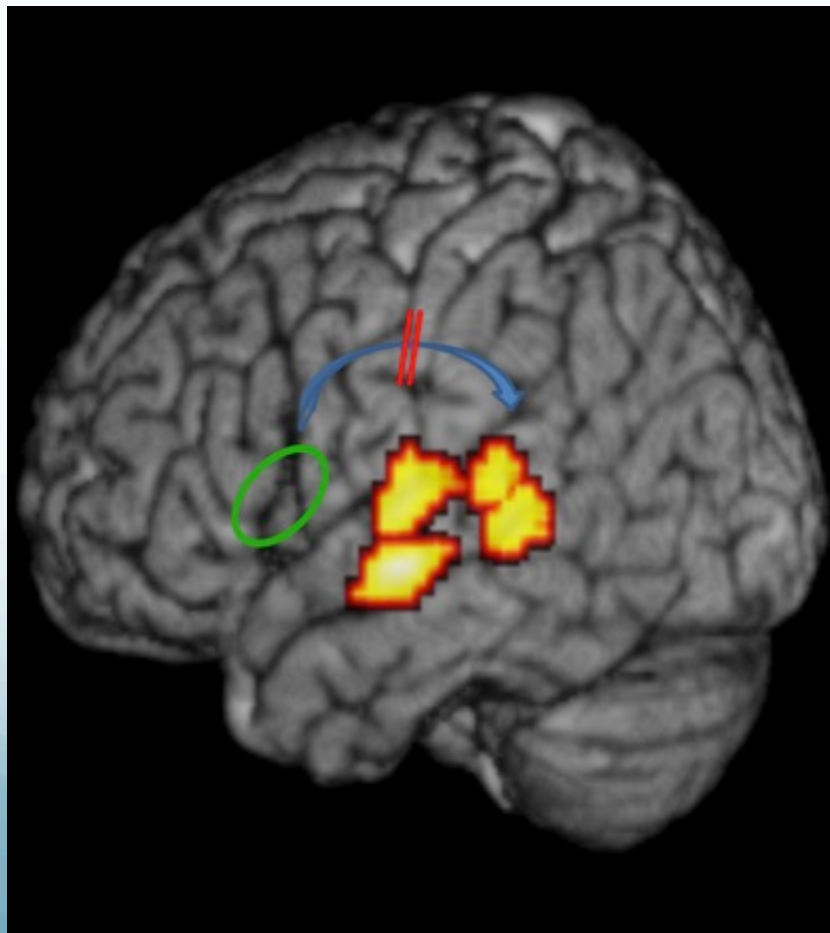


Difference Waves

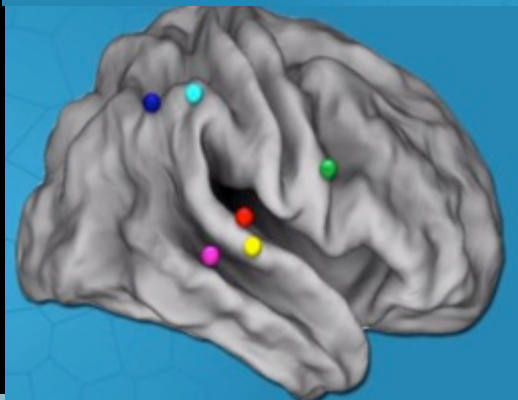


Boets et al., 2013:

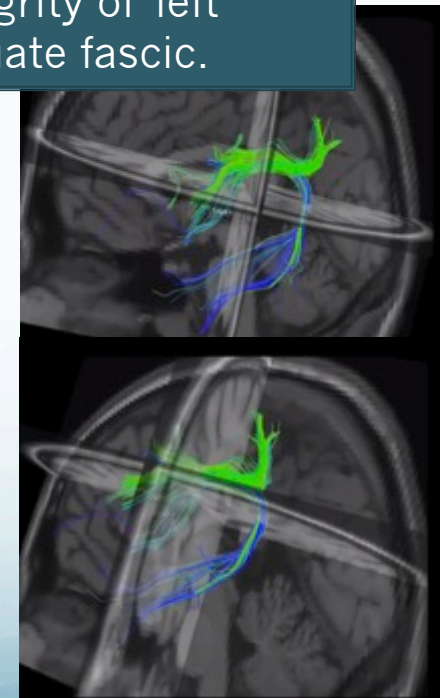
- les corrélations sont plus fortes au sein d'une catégorie qu'entre les catégories : signe la robustesse des représentations
- phonemic representations are as robust in DYS as in NORM : they are not degraded as previously thought → DYS people have a problem of **access to otherwise intact representations**



Impaired fonctional connectivity between Broca's area and R/L auditory areas



Reduced anatomical integrity of left arcuate fascic.



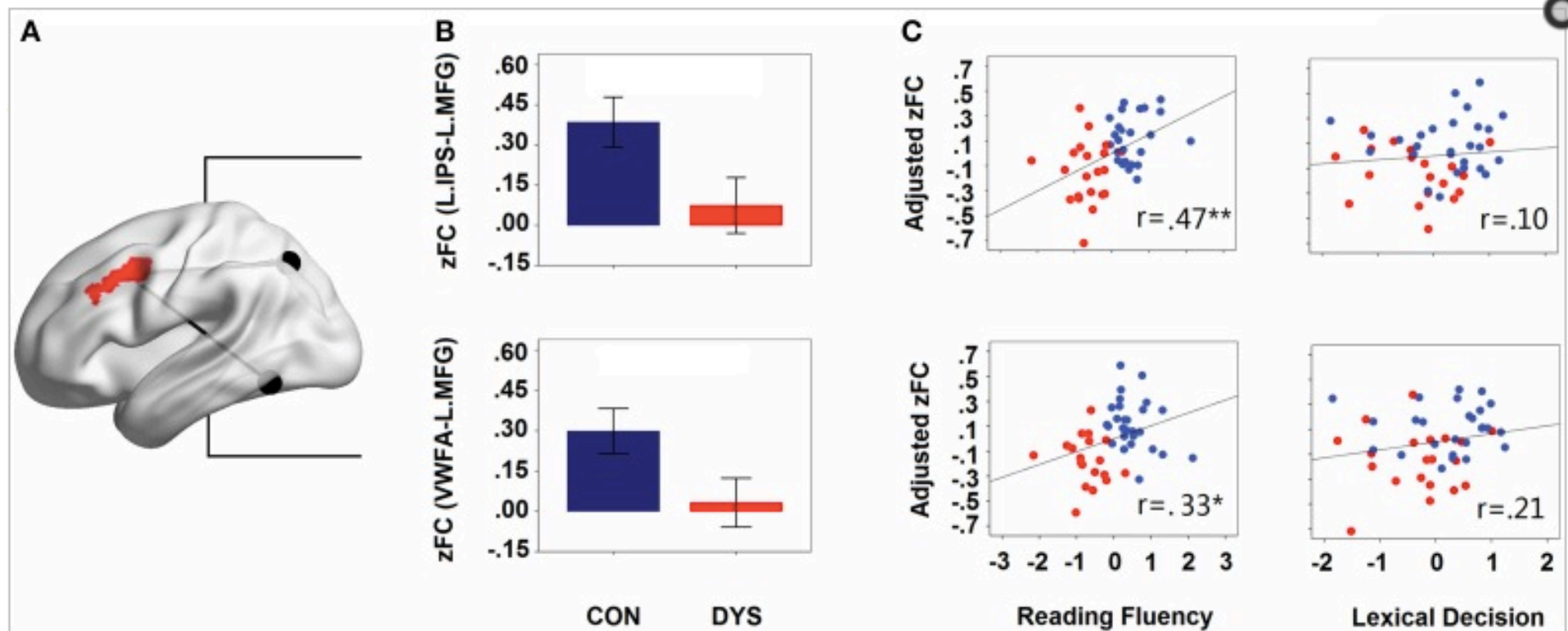


Altered connectivity of the dorsal and ventral visual regions in dyslexic children: a resting-state fMRI study

Wei Zhou^{1,2,3}, Zhichao Xia^{1,2}, Yanchao Bi^{1,2} and Hua Shu^{1,2*}

¹State Key Laboratory of Cognitive Neuroscience and Learning and IDG/McGovern Institute for Brain Research, Beijing Normal University, Beijing, China

Étude de connectivité au repos (resting state) : moindre connectivité chez DYS entre 1-VWFA et 2-L-sillon intra-pariétal (IPS) et Gyrus frontal moyen (MFG)
Corrélé à fluence en lecture et non à décision lexicale



Traitement analogique (IPS) :

- appréciation des magnitudes
- comparaisons de quantités
- soustraction

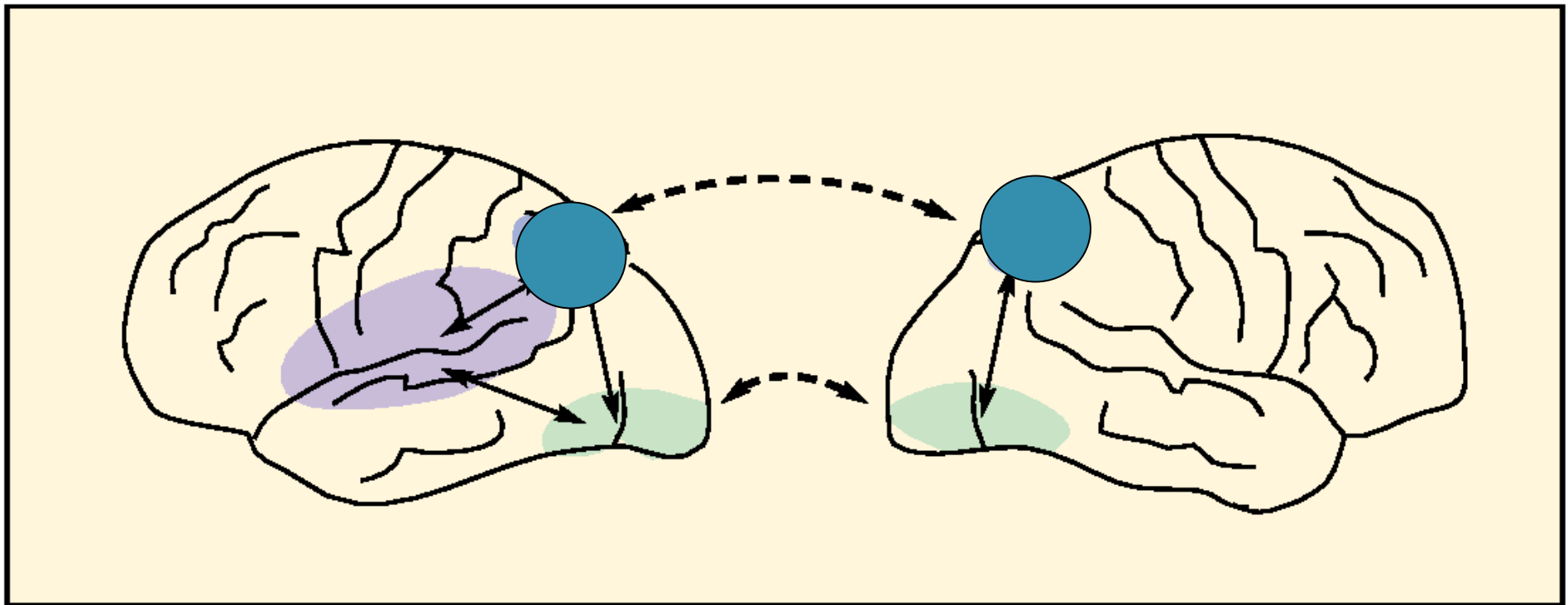
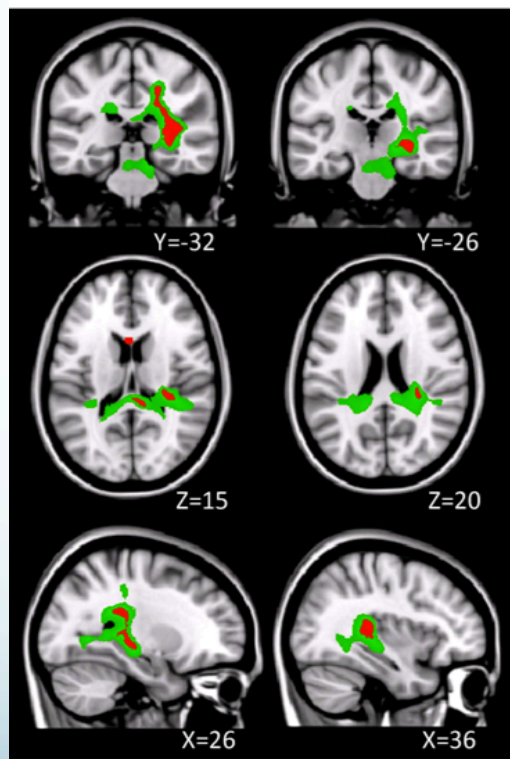


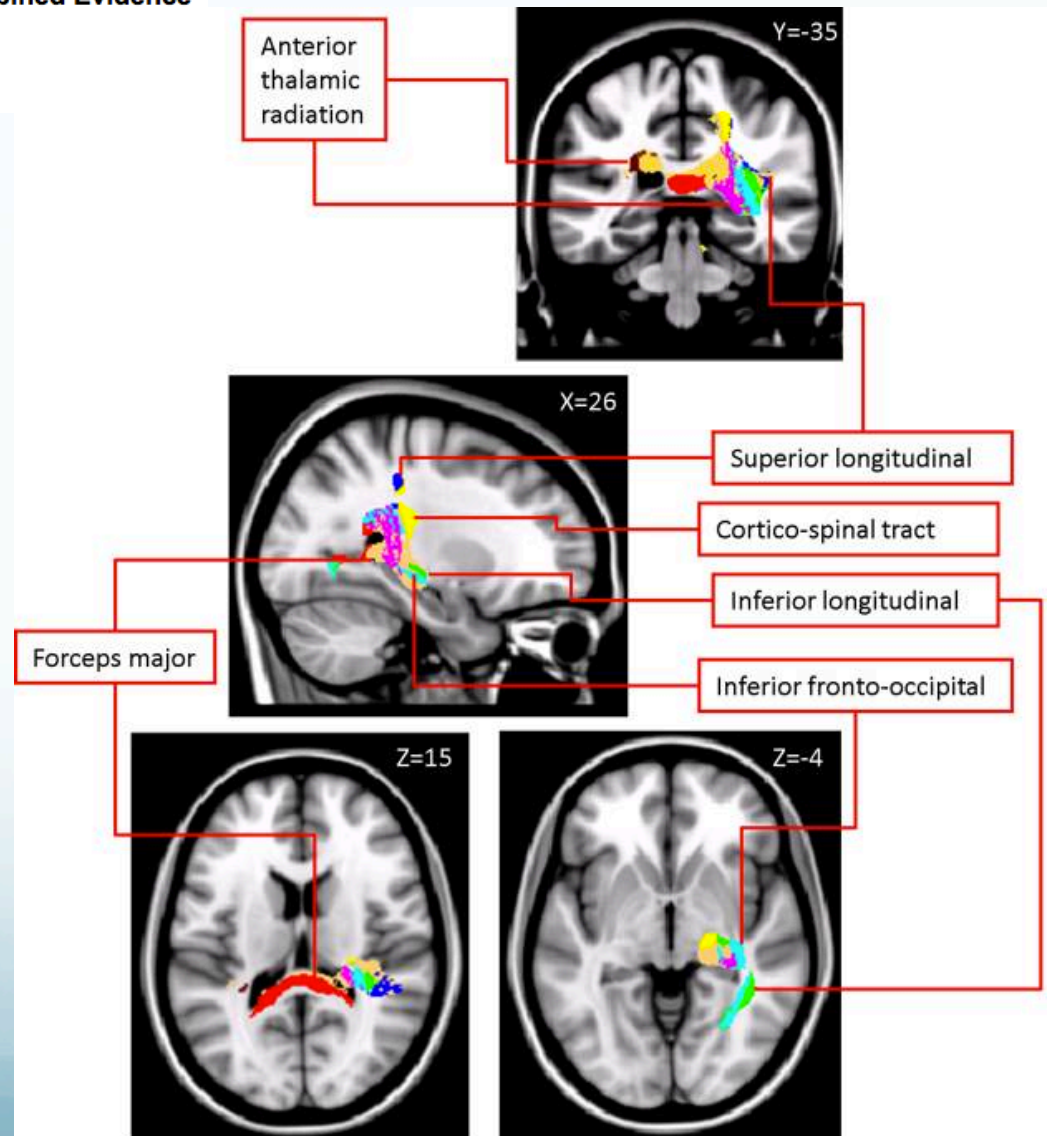
Figure 3 - Implémentation anatomique du triple code (traitement visuel arabe en vert, traitement analogique en bleu et traitement langagier en violet).

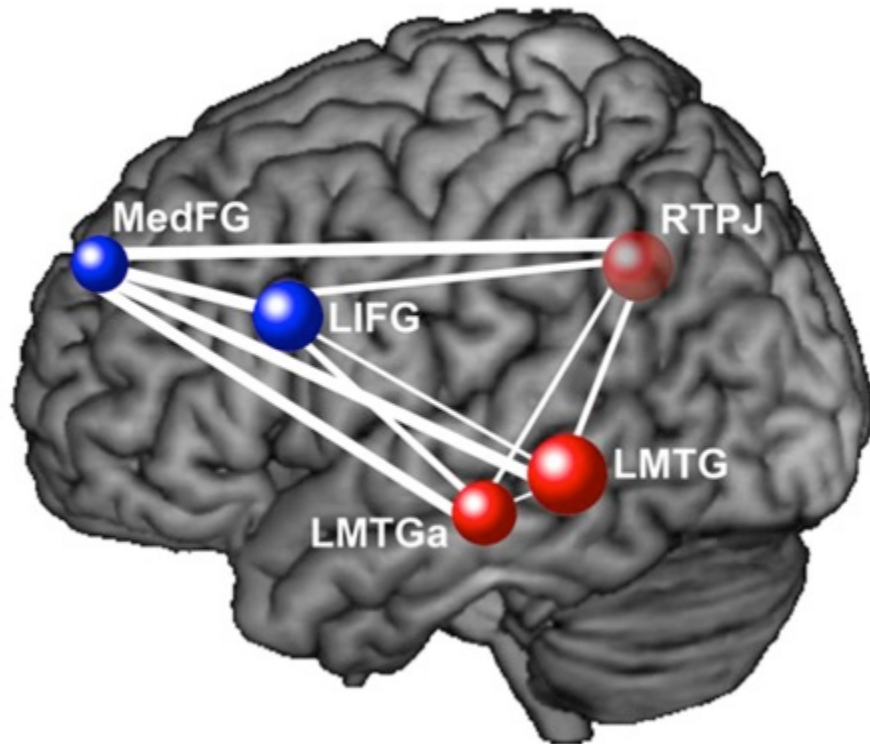
Neuroanatomical Correlates of Developmental Dyscalculia: Combined Evidence from Morphometry and Tractography

Elena Rykhlevskaia,^{1,2} Lucina Q. Uddin,¹ Leeza Kondos,¹ and Vinod Menon^{1,3,4,*}



DTI dans la dyscalculie : zones de différence entre dyscalculiques et témoins : connexions temporo-pariétales droites





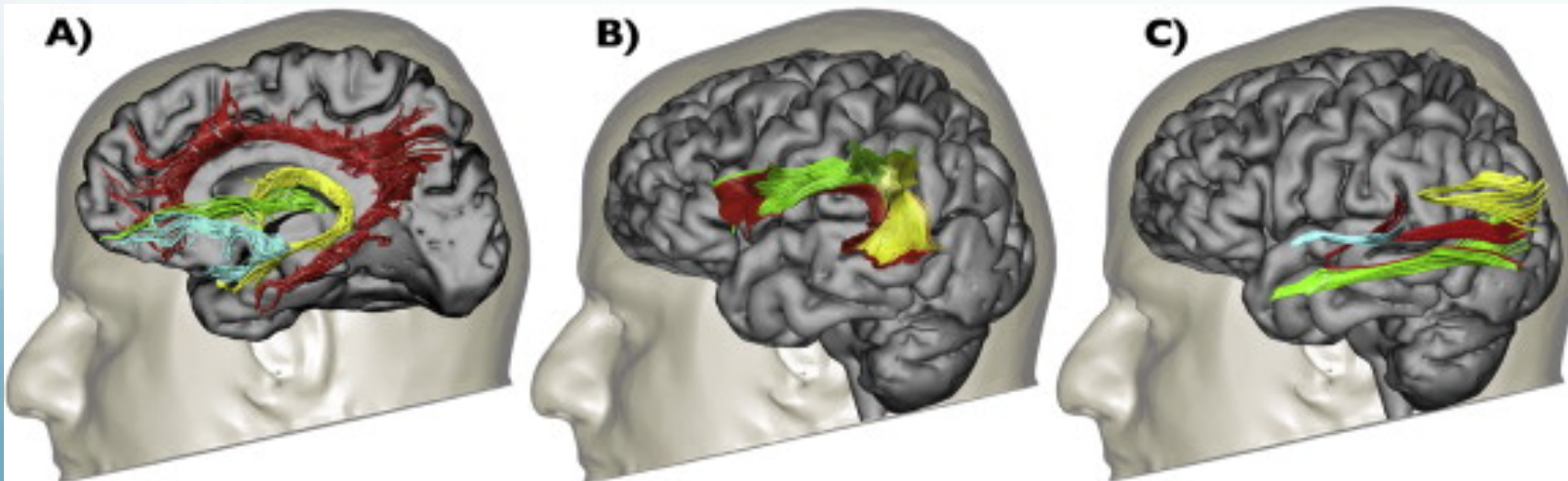
Autism : functional underconnectivity
between frontal/posterior areas.

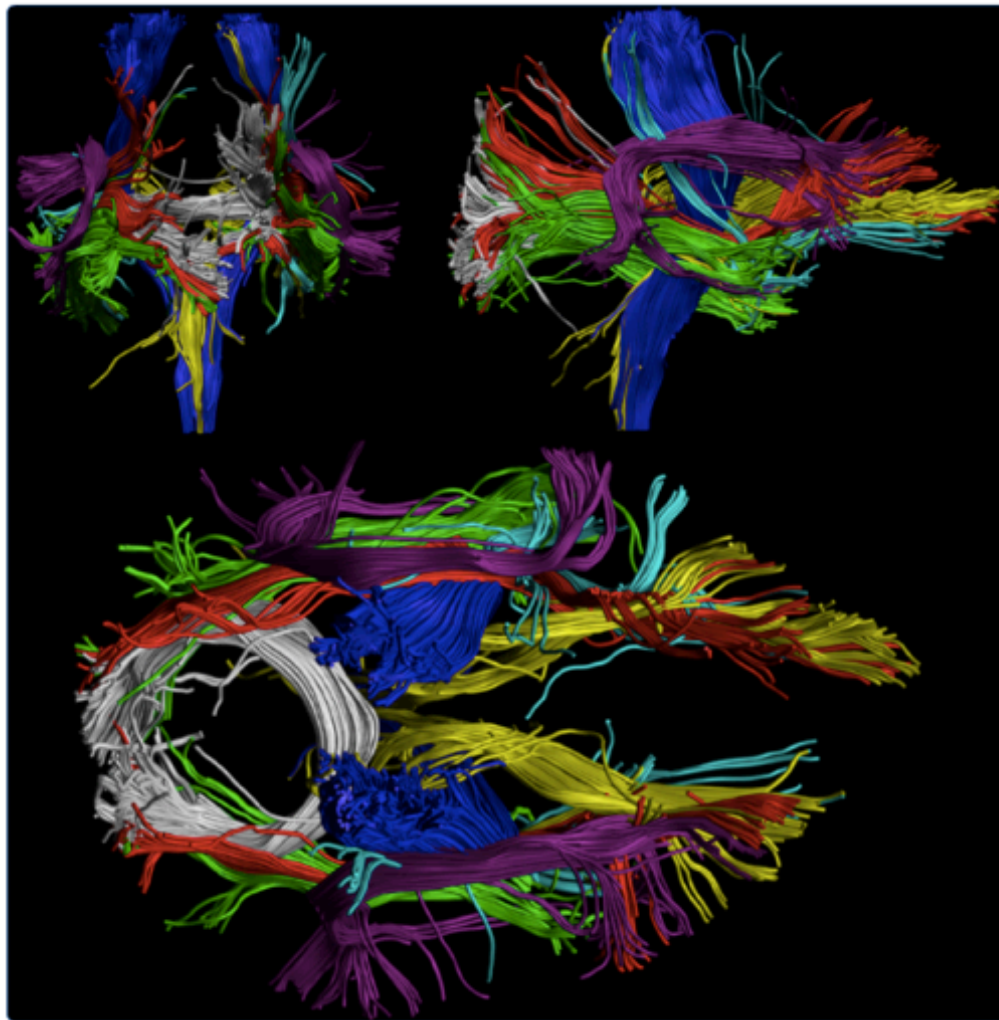
Mason et al., 2008

AUTISM

White matter tracts of the socio-
emotional processing system :
A:limbic system; B:mirror neuron
system; C: face processing system.

Ameis & Catani, Cortex, 2015





Constrained spherical deconvolution-based tractography and tract-based spatial statistics show abnormal microstructural organization in Asperger syndrome

Roine et al.

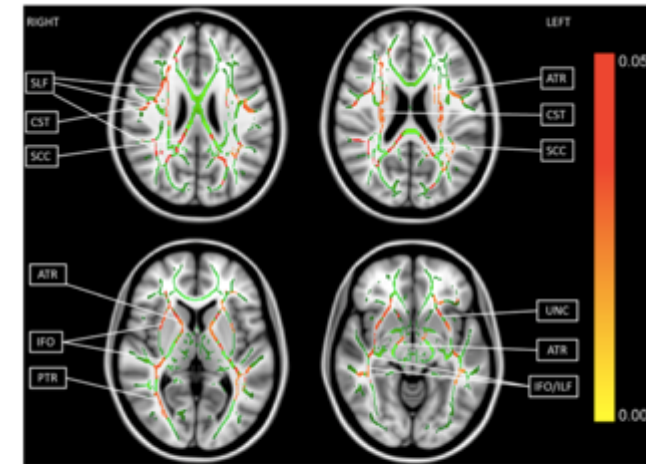
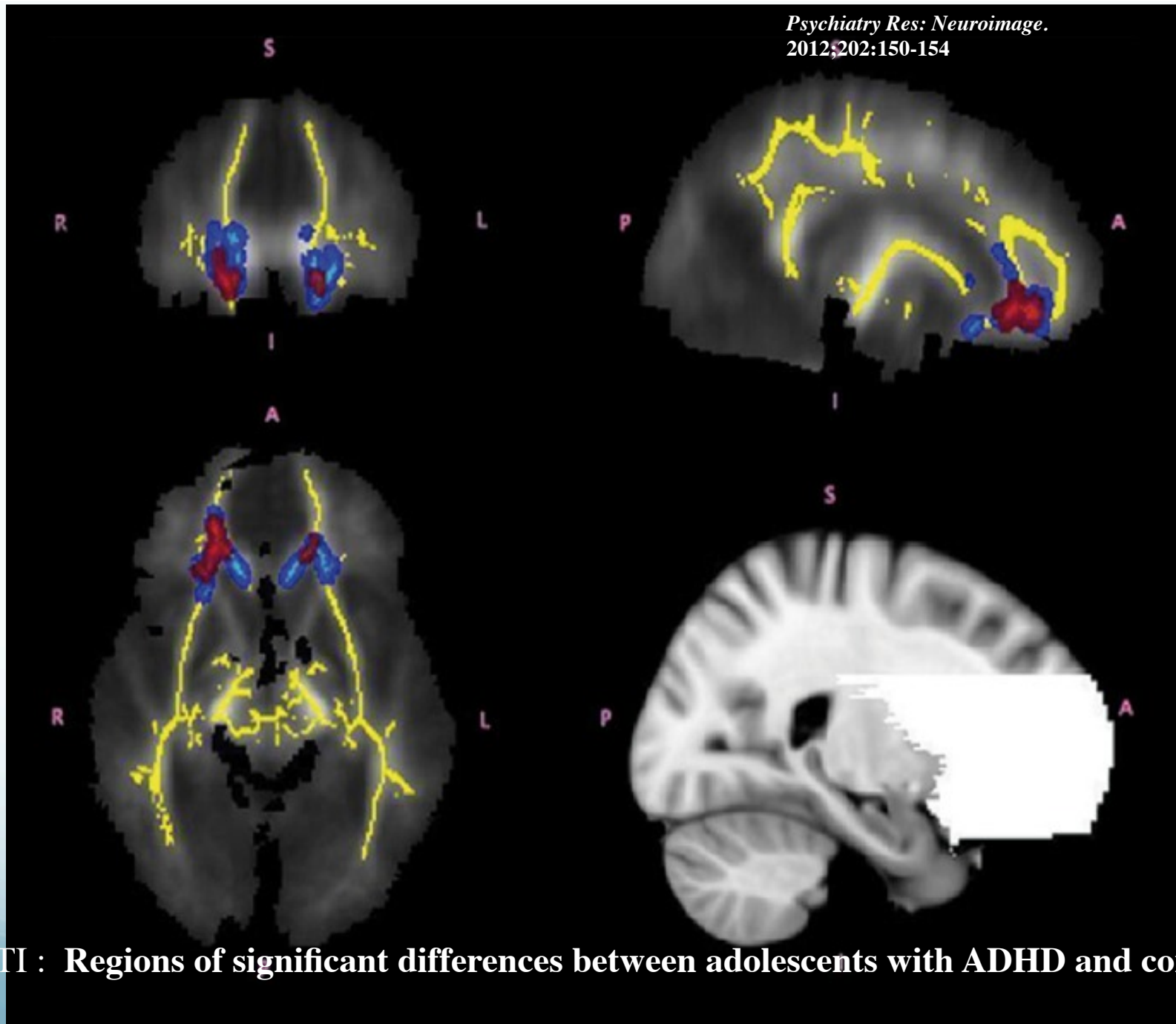


Figure 2 Tract-based spatial statistics (TBSS) revealed widely distributed local increases in fractional anisotropy (FA) in individuals with Asperger syndrome (AS). Four axial slices are shown (upper left: slice 97, upper right: slice 93, lower left: slice 77, lower right: slice 64). The green color shows the mean FA skeleton calculated from all subjects by TBSS, and the red color indicates the areas of increased FA in individuals with AS (corrected $P < 0.05$). SLF, superior longitudinal fasciculus; CST, corticospinal tract; SCC, splenium of corpus callosum; ATR, anterior thalamic radiation; IFQ, inferior fronto-occipital fasciculus; PTR, posterior thalamic radiation; UNC, uncinate fasciculus; ILF, inferior longitudinal fasciculus. The white matter (WM) tracts were identified with the JHU ICBM-DTI-81 White-Matter Labels Atlas in the Functional MRI of the Brain (FMRIB) Software Library (FSL).

14 H Asperger adultes, comparés à 19 témoins soigneusement sélectionnés, deux mesures d'anisotropie (FA) concordent pour montrer une augmentation de FA dans plusieurs faisceaux, principalement fronto-occipital et longitudinal inférieur gauche



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



Functional connectivity of neural motor networks is disrupted in children with developmental coordination disorder and attention-deficit/hyperactivity disorder

Kevin R. McLeod^{a,c}, Lisa Marie Langevin^{b,c,d}, Bradley G. Goodyear^{e,f,g,h,i}, Deborah Dewey^{b,c,d,j,i}

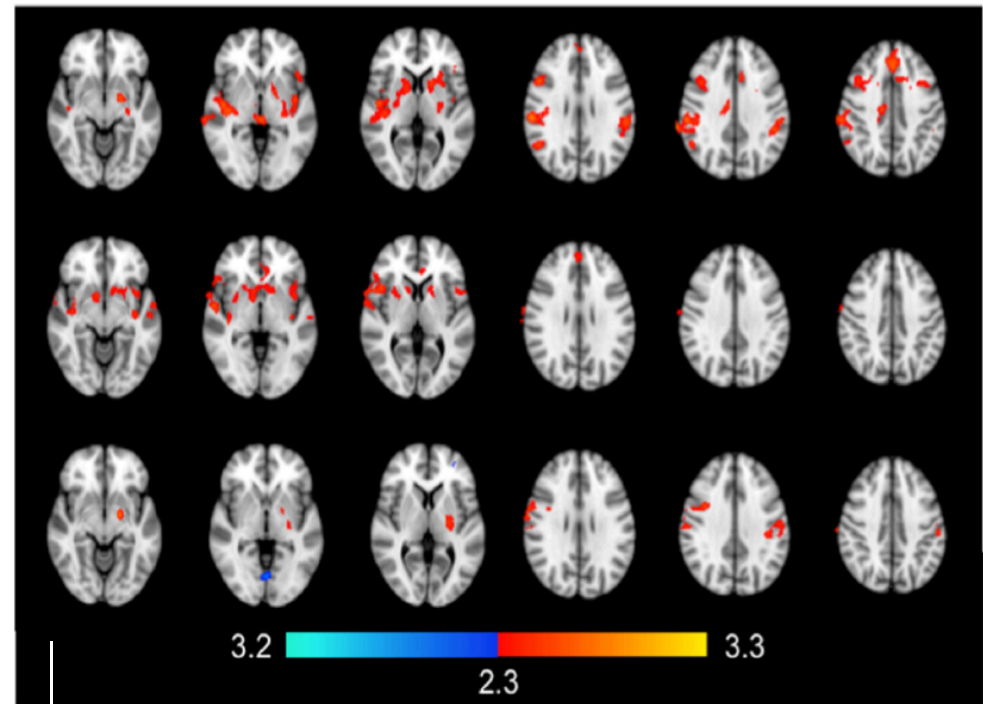
^aMedical Science, University of Calgary, Calgary, Alberta, Canada

Compared to typically developing controls, children with DCD and/or ADHD exhibit FC alterations between M1 and brain regions involved in motor functioning and sensorimotor processing. Our findings support the hypothesis that common neurophysiological substrates underlie motor and attention problems.

ADHD

DCD

ADHD/DCD



Evidence from neuroimaging research suggests that children with these disorders exhibit disruptions in motor circuitry, which could account for the high rate of co-occurrence. The primary objective of this study was to investigate the functional connections of the motor network in children with DCD and/or ADHD compared to typically developing controls, with the aim of identifying common neurophysiological substrates. Resting-state fMRI was performed on seven children with DCD, 21 with ADHD, 18 with DCD + ADHD and 23 controls.

Table 1
Participant characteristics.

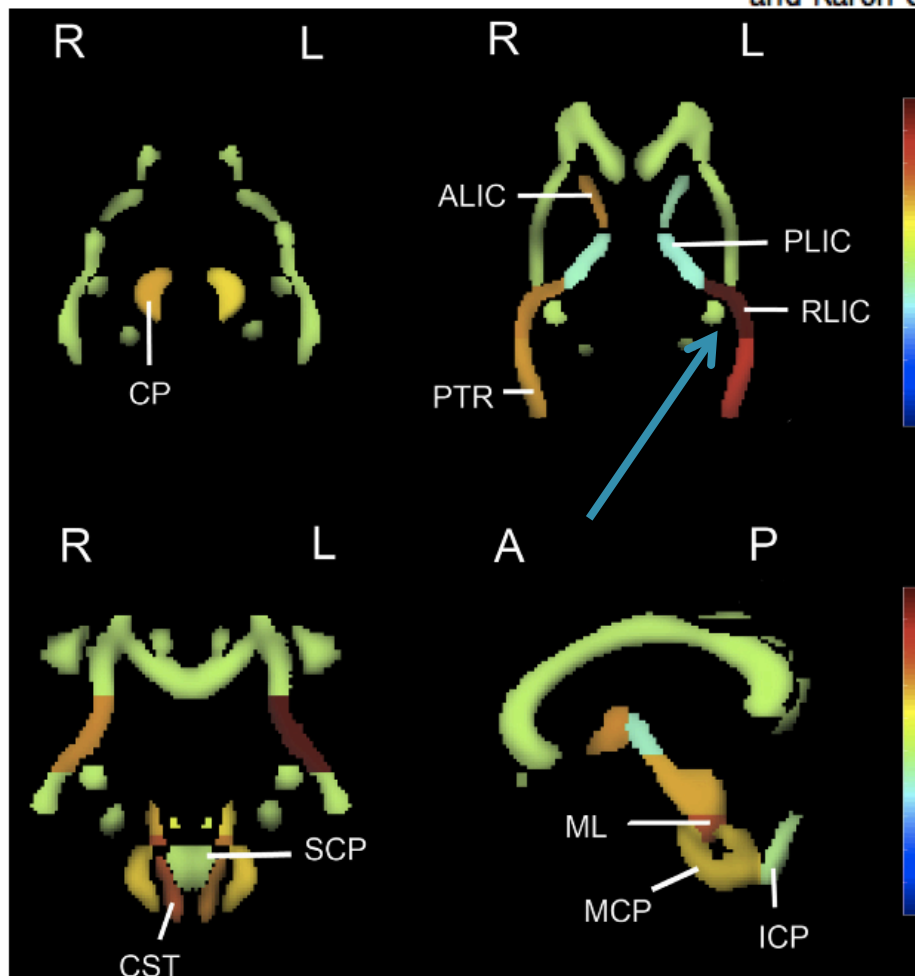
	Controls	ADHD	DCD	DCD + ADHD
Age in years	11.3 ± 2.8	12.5 ± 2.9	13.0 ± 2.5	11.5 ± 3.0
N (females)	23 (12)	21 (1) ^a	7 (2)	18 (4)
Left-handed	2	2	1	4
WASI IQ	113.0 ± 13.4	105.4 ± 11.8	107.0 ± 13.0	104.8 ± 15.8
CPRSC-C score	51.7 ± 9.5	72.5 ^{a,b} ± 8.7	50.9 ± 3.9	72.2 ^{a,b} ± 12.0
CPRSC-H score	51.6 ± 9.4	71.1 ^{a,b} ± 14.1	49.7 ± 3.4	65.0 ^{a,b} ± 13.8
MABC-2 score	10.1 ± 2.2	9.5 ± 1.6	5.1 ^{a,c} ± 2.0	4.4 ^{a,c} ± 2.2



Brain Connectomics of Visual-Motor Deficits in Children with Developmental Coordination Disorder

(J Pediatr 2016;169:21-7).

Julie Debrabant, MSc¹, Guy Vingerhoets, PhD², Hilde Van Waelvelde, PhD¹, Alexander Leemans, PhD³, Tom Taymans, MSc¹, and Karen Caeyenberghs, PhD^{1,4}



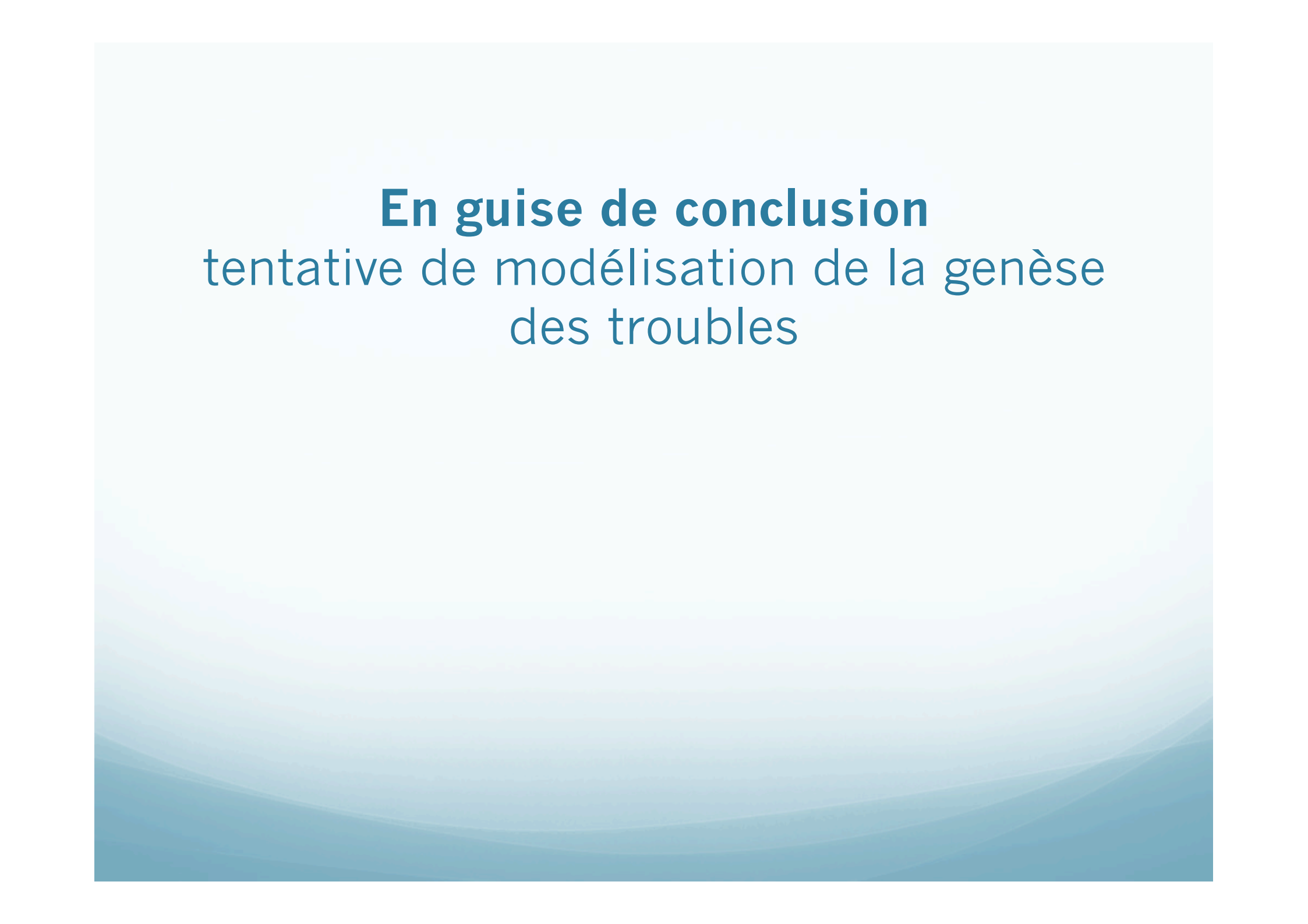
FA significantly differed between children with DCD and those with typical development in the left retrolenticular limb of the internal capsule. The fibers within convey mainly visual information and lie proximal to sensorimotor loops that subserve coordinated movement.

In addition to the group differences, our results indicate that DCD-related FA reductions in the left retrolenticular limb of the internal capsule were associated with deficits in eye-hand coordination

Nodal efficiency at the cerebellar lobule VI and right parietal superior gyrus were found significant predictors to discriminate between children with DCD and those with typical development.

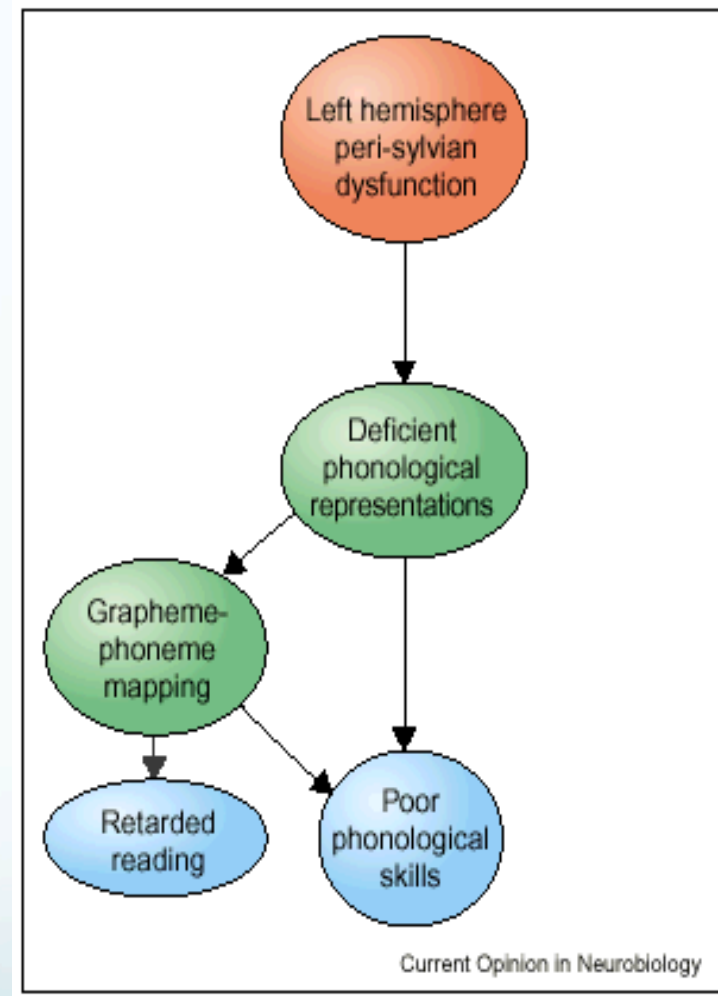
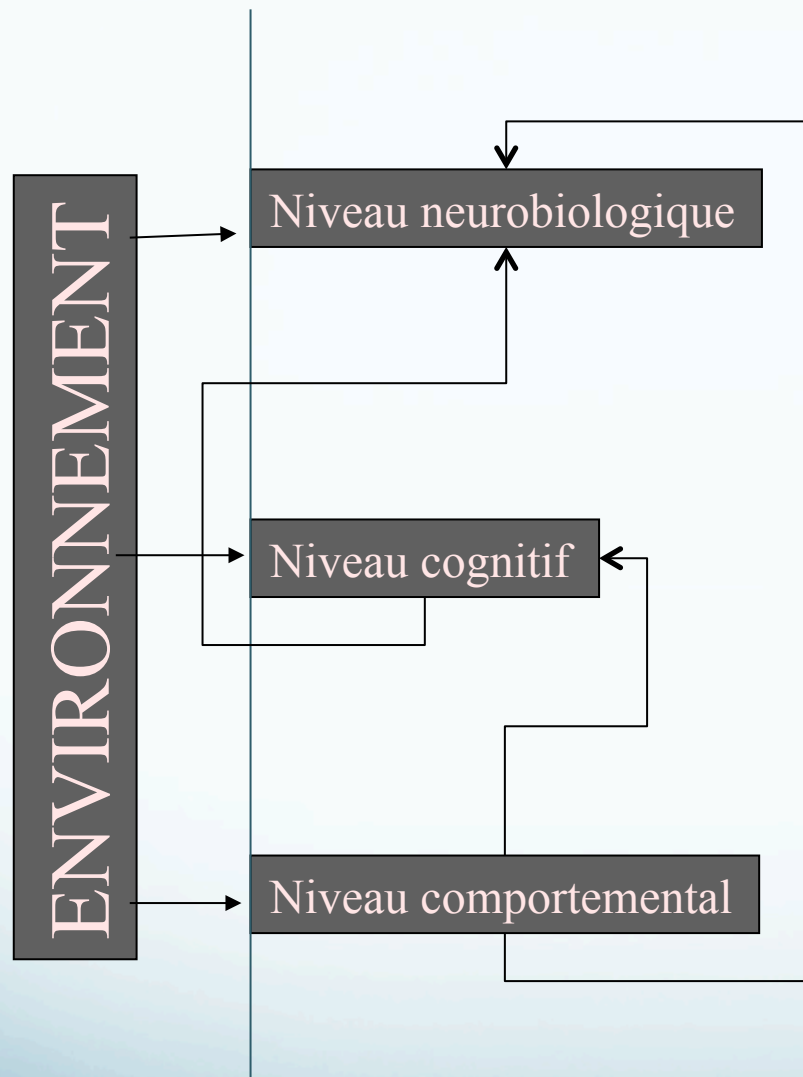
En définitive

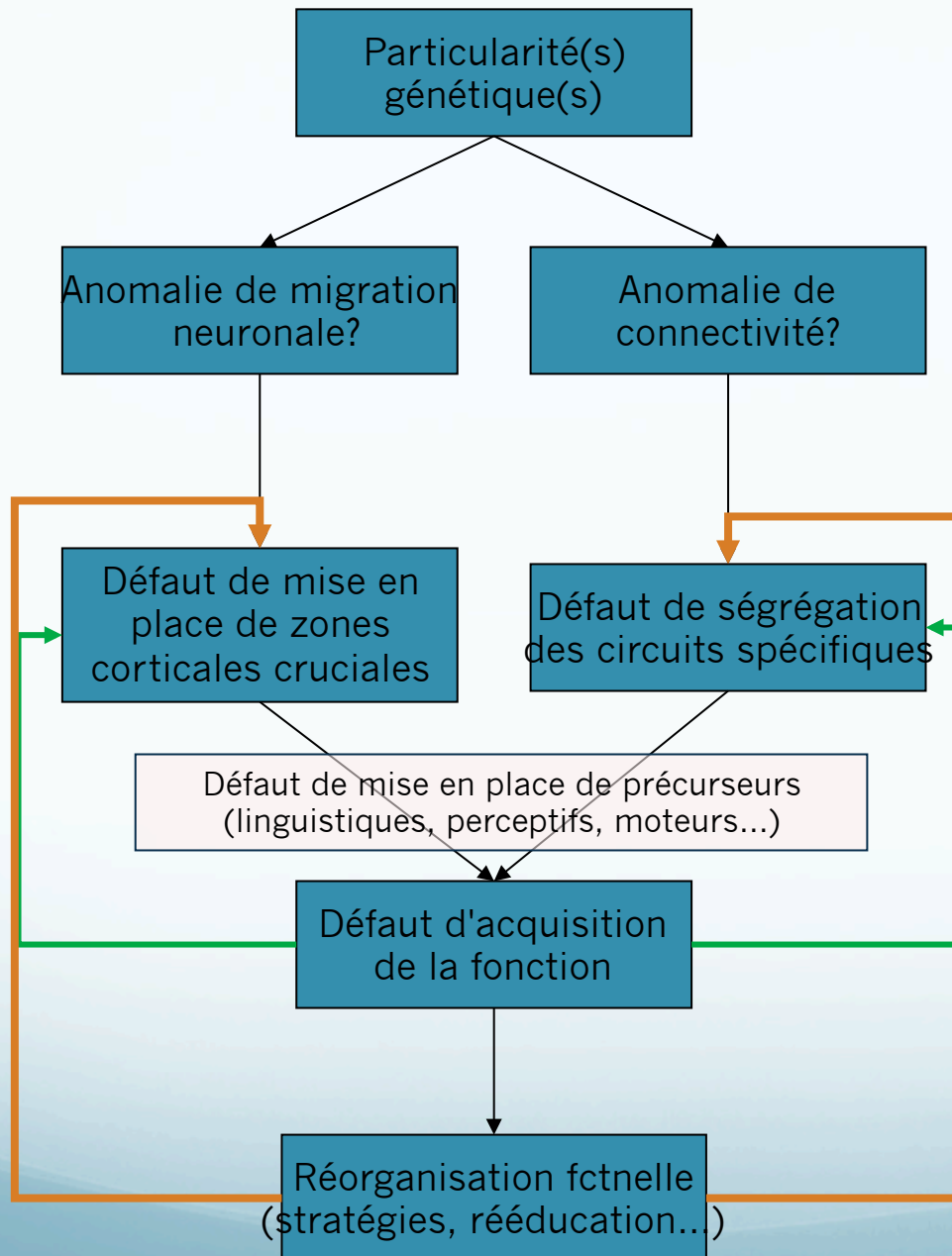
- Les différents syndromes "dys", malgré leur diversité, pourraient bien correspondre à un mécanisme neurodéveloppemental similaire, réalisant une dysconnexion fonctionnelle entre deux ou plusieurs modules traitant l'information simultanément sous des modalités différentes, compromettant l'intégration multimodale nécessaire à certains apprentissages
- La manifestation de ce défaut d'intégration serait un trouble d'apprentissage, qui se manifesterait de façon d'autant plus nette que trois éléments seraient présents:
 - Le caractère multimodal de la connaissance à acquérir
 - La simultanéité temporelle des divers événements
 - La répétition un grand nombre de fois devant aboutir à une automatisation de la procédure (cf synapse de Hebb)

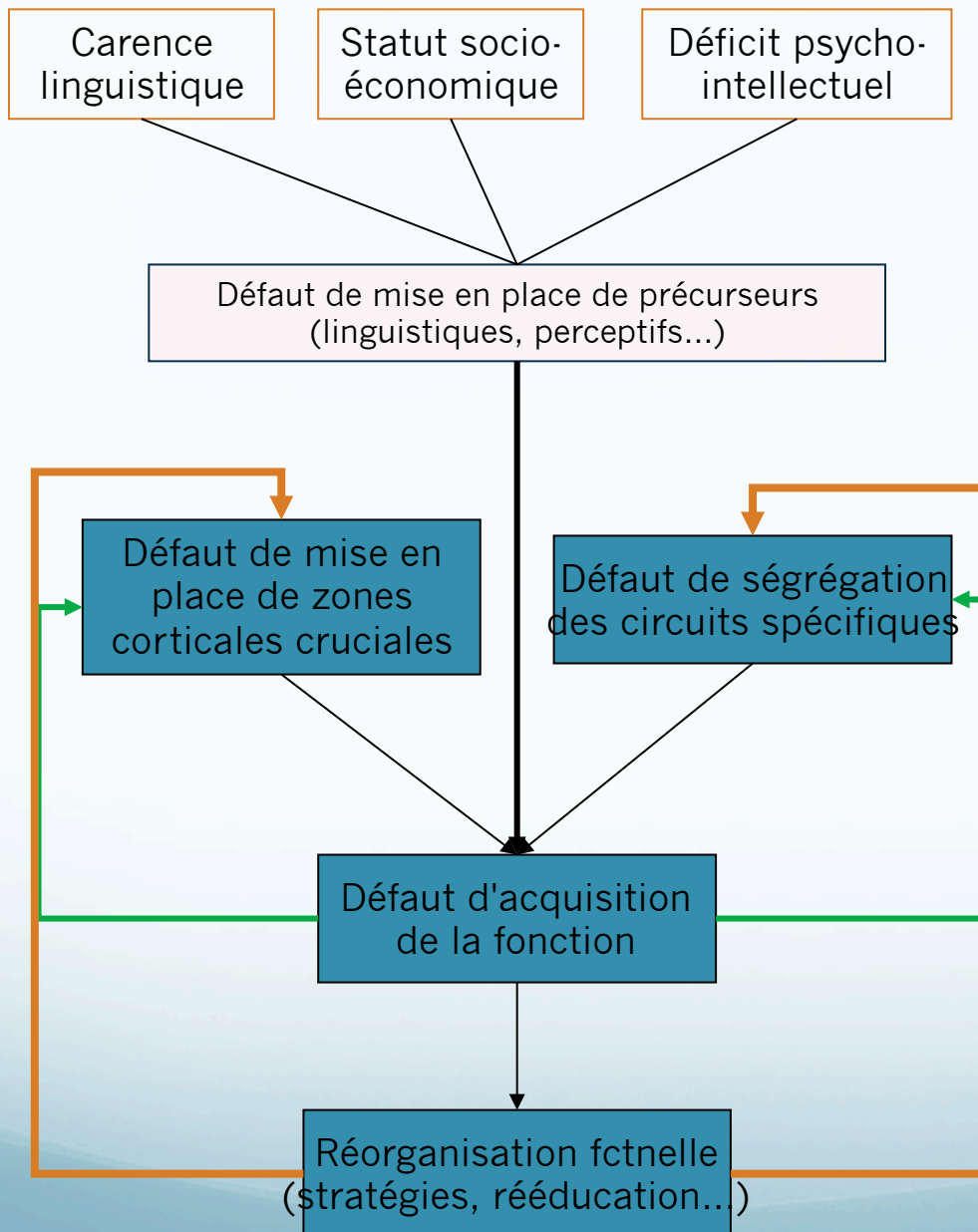
The background of the slide features a series of horizontal, wavy lines in various shades of blue, creating a sense of movement and depth. The lines are more pronounced in the lower half of the slide, where they form a series of overlapping, undulating shapes that resemble a stylized landscape or a series of waves. The upper half of the slide is a solid, light blue color, providing a clean backdrop for the text.

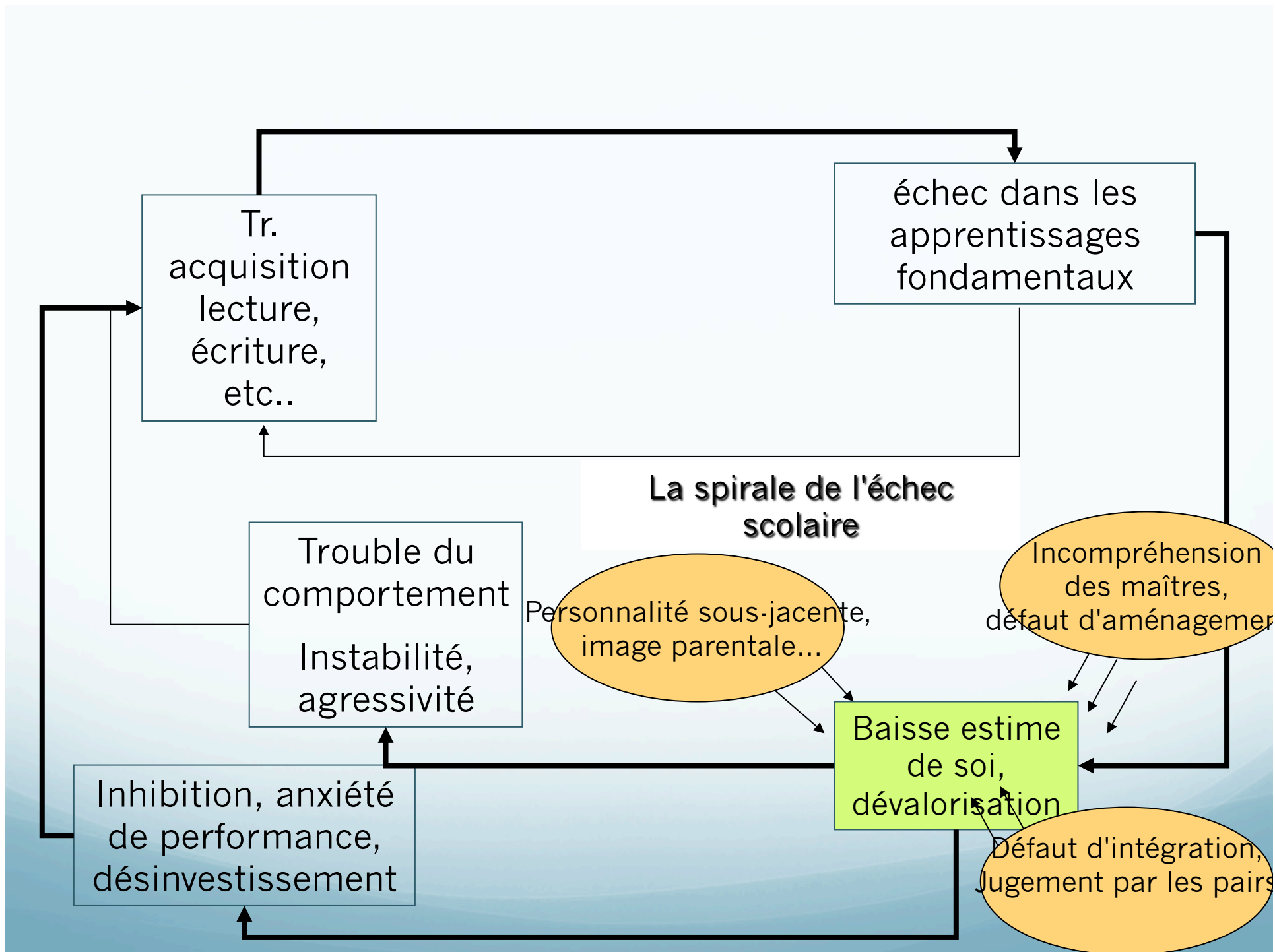
En guise de conclusion

tentative de modélisation de la genèse des troubles

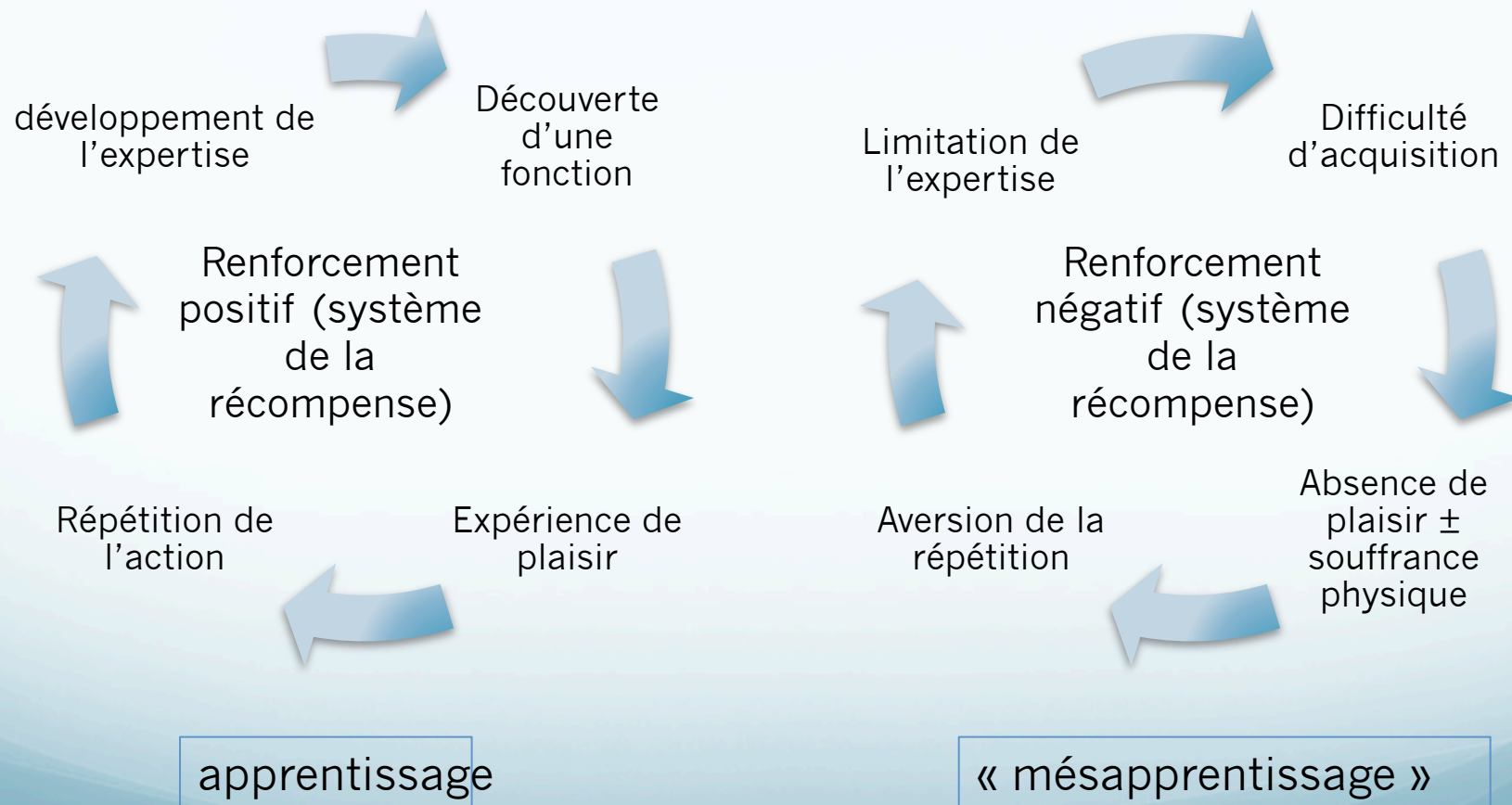








L'apprentissage : entre contrainte et plaisir = la motivation à apprendre



Le lien nécessaire entre soins et pédagogie

- La nature même du trouble, sa génèse quasi-exclusive dans le milieu scolaire, rend nécessaire pour le rééducateur la prise en compte optimale de la situation scolaire au jour le jour.
- La complexité de la problématique rend pratiquement inévitable une relation étroite entre soignant et pédagogue et une réflexion commune sur les outils et les stratégies.
- La lourdeur rééducative est souvent un fardeau inaccessible pour beaucoup de familles limitées dans leurs déplacements et leurs dépenses. D'où l'avantage majeur d'une rééducation sur le lieu même de la scolarisation de l'enfant et d'un programme intégré incluant toutes les interventions.
- Les capacités attentionnelles limitées de la quasi-totalité des cas rend nécessaire une adaptation au cas par cas des plannings et une ré-évaluation de la finalité de l'apprentissage (notion de programme).

