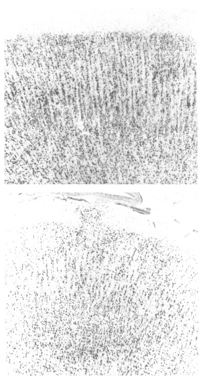
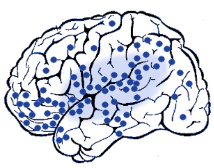
Neurologie de la dyslexie : données récentes de la recherche

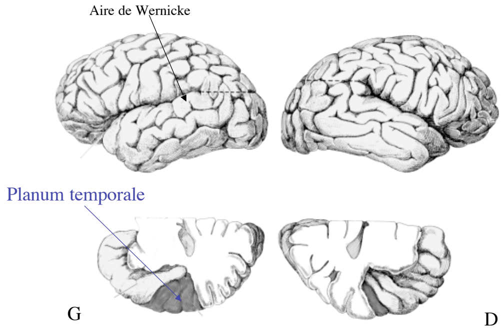
Michel Habib

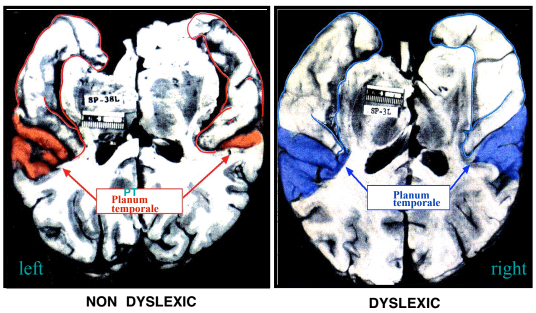
I/ Le cerveau du dyslexique





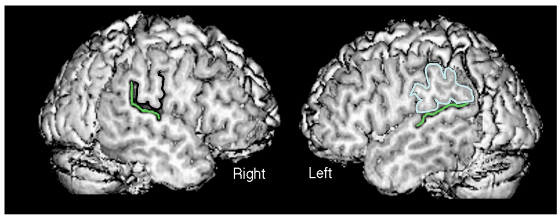
Ectopies sur le cerveau dyslexique (Galaburda et al., 1979, 1985)

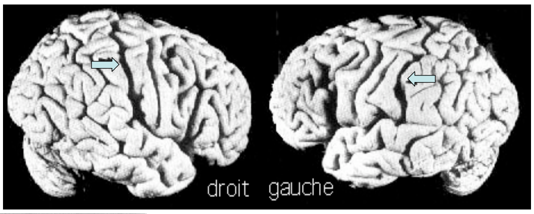


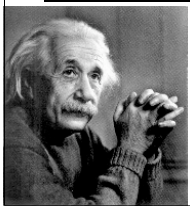


Absence of planum asymmetry in the dyslexic brain
From Galaburda et al., 1979; 1985

Dyslexie : opercule pariétal gauche plus vaste







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

ELSEVIER
Brain and Language xxx (2006) xxx–xxx
www.elsevier.com/locate/b&l

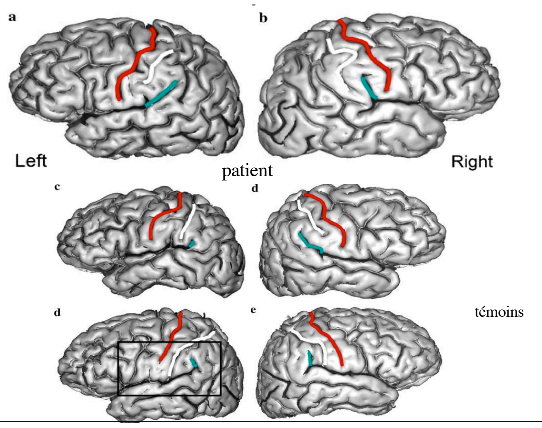
Neuroanatomical and behavioral asymmetry in an adult compensated dyslexic ☆

Christine Chiarello [a,*], Linda J. Lombardino [b], Natalie A. Kacinik [a,c], Ronald Otto [d], Christiana M. Leonard [b]

Table 1
Standardized test results for T.F.

Category	Skill (measure)	Score*	Percentile
Nonverbal IQ	(Ravens Advanced Progressive Matrices)	29	86
Reading	Untimed word reading aloud (WRMT-R Word Identification)	93	32
	Timed word reading aloud (TOWRE Sight Word Efficiency)	83	13
	Untimed nonword reading aloud (WRMT-R Word Attack)	92	29
	Timed nonword reading aloud (TOWRE Phonemic Decoding Efficiency)	94	35
	Word comprehension (WRMT-R Word Comprehension)	109	72
	Text comprehension (WRMT-R Passage Comprehension)	124	95
Spelling	Untimed written spelling of spoken words (WRAT3)	104	61
Grammar	Grammaticality judgment (CASL Grammaticality Judgment)	92	30
	Syntax Construction (CASL Syntax Construction)	100	50
Rapid naming	Letter naming (CTOPP Rapid Letter Naming)	10	50
	Digit naming (CTOPP Rapid Digit Naming)	10	50
Span memory	(WAIS-R Digits Forward)	11	52
	(WAIS-R Digits Backward)	6	14
Math	Timed arithmetic computations (WJ COG III Math Fluency)	96	39
	Untimed computations and solving equations (WJ COG III Calculation)	112	78

* Note: Scores listed are standard scores for all tests except WAIS digit spans, and Raven's Matrices.



RESEARCH REPORT
Cortex, (2006) 42, 1107-1118

BRAIN MORPHOLOGY AND NEUROPSYCHOLOGICAL PROFILES IN A FAMILY DISPLAYING DYSLEXIA AND SUPERIOR NONVERBAL INTELLIGENCE

Jason G. Craggs[1], Juliana Sanchez[1], Michelle Y. Kibby[2], Jeffrey W. Gilger[3] and George W. Hynd[4]
([1]Center for Clinical and Developmental Neuropsychology, University of Georgia, Athens, GA, USA; [2]Washington State University, Pullman, WA, USA; [3]California State University, Los Angeles, CA, USA; [4]Purdue University, West Lafayette, IN, USA)

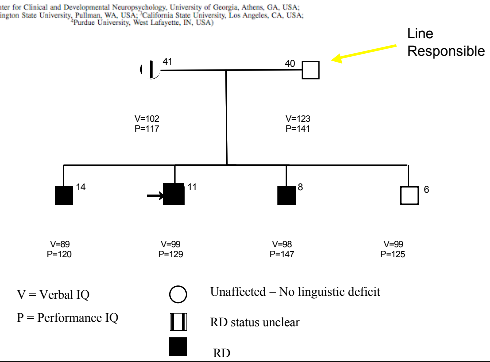
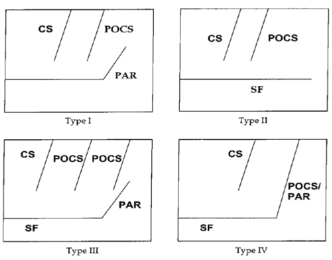
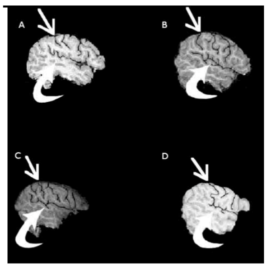


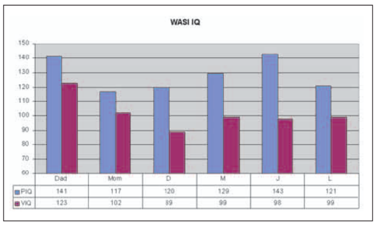
TABLE II
Frequency of typology presentation in Steinmetz et al.'s (1990) sample

Type	Left hemisphere (62)	Right hemisphere (58)	Overall (120)
I	41 (66%)	48 (83%)	89 (74.16%)
II	9 (15%)	–	9 (7.5%)
III	10 (16%)	2 (3%)	12 (10%)
IV	2 (3%)	8 (14%)	10 (8.33%)

Note: Reported frequencies are combined from post-mortem and MRI data.
Parentheses indicate number of hemispheres used.







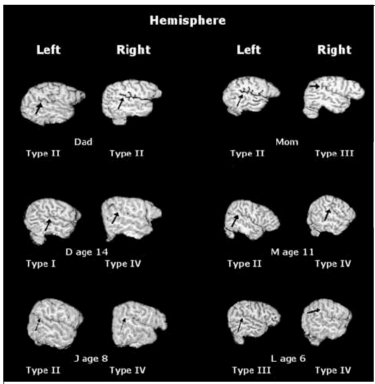
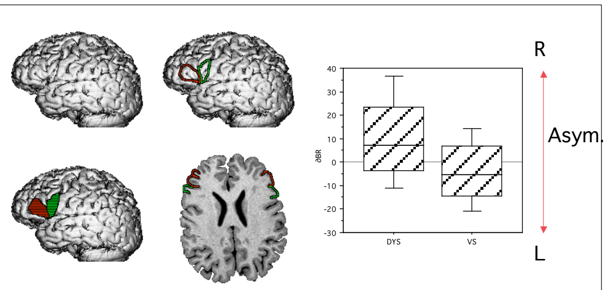


TABLE X

Steinmetz et al. (1990) prevalence rates in the current family

	Left hemisphere	Right hemisphere	Overall
Type I	16%	0	8%
Type II	67%	16%	42%
Type III	16%	16%	17%
Type IV	0	67%	33%



Robichon et al. (2000) : réduction (inversion) d’asymétrie de l’aire de Broca chez les adultes dyslexiques

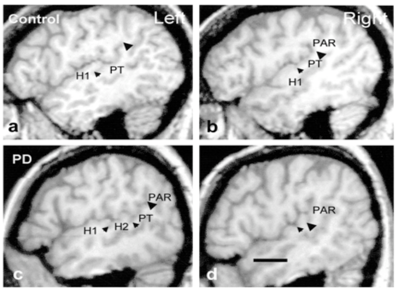
Anatomical Risk Factors for Phonological Dyslexia

Christiana M. Leonard, Mark A. Eckert, Linda J. Lombardino[1], Thomas Oakland[2], John Kranzler[2], Cecile M. Mohr, Wayne M. King and Alan Freeman

Department of Neuroscience, [1]Department of Communication Sciences and Disorders, and [2]Department of Education Foundations, University of Florida Brain Institute, Gainesville, FL 32611, USA

Leonard et al. (2001) : extreme leftward asymmetry of temporal and parietal cortices

(15 college students vs 15 dyslexic adolescents)



Cerebral Cortex Feb 2001;11:148–157; 1047–3211/01/$4.00

DOI: 10.1093/brain/awg026 *Brain* (2003), **126**, 482–494

Anatomical correlates of dyslexia: frontal and cerebellar findings

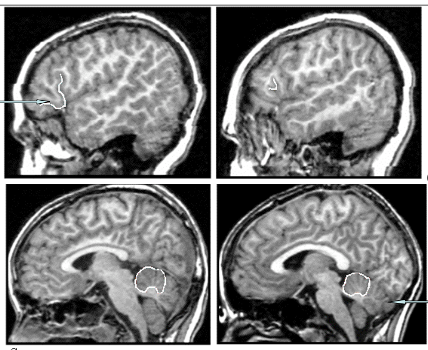
Mark A. Eckert,[1] Christiana M. Leonard,[1] Todd L. Richards,[2] Elizabeth H. Aylward,[2] Jennifer Thomson[3] and Virginia W. Berninger[3]

[1]Department of Neuroscience, McKnight Brain Institute of the University of Florida, Gainesville, FL, Departments of [2]Radiology and [3]Education, University of Washington, Seattle, WA, USA

Correspondence to: Mark Eckert, PO Box 100244, Department of Neuroscience, University of Florida McKnight Brain Institute, Gainesville, FL 32610, USA E-mail: eckert@ufl.edu

Aire de Broca

témoin



dyslexique

cervelet

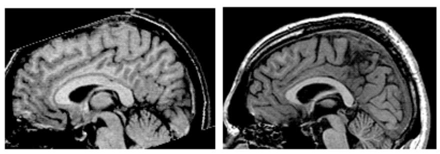
C.

DOI: 10.1093/brain/awg026 Brain (2003), 126, 482–494

Anatomical correlates of dyslexia: frontal and cerebellar findings

Mark A. Eckert,[1] Christiana M. Leonard,[1] Todd L. Richards,[2] Elizabeth H. Aylward,[2] Jennifer Thomson[3] and Virginia W. Berninger[3]

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]

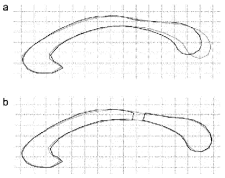


Fig. 4. Comparing the control (shown in grey) and dyslexic (shown in black) average CC shapes (prototypes) (a). The dyslexic prototype is cut into two pieces that are aligned separately at rostrum and splenium (b). The posterior midbody region in the dyslexic subjects is significantly shorter than in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

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

Table 2
Mean values (SD) for CC area measurements

	Dyslexic group, $n = 20$ (mm^2)	Control group, $n = 20$ (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)

Modern morphological imaging (with MRI)

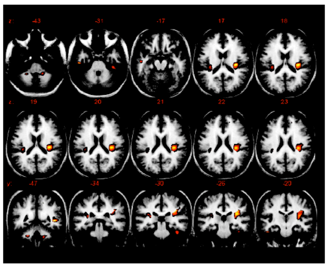
Voxel-based morphometry — Averages grey and/or white matter density

Diffusion tensor imaging — Looks at regions of different fibers orientation (anisotropy)

Whole-brain analysis (non R.O.I.) methods

Regional reductions of gray matter volume in familial dyslexia

S.M. Brambati, BS; C. Termine, MD; M. Ruffino, BS; G. Stella, PhD; F. Fazio, MD; S.F. Cappa, MD; and D. Perani, MD



- 10 dyslexic subjects (5 females, 5 males; age range 13 to 57 years, mean 31.6 years) belonging to four different families characterized by the presence of a proband with persistent, severe developmental dyslexia
- 11 matched controls
- Regions of reduction in grey matter volume
  - PT bilat
  - inferior temporal bilat
  - Left sup and inf tempor gyrus

NEUROLOGY 2004;63:742–745

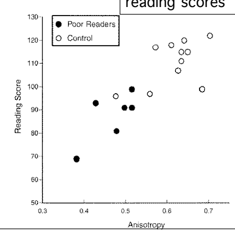
Neuron, Vol. 25, 493–500, February, 2000, Copyright ©2000 by Cell Press

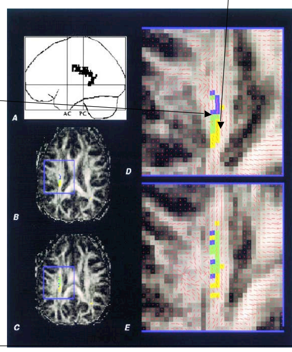
Microstructure of Temporo-Parietal White Matter as a Basis for Reading Ability: Evidence from Diffusion Tensor Magnetic Resonance Imaging

Torkel Klingberg,*§ Maj Hedehus,† Elise Temple,* Talya Salz,*‡ John D. E. Gabrieli,*† Michael E. Moseley,† and Russell A. Poldrack*
*Department of Psychology
†Department of Radiology
Stanford University
Stanford, California 94305
‡Scientific Learning Corporation
Berkeley, California 94704

VOI of maximal anisotropy difference between 6 adult dyslexic and 11 controls

Significant correlation with reading scores

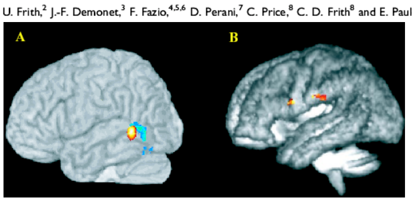




doi:10.1093/brain/awh579 Brain (2005) Page 1 of 9

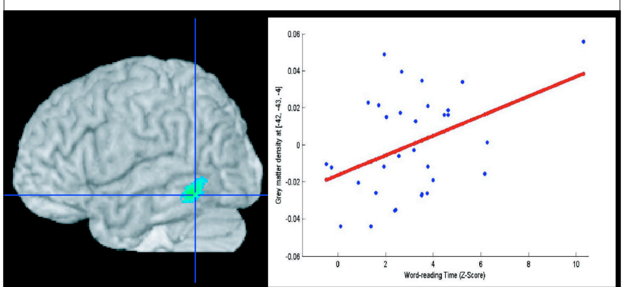
Brain abnormalities underlying altered activation in dyslexia: a voxel based morphometry study

G. Silani,[1] U. Frith,[2] J.-F. Demonet,[3] F. Fazio,[4,5,6] D. Perani,[7] C. Price,[8] C. D. Frith[8] and E. Paulesu[1]



decrease
increase
Gray matter dyslex/controls

decrease
White matter dyslex/controls



Silani et al. (2005) : a lateral temporal zone of increased voxel density correlates inversely with reading performance

CHILDREN'S READING PERFORMANCE IS CORRELATED WITH WHITE MATTER STRUCTURE MEASURED BY DIFFUSION TENSOR IMAGING

Gayle K. Deutsch[1*], Robert F. Dougherty[1], Roland Bammer[2], Wai Ting Siok[1], John D.E. Gabrieli[1] and Brian Wandell[1]

([1]Department of Psychology, Stanford University, Stanford, CA, USA; [2]Department of Radiology, Stanford University, Stanford, CA, USA)

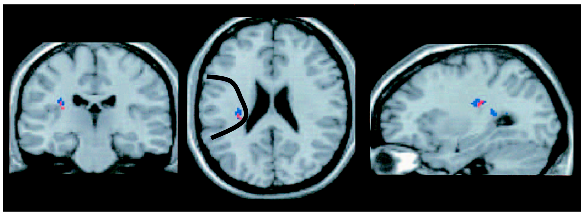
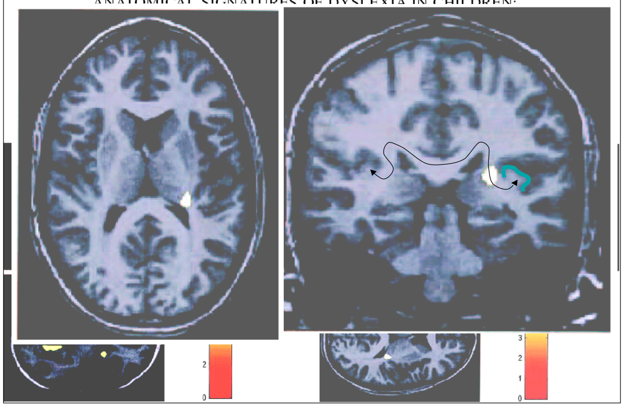


Fig. 1 – Brain regions that showed significant differences in normal and poor reading children are presented. Left temporo-parietal regions are shown in three slices of the SPM99 T1 canonical brain. Red indicates voxels with significant group differences in FA and blue indicates voxels with significant differences in CI.

SPECIAL ISSUE Cortex, (2005) 41, 304-315

ANATOMICAL SIGNATURES OF DYSLEXIA IN CHILDREN:



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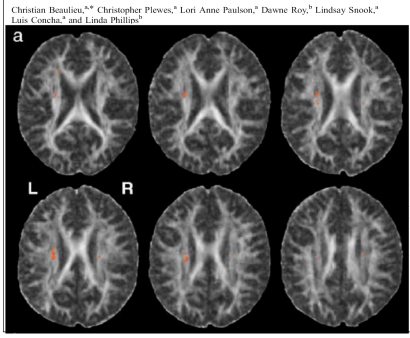
NeuroImage

www.elsevier.com/locate/ynimg
NeuroImage 25 (2005) 1266–1271

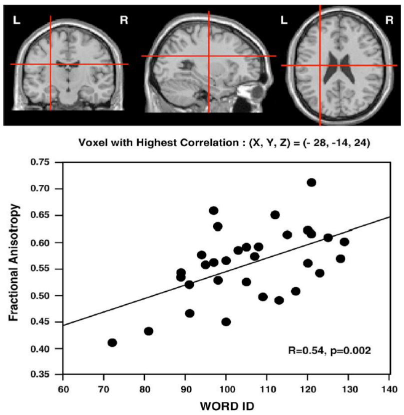
Imaging brain connectivity in children with diverse reading ability

Christian Beaulieu,[a,*] Christopher Plewes,[a] Lori Anne Paulson,[a] Dawne Roy,[b] Lindsay Snook,[a] Luis Concha,[a] and Linda Phillips[b]



•32 volunteers (14 male, 18 female).
•8.3–12.9 years mean 11.1 ± 1.3 years
•30/32 right handed.
• aptitudes en lecture variables évaluées par un test d'identification de mots

Corrélation avec performance en lecture : voxels de plus forte corrélation



Voxel of higher correlation with word identification rate

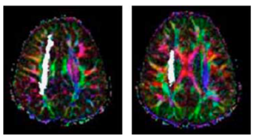
Neuropsychologia 44 (2006) 2178–2188

Left lateralized white matter microstructure accounts for individual differences in reading ability and disability

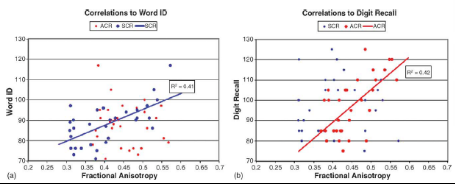
Sumit N. Niogi, Bruce D. McCandliss*

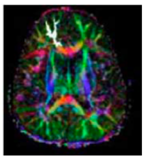
Structure	Word ID	Word Attack	Digit Recall
CS right	0.38	0.14	0.35
CS left	0.58	0.25	-0.11
SCR right	-0.18	-0.02	-0.22
SCR left	0.64	0.37*	0.15
SLF right	-0.22	0.10	0.16
SLF left	-0.12	0.03	-0.16
ACR right	-0.18	-0.30	0.66
ACR left	-0.08	-0.11	0.61
PLIC right	0.28	0.05	0.17
PLIC left	-0.21	0.02	-0.19
LAT SCR	-0.61	-0.28	-0.26
LAT CS	-0.23	-0.12	0.32

DTI : 31 children, 6-10yr
21 Nl, 10 dlx



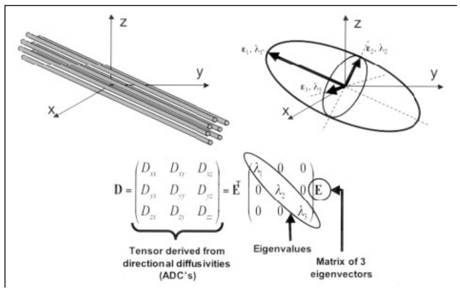
Centrum semi-ovale



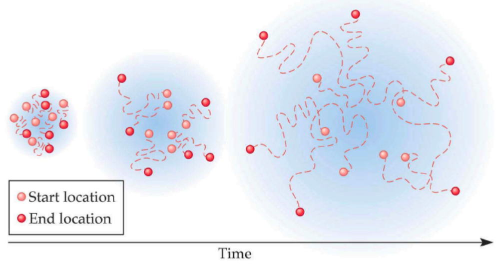


anterior corona radiata

Diffusion Anisotropy

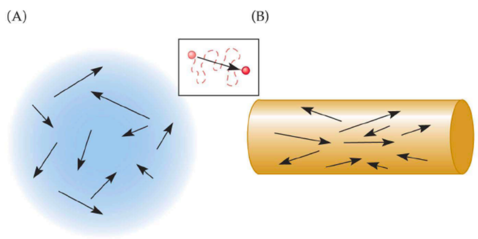


5.17 Diffusion. Over time, molecules within gases or liquids will move freely through the medium.



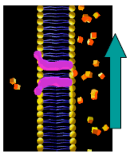
FUNCTIONAL MAGNETIC RESONANCE IMAGING, Figure 5.17 © 2004 Sinauer Associates, Inc.

5.18 Isotropic and anisotropic diffusion.



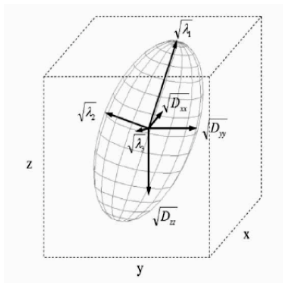
FUNCTIONAL MAGNETIC RESONANCE IMAGING, Figure 5.18 © 2004 Sinauer Associates, Inc.

H_2O Diffusion Probes Microscopic Structures In the Brain



Along the axon, within the cytoskeleton, there is a large Apparent Diffusion Coefficient (ADC)

Mathematical Description:
An Ellipsoid (Diffusion Tensor)



This surface summarizes the mean distance from the starting position that a typical particle (water molecule) will travel in diffusion time T = ½

In summary (1) : brain imaging

- Despite convincing evidence of abnormal lateralization in dyslexics, early emphasis put on brain asymmetry proves to be largely irrelevant for explaining dyslexia
- There is now strongly supportive evidence for a specific locus of gray and white matter changes in the superior (mainly left) temporal region
- This locus probably is involved in abnormal auditory processing in dyslexics, but also compatible with interhemispheric imbalance

Neurological and MRI profiles of children with developmental language impairment

Developmental Medicine & Child Neurology 2000, 42: 470–475

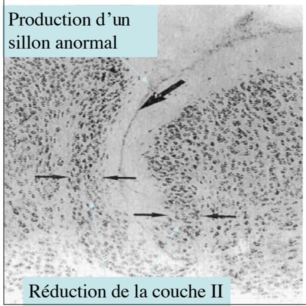
Doris Trauner* MD, Departments of Neurosciences and Pediatrics, University of California, San Diego School of Medicine;
Beverly Wulfeck PhD, Department of Communication Disorders, San Diego State University, San Diego, CA;
Paula Tallal PhD, Center for Molecular and Behavioral Neuroscience, Rutgers University, Newark, NJ;
John Hesselink MD, Department of Radiology, University of California, San Diego School of Medicine, La Jolla, CA, USA.

particularly walking. On neurological examination, abnormalities were found in 70% of the children with LI and only 22% of the control children. The most common abnormalities in the LI group included obligatory synkinesis, fine motor impairments, and hyperreflexia. The children with LI with the most abnormal neurological findings had the lowest language scores. Finally, 12 of 35 children with LI had abnormalities on their MRI scan, while none of the 27 control children had abnormal scans. Abnormal findings included ventricular enlargement (in five), central volume loss (in three), and white matter abnormalities (in four). These findings suggest that developmental LI is not an isolated finding but is indicative of more widespread nervous system dysfunction. Children with LI may need more comprehensive intervention programs than language therapy alone, depending on their other areas of dysfunction. Early identification of such problems may allow for more successful remediation.

Table II: Types of abnormalities on neurological examination of children with language impairment (LI) and control children

Abnormality	*Children with LI n (%)*	*Control children n (%)*	*p*
Obligatory synkinesis	30 (42)	6 (7)	0.001
Fine motor impairment	25 (35)	4 (5)	0.001
Hyperreflexia	10 (14)	3 (4)	0.038
Oromotor apraxia	9 (13)	1 (1)	0.004
Gross motor impairment	8 (11)	5 (6)	ns
Sensory deficit	7 (10)	0	0.004
Hypotonia	4 (6)	3 (4)	ns
Muscle weakness	2 (3)	1 (1)	ns
Ataxia	1 (1)	0	ns
Tremor	1 (1)	1 (1)	ns
Microcephaly	1 (1)	0	ns

Rendre des rats dyslexiques ? La microgyrie induite

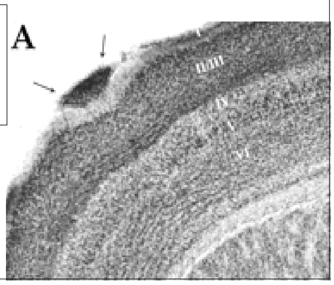


Lésions de « freezing » de la surface corticale J1 post-natal
Observation de malformation sur le cerveau adulte
Modification comportementale : trouble de discrimination temporelle
Seulement chez les rats mâles (les seuls à avoir des anomalies thalamiques associées)

Galaburda et al., 2001

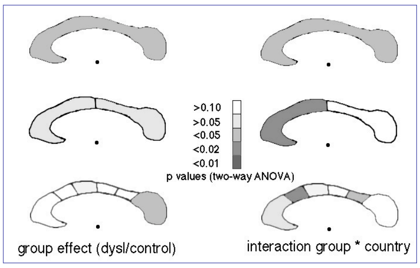
Souris dyslexiques : des ectopies génétiquement déterminées

2 souches de souris (NZB et NXSM) présentent à la naissance des anomalies corticales et des troubles d'apprentissage spatio-moteur (labyrinthe)



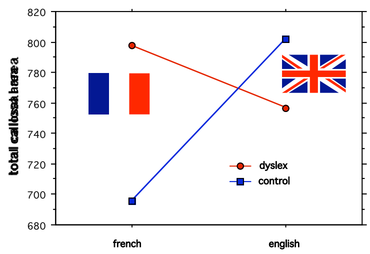
Jenner AR, Galaburda AM, Sherman GF, 2000.

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



Modifications neuroanatomiques dans la dyslexie : quelle réalité? quelle signification?

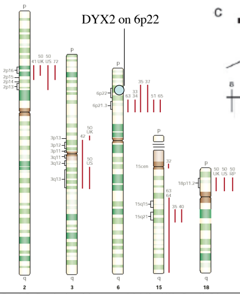
- Le cerveau du dyslexique/dysphasique est-il plus symétrique?
  - oui, mais pas là où on croyait
  - cette symétrie n'est pas nécessairement liée à un plus fort développement du côté droit
- Les relations interhémisphériques sont- elles différentes?
  - oui, en général dans le sens d'une hypertrophie
  - mais dans certains cas: hypotrophie

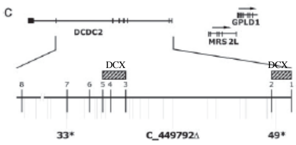
Modifications neuroanatomiques dans la dyslexie : quelle signification?

- L'excès possible de neurones et/ou connexions interhémisphériques n'est pas nécessairement lié à des événements péri-nataux (rôle de plus en plus probable de facteurs liés à l'expérience et l'entraînement)
- Les différences d'asymétries et de connexions interhémisphériques
  - ne sont pas nécessairement la cause du déficit
  - pourraient n'être que des témoins d'un processus dysmaturatif plus global

DCDC2 is associated with reading disability and modulates neuronal development in the brain

Haiying Meng, Shelley D. Smith, Karl Hager, Matthew Held, Jonathan Liu, Richard K. Olson, Bruce F. Pennington, John C. DeFries, Joel Gelernter, Thomas O'Reilly-Pol, Stefan Somlo, Pawel Skudlarski, Sally E. Shaywitz, Bennett A. Shaywitz, Karen Marchione, Yu Wang, Murugan Paramasivam, Joseph J. LoTurco, Grier P. Page, and Jeffrey R. Gruen





DCDC2 : deletion in strong linkage with reading performance

Contains doublecortine (DCX) gene domain (responsible for lissencephaly & double cortex syndrome)

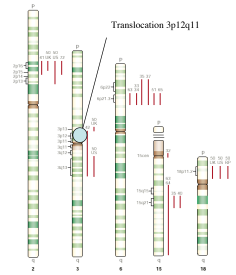
RNA present in cerebral tissue from reading-associated regions

Thus should be associated to abnormal migration

OPEN ACCESS Freely available online PLoS GENETICS

The Axon Guidance Receptor Gene *ROBO1* Is a Candidate Gene for Developmental Dyslexia

Katariina Hannula-Jouppi[1], Nina Kaminen-Ahola[1], Mikko Taipale[1,2], Ranja Eklund[1], Jaana Nopola-Hemmi[1,3], Helena Kääriäinen[4,5], Juha Kere[1,6*]



ROBO1 has a role in regulating axon crossing across the midline between brain hemispheres and guidance of neuronal dendrites

PLoS Genetics | www.plosgenetics.org 0467 October 2005 | Volume 1 | Issue 4 | e50

CHILDHOOD DEVELOPMENTAL DISORDERS PERSPECTIVE
nature neuroscience

From genes to behavior in developmental dyslexia

Albert M Galaburda, Joseph LoTurco, Franck Ramus, R Holly Fitch & Glenn D Rosen

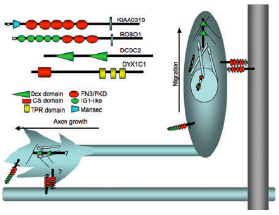
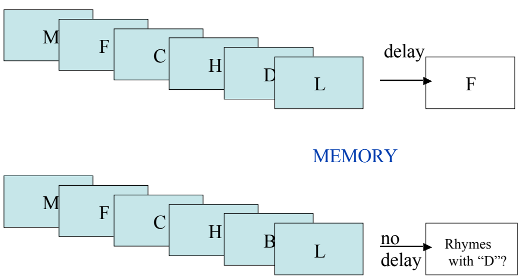


Figure 1 Protein domains and possible functions. KIAA0319 and ROBO1 serve as transmembrane adhesion molecules and receptors that guide axons to appropriate targets. DCDC2, and perhaps DYX1C1, are proposed to act as downstream targets that then serve to modulate changes in cytoskeletal dynamic processes involved in the motility of developing neurons. Critical future studies must now address whether there are links between the functions of these proteins in migration and axonal pathfinding.

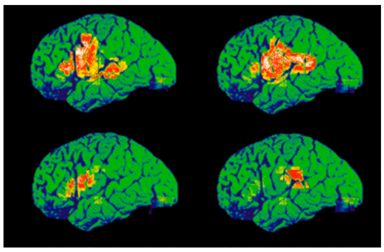
VOLUME 9 | NUMBER 10 | OCTOBER 2006 NATURE NEUROSCIENCE

II/ Imagerie fonctionnelle au cours de la lecture et d'épreuves phonologiques



Paulesu et al., 1996

RHYME

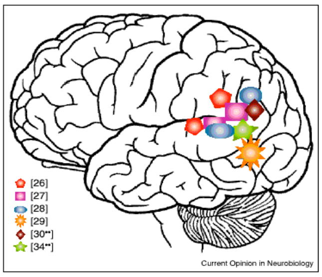


CONTROLS

DYSLEXICS

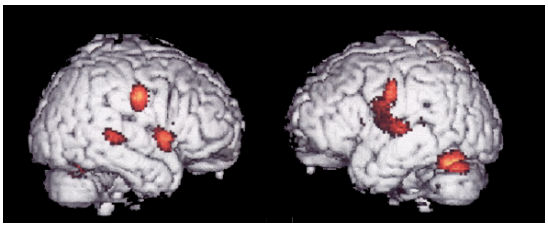
RHYME MEMORY

Paulesu et al., 1996

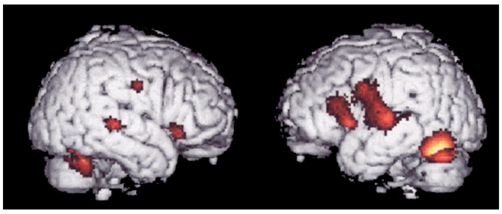


Elise Temple (2002) : Neural disruption of phonological processing in dyslexia

reading words-rest (cont)



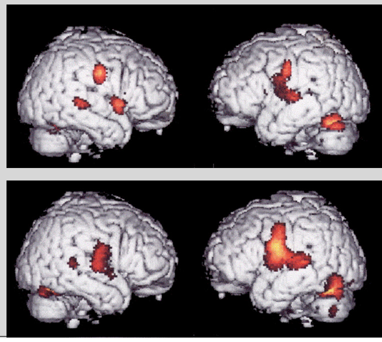
reading nonwords-rest (cont)

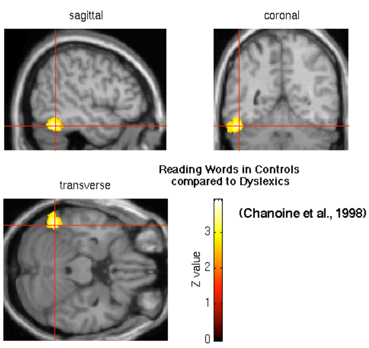


words-rest

controls

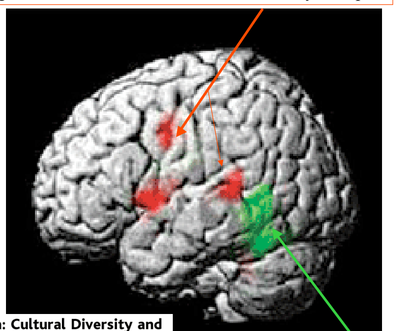
dyslexics





(Chanoine et al., 1998)

également activé chez les témoins et les dyslexiques

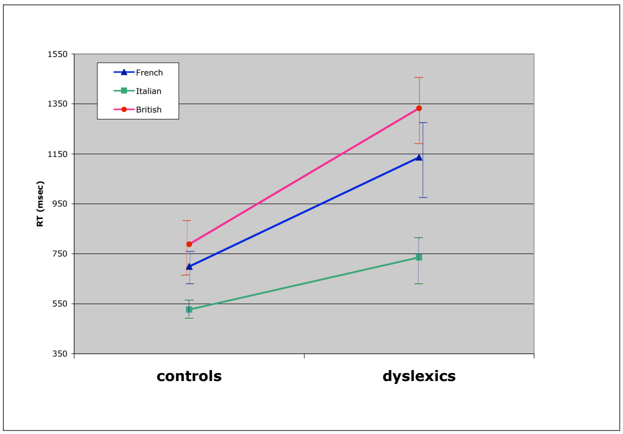


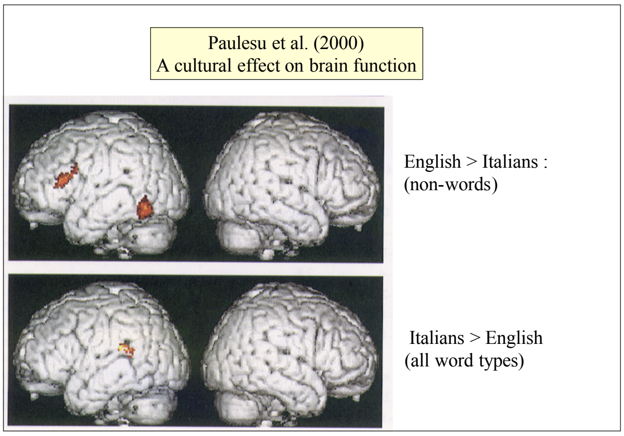
Paulesu et al., 2001

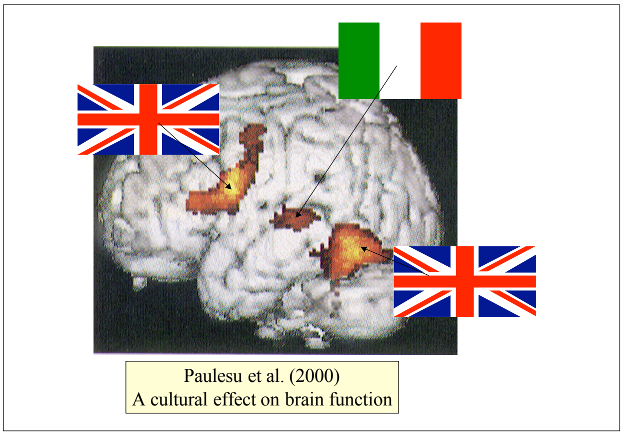
Dyslexia: Cultural Diversity and Biological Unity

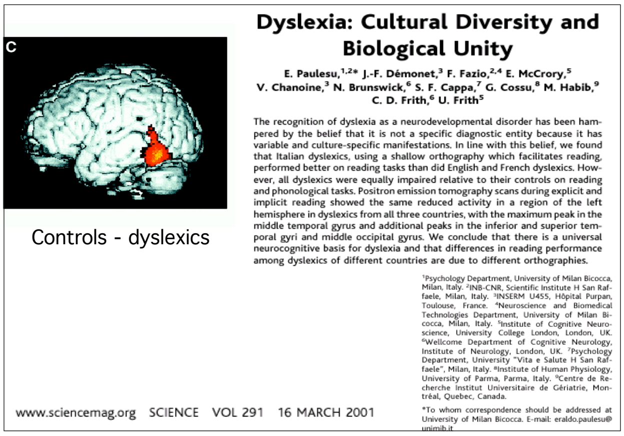
E. Paulesu,[1,2*] J.-F. Démonet,[3] F. Fazio,[2,4] E. McCrory,[5] V. Chanoine,[3] N. Brunswick,[6] S. F. Cappa,[7] G. Cossu,[8] M. Habib,[9] C. D. Frith,[6] U. Frith[5]

significativement moins activé chez les dyslexiques









Dyslexia: Cultural Diversity and Biological Unity

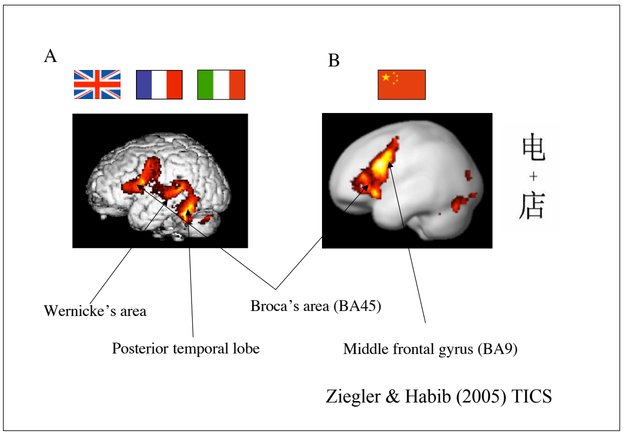
E. Paulesu,[1,2]* J.-F. Démonet,[3] F. Fazio,[2,4] E. McCrory,[5] V. Chanoine,[3] N. Brunswick,[6] S. F. Cappa,[7] G. Cossu,[8] M. Habib,[9] C. D. Frith,[6] U. Frith[5]

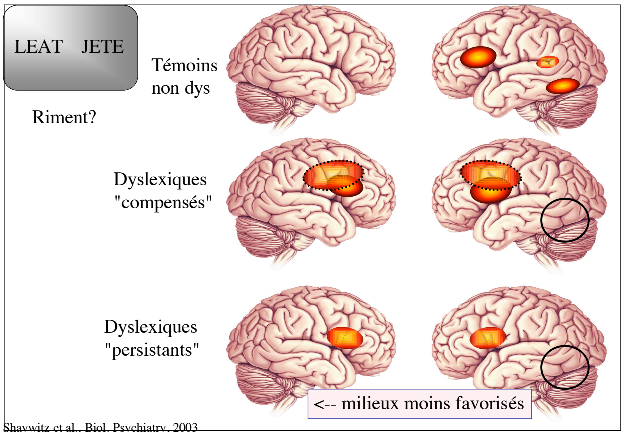
The recognition of dyslexia as a neurodevelopmental disorder has been hampered by the belief that it is not a specific diagnostic entity because it has variable and culture-specific manifestations. In line with this belief, we found that Italian dyslexics, using a shallow orthography which facilitates 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.

[1]Psychology Department, University of Milan Bicocca, Milan, Italy. [2]INB-CNR, Scientific Institute H San Raffaele, Milan, Italy. [3]INSERM U455, Hôpital Purpan, Toulouse, France. [4]Neuroscience and Biomedical Technologies Department, University of Milan Bicocca, Milan, Italy. [5]Institute of Cognitive Neuroscience, University College London, London, UK. [6]Wellcome Department of Cognitive Neurology, Institute of Neurology, London, UK. [7]Psychology Department, University "Vita e Salute H San Raffaele", Milan, Italy. [8]Institute of Human Physiology, University of Parma, Parma, Italy. [9]Centre de Recherche Institut Universitaire de Gériatrie, Montréal, Quebec, Canada.

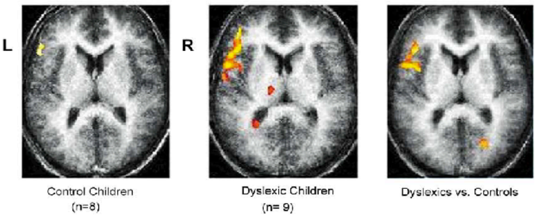
*To whom correspondence should be addressed at University of Milan Bicocca. E-mail: eraldo.paulesu@unimib.it

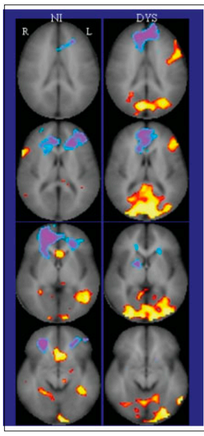
www.sciencemag.org SCIENCE VOL 291 16 MARCH 2001





P. Georgiewa et al. / Neuroscience Letters 318 (2002) 5–8





35 girls, 78 boys; ages, 7–18 years; mean age, 12.7 years) and 119 nonimpaired (NI) readers
(52 girls, 67 boys; ages, 7–17 years; mean age, 11.3 years)

Correlation maps between age and activation for nonimpaired (NI) and dyslexic (DYS) readers during a nonword rhyming (NWR) task

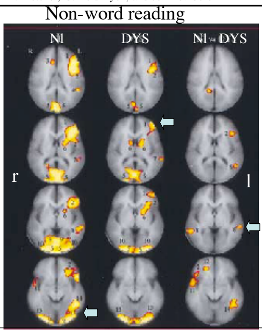
---

Disruption of Posterior Brain Systems for Reading in Children with Developmental Dyslexia

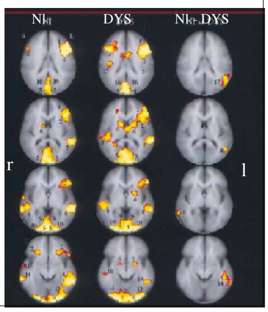
Biol Psychiatry 2002;52:101–110 ©

Bennett A. Shaywitz, Sally E. Shaywitz, Kenneth R. Pugh, W. Einar Mencl, Robert K. Fulbright, Pawel Skudlarski, R. Todd Constable, Karen E. Marchione, Jack M. Fletcher, G. Reid Lyon, and John C. Gore

Non-word reading



Semantic category judgment



Neural Systems for Compensation and Persistence: Young Adult Outcome of Childhood Reading Disability

Sally E. Shaywitz, Bennett A. Shaywitz, Robert K. Fulbright, Pawel Skudlarski, W. Einar Mencl, R. Todd Constable, Kenneth R. Pugh, John M. Holahan, Karen E. Marchione, Jack M. Fletcher, G. Reid Lyon, and John C. Gore

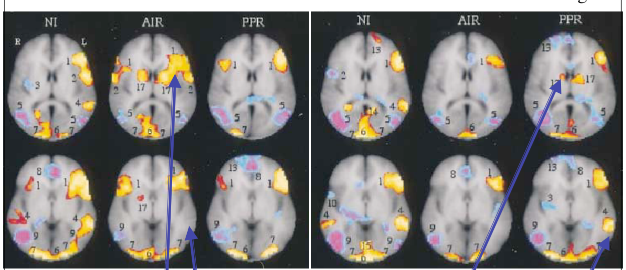
BIOL PSYCHIATRY
2003;54:25–33

3 groups :
NI (non-impaired)
AIR (compensated)
PPR (persistent poor)

2 tasks :
NWR = « do [LEAT] and [JETE] rhyme? »
CAT = « are [CORN] and [RICE] from the same category »

Non-mots / rimes

catégorie



Compensated :
- more frontal activation (bilat)
- no sup. temp. activ.

Persistent :
- bilat. Basal gglia activation
- preserved or increased post temporal activation

Paradoxalement, le groupe persistant se rapproche plus du témoin normal que le groupe compensé.

Table 1. Early Influences and Measures as Young Adults

	Group				
	NI (n = 27)		AIR (n = 19)		PPR (n = 24)
Early Influences					
Family SES[a,f]					
High	18		6		8
Average	7	>	6	=	6
Low	2		7		10
% School Subsidized Meals[b,g]	11.2 (13.3)		15.5 (19.5)		28.4 (25.6)
Child					
WISC-R (Wechsler 1981) FSIQ—Grade 1[c]	116 (9.1)	=	108 (11.0)	>	97 (16.1)
Woodcock Johnson Reading (Woodcock and Johnson 1977)—Grade 1[a]	117 (9.4)		94.0 (11.2)		87.9 (15.1)
Measures as Young Adults					
Age (years)	20.3 (1.0)		19.9 (.9)		19.9 (1.1)
WAIS-R (Wechsler 1981) FSIQ[d]	110 (8.5)	>	100 (9.9)	>	91.2 (11.0)
Woodcock-Johnson Revised (Woodcock and Johnson 1989)					
Letter-Word Identification[d]	123 (13.0)		109 (15.0)		95.8 (3.9)
Word Attack[d]	141 (11.4)		122 (16.6)		104 (11.4)
Gray Oral Reading (Wiederholt and Bryant 1992)					
Accuracy[d]	12.2 (3.3)		5.7 (3.2)		3.1 (2.3)
Rate[d]	14.1 (1.2)		9.2 (2.1)		6.7 (2.0)
Passage[d]	13.2 (2.1)		7.6 (2.2)		4.9 (2.0)
Comprehension[c]	10.5 (3.4)		10.2 (2.8)		7.7 (3.4)
Quotient[d]	111 (12.4)		93.2 (12.9)		77.9 (13.7)
Prose Literacy[c,h]	341 (28.2)		319 (27.1)		283 (36.8)

Numbers in parentheses are SD.
NI, nonimpaired readers; AIR, accuracy improved (compensated) readers; PPR, persistently poor readers; SES, socioeconomic status; WISC-R, Wechsler Intelligence Scale for Children-Revised; FSIQ, fullscale intelligence quotient; WAIS-R, Wechsler Adult Intelligence Scale-Revised.
[a]NI > AIR, AIR = PPR, NI > PPR
[b]NI = AIR, AIR = PPR, NI < PPR
[c]NI = AIR, AIR > PPR, NI > PPR
[d]NI > AIR, AIR > PPR, NI > PPR
[e]NI = AIR, AIR = PPR, NI > PPR

Shaywitz et al., 2003 : Conclusion

- À égalité de sévérité initiale de la dyslexie
- Les deux groupes (compensé et persistant) diffèrent
  - outre l'évolution de la dyslexie
  - Par le QI de départ (compensé >persistant)
  - Par le niveau socio-culturel (non significativment différent au début)
  - Par le degré de compréhension écrite (pers.>comp.)

« PPR may represent a more environmentally influenced dyslexic reader »

Developmental Science 9:6 (2006), pp 642–654

PAPER

Brain–behavior relationships in reading acquisition are modulated by socioeconomic factors

Kimberly G. Noble,[1,2] Michael E. Wolmetz,[1] Lisa G. Ochs,[1] Martha J. Farah[2] and Bruce D. McCandliss[1]

1. Sackler Institute for Developmental Psychobiology, Weill Medical College of Cornell University, USA

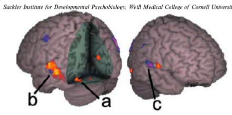
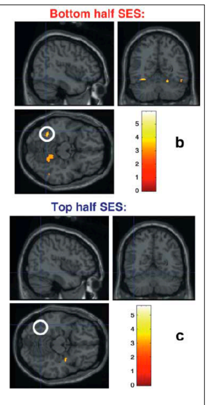


Figure 2 Correlations of PA and activity in left fusiform and superior temporal gyrus regions, across a median split of SES. As in Figure 1, although all analyses were conducted using SES as a continuous variable, the continuum of SES has been schematically represented by dividing subjects by SES median split. Red-yellow represents correlations between PA and brain activity among children below the median SES, while blue-purple represents correlations between PA and activity among children above the median SES. Lower SES children show a positive correlation between PA and activity in (a) left fusiform (interaction cluster peak −34, −58, −16). This correlation is not observed in higher SES children. While both lower SES and higher SES children show areas of positive correlation between PA and activity in (b) left perisylvian cortex (interaction cluster peak −54, −10, 10) and (c) right perisylvian cortex (interaction cluster peak 62, −26, 6), the size of the regions exhibiting these correlations are qualitatively much larger in lower and higher SES children, respectively. Maps are depicted at p < .005 uncorrected.

Pixels présentant une interaction entre PA (conscience phonologique) x SES (statut socio-économique)



Seminar

Developmental dyslexia

Jean-François Démonet, Margot J Taylor, Yves Chaix

Lancet 2004; **363:** 1451–60

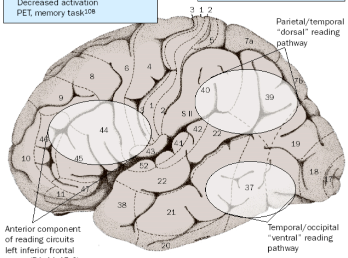
INSERM U455, Hôpital Purpan, IFR 96, Toulouse, France (J-F Démonet MD); **CNRS UMR 5549, Faculté de Médecine de Toulouse-Rangueil, IFR 96, Toulouse, France** (M J Taylor PhD); **and Unité de Neuro-Pédiatrie, Hôpital des Enfants, Toulouse, France** (Y Chaix MD)

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

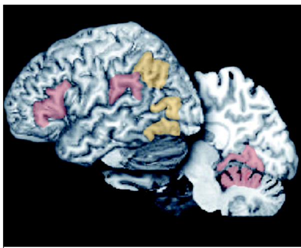
Dysfunction of left inferior frontal area
Increased activation:
fMRI, hierarchically organised tasks with phonological process;[106]
PET, implicit and explicit word and pseudoword reading[107]

Decreased activation
PET, memory task[108]

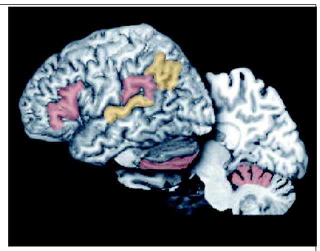
Reduced activity in left parietal/temporal regions
PET, rhyming task;[108,109]
PET, pronunciation and decision making tasks;[110]
fMRI, hierarchically organised tasks with phonological process[106]
PET, reading[111]



Reduced activity in left inferior temporal/occipital area
MEG, letter perception[101]
PET, implicit and explicit word and pseudoword reading[107,112]



Anatomical areas activated during written language tasks and that exhibit significant differences from controls in studies of dyslexia



Anatomical areas activated during oral language tasks and that exhibit significant differences from controls in studies of dyslexia

REVIEW ■

Neuroanatomical Markers for Dyslexia:
A Review of Dyslexia Structural Imaging Studies

MARK ECKERT

NEUROSCIENTIST 10(3):000–000, 2004

PNAS

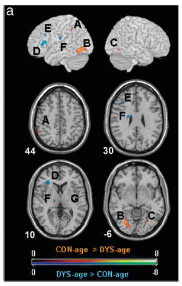
Functional and morphometric brain dissociation between dyslexia and reading ability

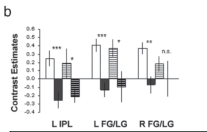
Fumiko Hoeft*†‡, Ann Meyler§, Arvel Hernandez*, Connie Juel¶, Heather Taylor-Hill*, Jennifer L. Martindale*, Glenn McMillon*, Galena Kolchugina*, Jessica M. Black*¶, Afrooz Faizi*, Gayle K. Deutsch*, Wai Ting Siok*‖, Allan L. Reiss†, Susan Whitfield-Gabrieli*,**, and John D. E. Gabrieli*,**

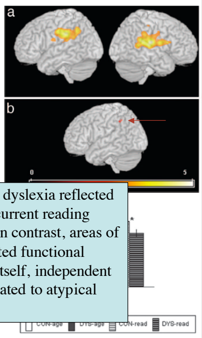
*Department of Psychology, Stanford University, Building 420, m/c 2130, Palo Alto, CA 94305-2130; †Center for Interdisciplinary Brain Sciences Research (CIBSR), Department of Psychiatry and Behavioral Sciences, Stanford University School of Medicine, 401 Quarry Road, Palo Alto, CA 94305-5795; §Department of Psychology, Carnegie Mellon University, Baker Hall, Pittsburgh, PA 15213-3890; ¶School of Education, Stanford University, 485 Lausen Mall, Palo Alto, CA 94305-3096

Edited by Michael M. Merzenich, University of California School of Medicine, San Francisco, CA, and approved December 27, 2006 (received for review October 26, 2006)

a) régions de diminution de volume
b) idem pour zones d'activation réduite en fMRI (L IPL)







Thus, areas of hyperactivation in dyslexia reflected processes related to the level of current reading ability independent of dyslexia. In contrast, areas of hypoactivation in dyslexia reflected functional atypicalities related to dyslexia itself, independent of current reading ability, and related to atypical brain morphology in dyslexia.

I/ IRMf

II/ VBM

III/ De l'anatomie à la fonction : les mécanismes de la 'dys'fonction.

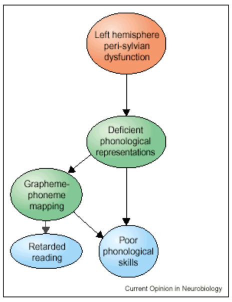
- Piste 1 : Trouble de la latéralisation hémisphérique (du langage)
- Piste 2 : Du déficit magnocellulaire à la dyslexie « visuelle »
- Piste 3 : Le trouble perceptivo-auditif et l'hypothèse phonologique
- Piste 4 : Déficit du traitement temporel : comment le cerveau dyslexique gère le temps
- Piste 5 : Trouble cérébelleux : une hypothèse conciliatrice

ENVIRONMENT

Neurobiological level

Cognitive level

Behavioural level



The classical view (U. Frith, J. Morton, F. Ramus…)

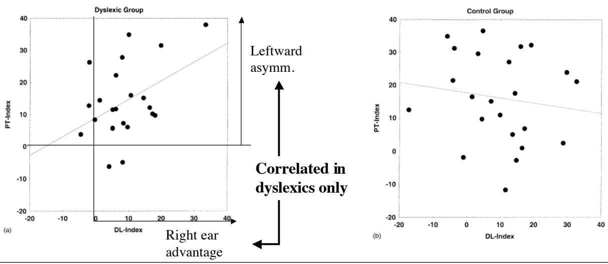
1ere piste

Défaut de mise en place de la latéralisation du langage

PERGAMON
Neuropsychologia 41 (2003) 666–675
www.elsevier.com/locate/neuropsychologia

Significant relation between MR measures of planum temporale area and dichotic processing of syllables in dyslexic children

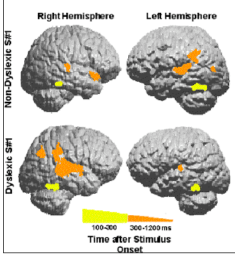
Kenneth Hugdahl[a,*], Einar Heiervang[b], Lars Ersland[e], Arvid Lundervold[f], Helmuth Steinmetz[c], Alf Inge Smievoll[d]

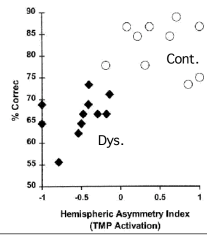


Neuroscience Letters

Brain activation profiles in dyslexic children during non-word reading: a magnetic source imaging study

Pseudo-word rhyme matching task :
- Reversed pattern of temporo-parietal asymmetry
- No difference in basal temporal activity

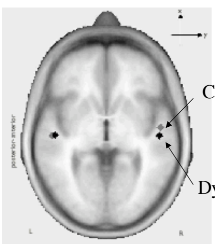




COGNITIVE NEUROSCIENCE AND NEUROPSYCHOLOGY NEUROREPORT

Altered hemispheric asymmetry of auditory N100m in adults with developmental dyslexia

Sabine Heim,[CA] Carsten Eulitz[1] and Thomas Elbert[1]



In the control group, the N100m source was located significantly more anterior in the right hemisphere than in the left ($F(1,18)=16.3$, $p<0.001$). By contrast, dyslexic subjects did not show hemispheric asymmetry in the location of the N100m ECD in the anterior-posterior direction.

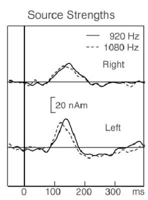
ORIGINAL ARTICLES

Diminished Auditory Mismatch Fields in Dyslexic Adults

Hanna Renvall, MD, and Riitta Hari, MD, PhD

Electroencephalographic studies have demonstrated smaller auditory responses to infrequent deviances of speech and nonspeech sounds in dyslexic than normal-reading subjects. We used a whole-scalp neuromagnetometer to study selectively reactivity of the auditory cortices to sound deviances in 8 dyslexic and 11 normal-reading adults. Within a monotonous sequence of 50-millisecond 1,000Hz binaural tones, tones of 920 and 1,080Hz occurred with 7% probability each. Magnetic mismatch fields, elicited by the stimulus deviances, were diminished in the left hemisphere of the dyslexic subjects. The results indicate deficient change detection in the left auditory cortex of right-handed dyslexic adults.

Ann Neurol 2003;53:551–557



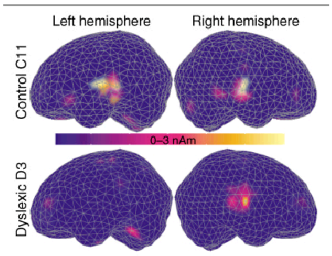
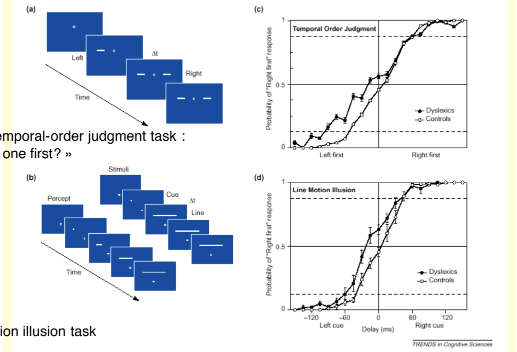


Fig 3. Minimum current estimates for MMFs to 920Hz deviant stimuli in Control Subject C11 and Dyslexic Subject D3 in the time window of 145 to 165 milliseconds.

Hari, R. et al. (2001) Left minineglect in dyslexic adults. Brain 124, 1373–1380

visual temporal-order judgment task :
« which one first? »

line motion illusion task



data from nine dyslexic and 14 normal reading subjects
In both tasks, the response distributions of dyslexic subjects were biased towards 'right first' responses.

ELSEVIER
Neuroscience Letters 331 (2002) 211–213
Neuroscience Letters
www.elsevier.com/locate/neulet

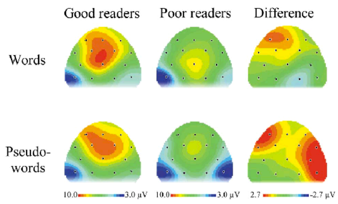
Children with dyslexia and right parietal lobe dysfunction: event-related potentials in response to words and pseudowords

Heinz Wimmer*, Florian Hutzler, Christian Wiener

University of Salzburg, Institute of Psychology, Hellbrunnerstrasse 34, A-5020 Salzburg, Austria

Received 6 May 2002; received in revised form 31 July 2002; accepted 1 August 2002

Hari and Renvall (Trends Cogn. Sci., 5 (2001) 525) proposed that dyslexic children suffer from sluggish attention deployment due to a right parietal lobe dysfunction. To examine this hypothesis, good and poor readers (12, 11-year-old boys in each group) had to read familiar words (low attentional demand) and pseudowords (high attentional demand). The amplitude of the event-related potential at around 100 ms post-stimulus (N1) in response to words and pseudowords was used as measure of attention deployment. Consistent with the attention deficit/right parietal lobe dysfunction hypothesis, poor readers showed lower N1 amplitudes in response to pseudowords, but not in response to words at central sites of the right hemisphere. However, poor readers also showed lower N1 amplitudes to both words and pseudowords at left frontal sites suggestive of an early deficit in activating phonological codes.



Dyslexia linked to talent: Global visual-spatial ability☆

Catya von Károlyi,[a] Ellen Winner,[b] Wendy Gray,[c] and Gordon F. Sherman[d,*]

[a] University of Wisconsin-Eau Claire, Wisconsin, USA
[b] Boston College and Harvard Project Zero, Chestnut Hill, MA, USA
[c] Brown University Medical School, Providence, RI, USA
[d] Newgrange School and Educational Outreach Center, Princeton, NJ, USA

Accepted 4 December 2002

The findings of this study were surprising: individuals with dyslexia proved significantly faster at recognizing impossible figures as impossible, and their greater speed

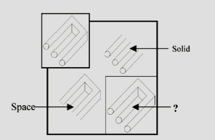
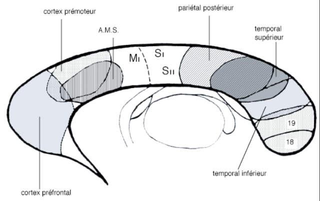


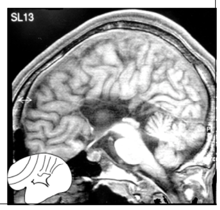
Fig. 1. The impossible trident illusion. If one attends only to the lower part of the figure, the central two lines are seen as solid; if one attends only to the upper part of the figure, they are seen as the edges of an empty space. In the context of the entire figure, the two central lines generate structural ambiguity.

Table 1
Reaction Time and accuracy scores on impossible figures in studies 1 and 2

	Study 1		Study 2	
	n	*M(SD)*	*n*	*M(SD)*
*Response Times (ms)**				
Dyslexia	40	2652 (1528)	29	1736 (766)
Control	22	3409 (1550)	35	2945 (2227)
Accuracy				
Dyslexia	40	0.776 (0.172)	29	0.729 (0.175)
Control	22	0.829 (0.203)	35	0.790 (0.224)

Note. * Significant group difference.





ELSEVIER
Cognitive Brain Research 10 (2000) 37–44
COGNITIVE BRAIN RESEARCH
www.elsevier.com/locate/bres

Research report

Corpus callosum size in children with developmental language disorder

Sabine Preis[a,*], Helmuth Steinmetz[b], Uwe Knorr[b], Lutz Jäncke[c]

ANAT.

Anomalies chez les dyslexiques, pas chez les dysphasiques

Déficit chez les dyslexiques, mais plus prononcé chez les dysphasiques

FONCT.

PERGAMON
Neuropsychologia 1393 (2002) 1–6
NEUROPSYCHOLOGIA
www.elsevier.com/locate/neuropsychologia

A callosal transfer deficit in children with developmental language disorder

Franco Fabbro*, Lucilla Libera, Alessandro Tavano

PERGAMON
Journal of Neurolinguistics 12 (1999) 147–156
Journal of NEUROLINGUISTICS
www.elsevier.com/locate/jneuroling

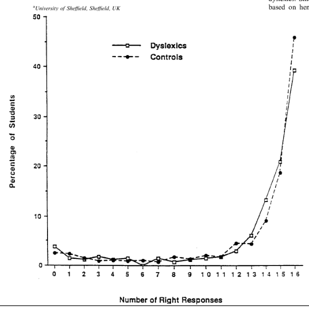
Handedness in developmental dyslexia: direct observation of a large sample

John L. Locke[a,*], Paul Macaruso[b]

[a] University of Sheffield, Sheffield, UK

Abstract

Manual laterality was assessed by direct observation of 407 students in a school for dyslexic young people and 604 students in regular public school classes. The task required subjects to pantomime 16 activities (e.g., dealing cards, writing a letter). Analysis revealed that although the dyslexics did not show precisely the same pattern of right and left responses as the controls, differences between groups were few and not present at the extremes of the continuum, i.e., there was neither a significantly lower percentage of pure right-handers nor a higher percentage of pure left-handers among the dyslexics. Moreover, left-handed dyslexics were not more severely reading-disabled than strongly right-handed dyslexics. Since the typical dyslexic adolescent is strongly right-handed, etiological theories based on hemispheric differences must derive support from other types of data. © 1999 … Ltd. All rights reserved.

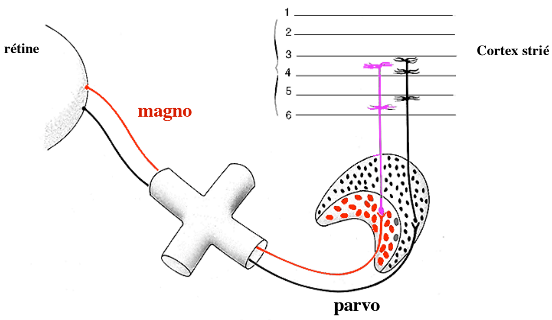


2eme piste

Déficit magnocellulaire

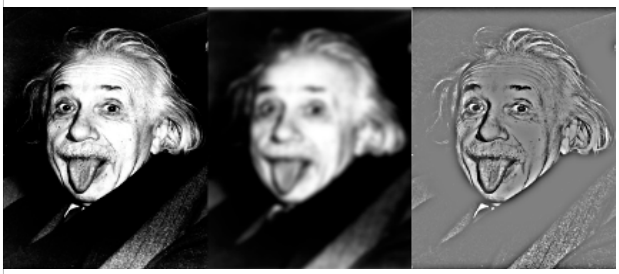
Dyslexie : mécanismes (1)

- **Théorie du déficit visuel :**
  - type des erreurs (confusions de lettres proches, pas de perception globale des mots)
  - Mise en évidence expérimentale d 'un déficit perceptif élémentaire (Stein, 1997) : sensibilité au contraste et persistance visuelle (théorie du déficit du ' magno - système ')
  - Imagerie fonctionnelle cérébrale (Eden et al., 1996; Demb et al., 1998)
- **Critiques de la théorie magno-cellulaire (Sokkun, 2000)** : inconstance du déficit de la sensibilité au contraste

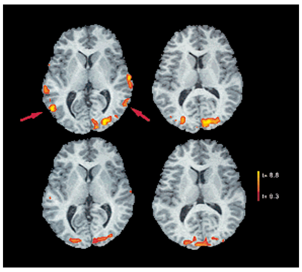


Défaut du système magno-cellulaire :
- sensibilité aux contrastes
- persistance visuelle excessive

Système parvo-cellulaire (« Sustained system »)	Système magno-cellulaire (« Transient system »)
Sens. aux hautes fréquences spatiales	Sens. aux basses fréquences spatiales
Sens. aux basses fréquences temporelles (p.e. stimulus stationnaire)	Sens. aux hautes fréquences temporelles (p.e. stimulus en mouvement ou clignotant)
Moins sensible au contraste	Sensible même aux faibles contrastes
Capable de distinguer les couleurs	De fait « aveugle pour les couleurs » mais activé par la lumière bleue et inhibé par lumière rouge
Temps de transmission lents	Temps de transmission rapides
Répond tout au long de la présentation du stimulus	Répond au début et à la fin du stimulus
Prédomine en vision centrale	Prédomine en vision périphérique
Champs réceptifs étroits	Champs réceptifs larges
Peut inhiber le système magno	Peut inhiber le système parvo



Normal — suppr. hautes freq. spatiales — suppr basses freq. spatiales



Dyslexics : failure to activate V5/MT « motion area »
(Eden et al., 1996)

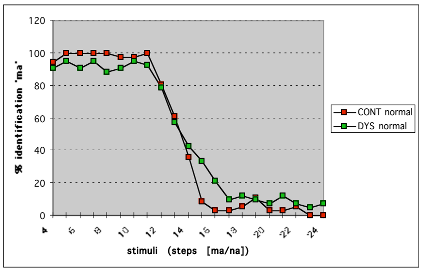
Déficit visuel dans la dyslexie

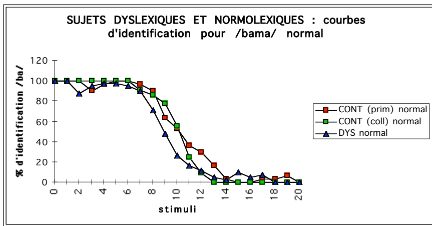
- Évidences expérimentales très contestées (Skottun, 2000)
- Fragilité du concept de dyslexie de surface
- Déficits perceptifs principalement décrits dans les dyslexies phonologiques
- Confusion entre dyslexie visuo-attentionnelle et trouble visuel dans la dyslexie
- Etude de jumeaux : concordance pour la phonologie, pas pour le déficit visuel

3eme piste

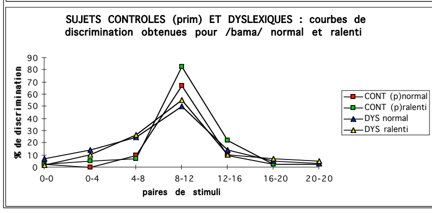
Déficit auditif central

Sujets témoins et dyslexiques: continuum [ma/na]





Courbe d'identification



Courbe de discrimination

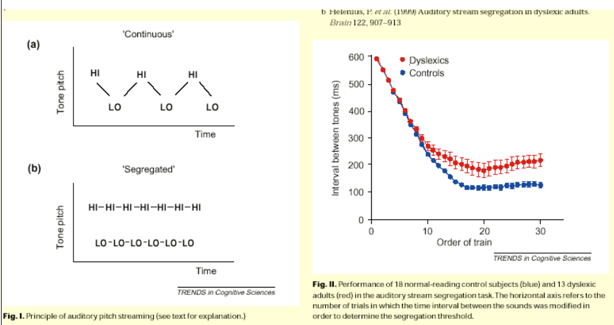


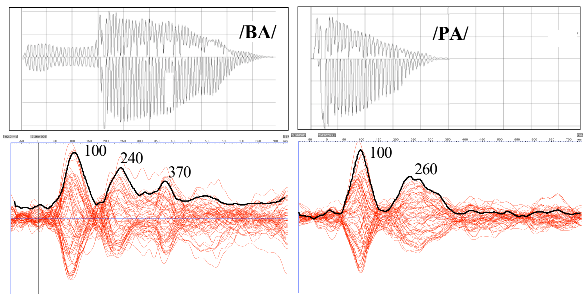
Fig. I. Principle of auditory pitch streaming (see text for explanation.)

Fig. II. Performance of 18 normal-reading control subjects (blue) and 13 dyslexic adults (red) in the auditory stream segregation task. The horizontal axis refers to the number of trials in which the time interval between the sounds was modified in order to determine the segregation threshold.

b Helenius, P. et al. (1999) Auditory stream segregation in dyslexic adults. *Brain* 122, 907–913

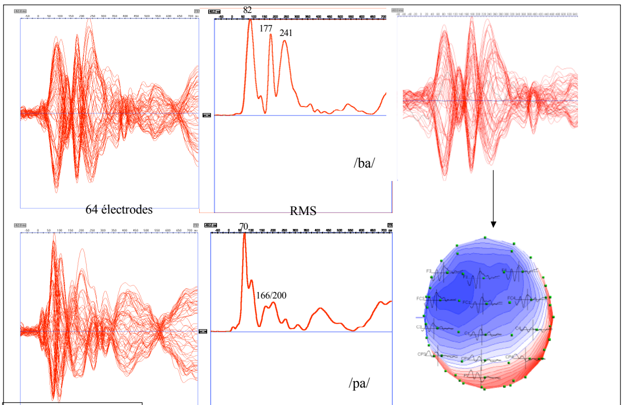
Corrélats électrophysiologiques du déficit de discrimination dans la dyslexie

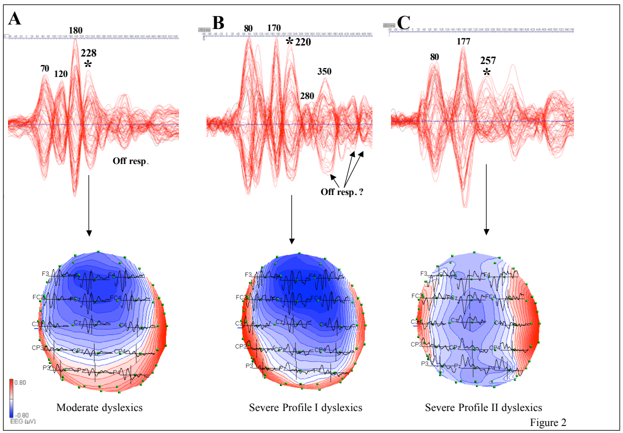
K. Giraud, C. Liégeois-Chauvel, M. Habib (In press)



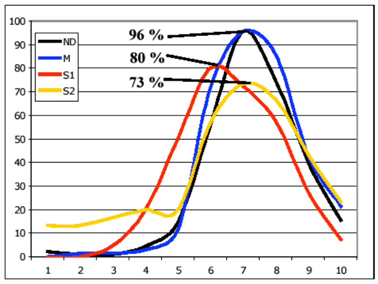
"Moderate" Dyslexics (N=7)				"Severe" Dyslexics (N=7)			
Subject	R.A. (yrs;mths)	Phono Score (/20)	Spell (%)	Subject	R.A. * (yrs;mths)	Phono Score(/20) n.s.	Spell* (%)
HC	14;1	13	60	AB	9;11	15	54
ED	13;3	14	75	AS	9;8	9	33
JR	12;10	15	81	CG	9;5	15	54
DR	12;10	17	63	PH	8;11	10	44
NR	12;2	14	60	FL	8;8	13	67
MD	11;2	15	63	CM	8;6	16	56
HJ	10;2	12	69	SC	7;2	7	15

14 dyslexic adults : reading, phonological, and spelling performances





Discrimination (/ba/-/pa/)



Categorial perception /ba/-/pa/ (discrimination curves): severe dyslexics score significantly below controls and moderate dyslexics

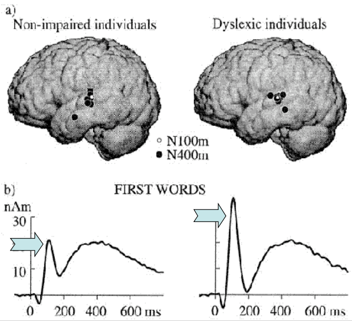
The Journal of Neuroscience, April 1, 2002, 22(7):2936–2944

Cortical Activation during Spoken-Word Segmentation in Nonreading-Impaired and Dyslexic Adults

Päivi Helenius,[1] Riitta Salmelin,[1] Elisabet Service,[2] John F. Connolly,[3] Seija Leinonen,[4] and Heikki Lyytinen[4]

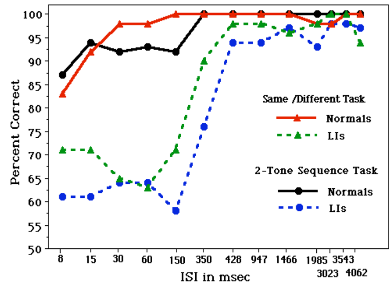
[1]Brain Research Unit, Low Temperature Laboratory, Helsinki University of Technology, FIN-02015 HUT, Espoo, Finland, [2]Department of Psychology, University of Helsinki, FIN-00014 Helsinki, Finland, [3]C Center, Dalhousie University, Halifax, Nova Scotia, Canada, B3H 4J1, and [4]Depar Jyväskylä, FIN-40351 Jyväskylä, Finland

N100 sur la région temporale gauche plus ample chez les dyslexiques (écoute de phrases)

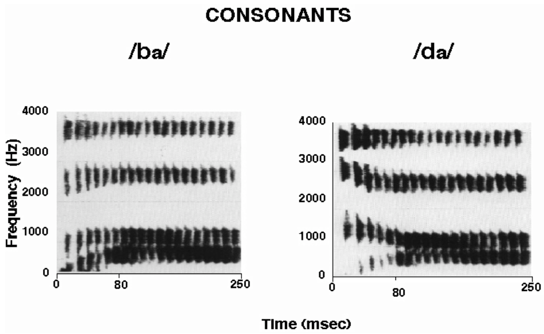


4eme piste

Déficit du traitement temporel (hypothèse 'Tallal')



Tallal et al., 1973-76



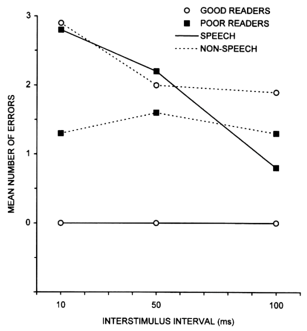


FIGURE 1. Mean number of errors by good and poor readers as a function of ISI on speech (/ba/–/da/) and nonspeech discrimination. (Reprinted from Mody et al., 1997.)

Mody et al., 1997 : le déficit de discrimination auditive chez le dyslexique est spécifique à la parole par rapport à la « non-parole » Pour la non-parole, les mauvais lecteurs ne sont pas significativement différents des témoins

Autre argument : si au lieu de ba/da on teste sa/sha, la différence témoins/dyslexiques disparaît

Journal of Child Psychology and Psychiatry 43:7 (2002), pp 931–938

Auditory processing in children with dyslexia

Einar Heiervang,[1] Jim Stevenson,[2] and Kenneth Hugdahl[1]
[1]University of Bergen, Norway; [2]University of Southampton, UK

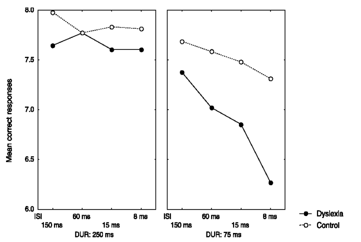


Figure 1 Mean number of correct responses in the dyslexia and control group, combined for the Same-Different and Rapid Perception subtests. Effect of tone duration and inter-stimulus interval (ISI)

The relationship between auditory temporal processing, phonemic awareness, and reading disability

Lesley Bretherton[a,*] and V.M. Holmes[b]

J. Experimental Child Psychology 84 (2003) 218–243

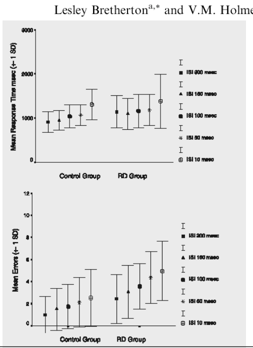


Table 3
Error rates and response times on the phoneme isolation tasks and error rates for phoneme deletion and reversal for the tone-order subgroups and the control group

Task	Average tone		Poor tone		Control	
	M	*SD*	*M*	*SD*	*M*	*SD*
Beginning sound isolation						
Number of errors	2.6	2.2	2.1	2.4	0.9	0.9
Response time (ms)	1358	417	1295	522	1019	349
End sound isolation						
Number of errors	4.9	3.2	4.3	3.8	0.9	1.0
Response time (ms)	1822	104	1785	396	1407	407
Deletion (Number of errors)						
Beginning sound	6.4	2.4	6.1	3.9	1.6	2.1
End sound	5.5	3.5	6.3	4.1	1.8	2.7
Reversal (Number of errors)	10.2	2.5	10.3	2.4	4.1	2.8

L. Bretherton, V.M. Holmes / Journal of Experimental Child Psychology 84 (2003) 218–243 237

Table 4
Mean error rates for the tone subgroups on the phonological tasks as a function of category of initial phoneme

Task	Stop consonant				Nasal/fricatives			
	Average tone		Poor tone		Average tone		Poor tone	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Isolation								
Beginning sound	1.1	1.3	1.0	1.0	1.6	1.2	1.1	1.6
End sound	2.1	1.9	2.0	2.2	2.8	1.7	2.3	1.9
Deletion								
Beginning sound	3.1	1.2	3.3	2.0	3.2	1.4	2.9	2.1
End sound	2.6	1.8	2.8	2.2	2.9	2.0	3.4	2.0
Reversal	5.2	1.2	5.2	1.1	5.1	1.5	5.2	1.5

“ In this study, deficient order judgement on a nonverbal auditory temporal order task (tone task) did not underlie phonological awareness or reading difficulties. ”

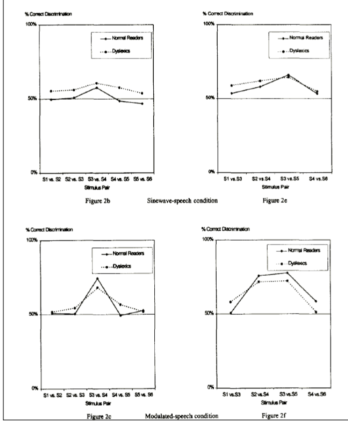
Perceptual Discrimination of Speech Sounds in Developmental Dyslexia

Willy Serniclaes
Laboratoire de Statistique Médicale
Ecole de Santé Publique
Université Libre de Bruxelles
Brussels, Belgium

Liliane Sprenger-Charolles
CNRS - LEAPLE
and
Université René Descartes
Paris, France

Experiments previously reported in the literature suggest that people with dyslexia have a deficit in categorical perception. However, it is still unclear whether the deficit is specific to the perception of speech sounds or whether it more generally affects auditory function. In order to investigate the relationship between categorical perception and dyslexia, as well as the nature of this categorization deficit, speech specific or not, the discrimination responses of children who have dyslexia and those of average readers to sinewave analogues of speech sounds were compared. These analogues were presented in two different conditions, either as nonspeech whistles or as speech sounds. Results showed that children with dyslexia are less categorical than average readers in the speech condition, mainly because they are better at discriminating acoustic differences between stimuli

384 *Journal of Speech, Language, and Hearing Research* • Vol. 44 • 384–399 • April 2001



Équivalent sinusoïdal de parole

Parole naturelle

NeuroImage

Top-down processes during auditory phoneme categorization in dyslexia: A PET study

O. Dufor, W. Serniclaes, L. Sprenger-Charolles, and J.-F. Démonet

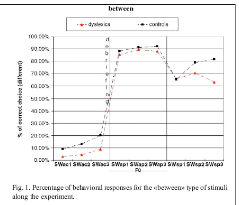
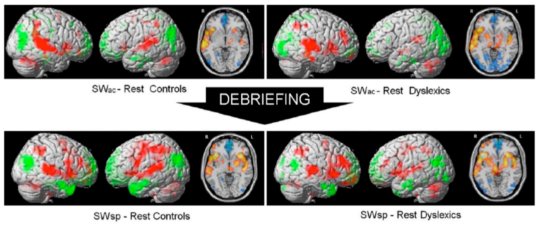
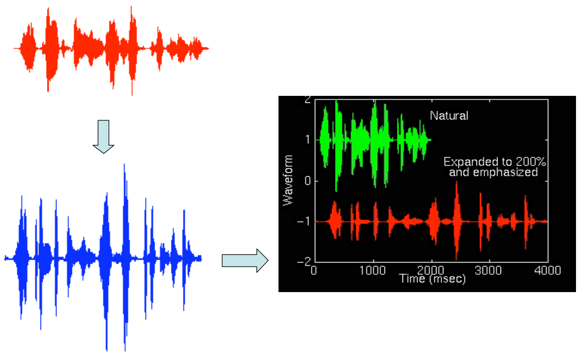


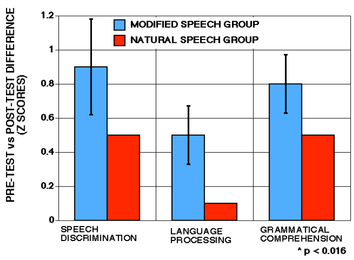
Fig. 1. Percentage of behavioral responses for the «between» type of stimuli along the experiment.

Contrôles : augmentation de la latéralisation à gauche après debriefing. Pas chez les dys

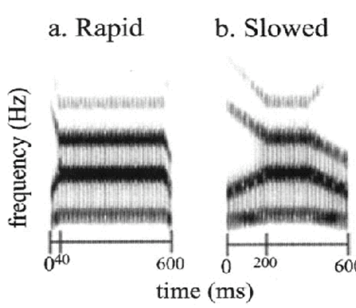




RESULTS FOR STUDY 2

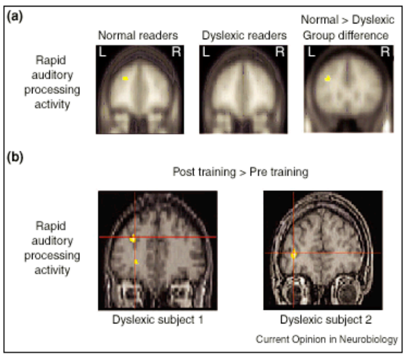


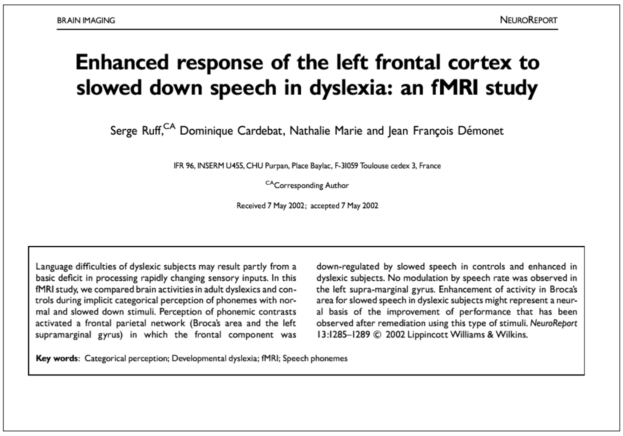
Merzenich et al., 1996; Tallal et al., *Science*, 1996



Disruption of the neural response to rapid acoustic stimuli in dyslexia: Evidence from functional MRI

E. Temple, R. A. Poldrack, A. Protopapas, S. Nagarajan, T. Salz, P. Tallal, M. M. Merzenich, and J. D. E. Gabrieli




BRAIN IMAGING NEUROREPORT

Enhanced response of the left frontal cortex to slowed down speech in dyslexia: an fMRI study

Serge Ruff,[CA] Dominique Cardebat, Nathalie Marie and Jean François Démonet

IFR 96, INSERM U455, CHU Purpan, Place Baylac, F-31059 Toulouse cedex 3, France

[CA]Corresponding Author

Received 7 May 2002; accepted 7 May 2002

Language difficulties of dyslexic subjects may result partly from a basic deficit in processing rapidly changing sensory inputs. In this fMRI study, we compared brain activities in adult dyslexics and controls during implicit categorical perception of phonemes with normal and slowed down stimuli. Perception of phonemic contrasts activated a frontal parietal network (Broca's area and the left supramarginal gyrus) in which the frontal component was down-regulated by slowed speech in controls and enhanced in dyslexic subjects. No modulation by speech rate was observed in the left supra-marginal gyrus. Enhancement of activity in Broca's area for slowed speech in dyslexic subjects might represent a neural basis of the improvement of performance that has been observed after remediation using this type of stimuli. *NeuroReport* 13:1285–1289 © 2002 Lippincott Williams & Wilkins.

Key words: Categorical perception; Developmental dyslexia; fMRI; Speech phonemes

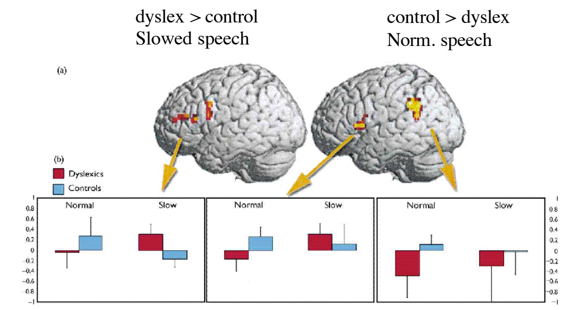
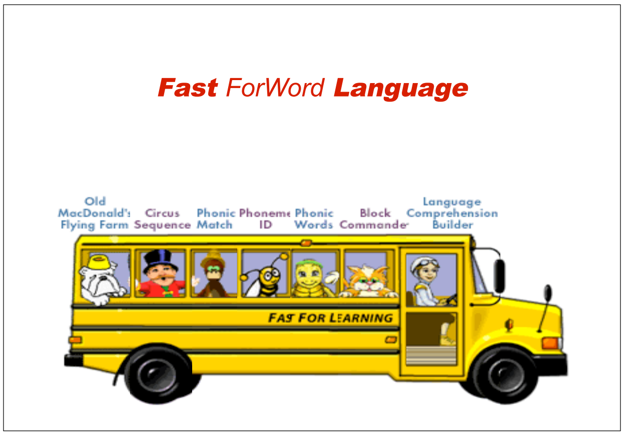


Fig. 1. Variable *vs* constant contrasts in dyslexic and control subjects. (**a**) Significant activations (random effect, $p < 0.01$, $k > 38$) shown on 3D surface rendering of the left hemisphere of a standard brain. (left) Specific activations in dyslexics for slowed-down speech compared with controls. (right) Cortical network sensitive to phonetic contrast in controls compared with dyslexics for normal speech rate. (**b**) Graphs of mean Z-scores of variable-constant contrasts in the 3 ROI centred around the peak of the 3 clusters shown above.



Special Forum on Fast ForWord

Looking Back: A Summary of Five Exploratory Studies of Fast ForWord

Ronald B. Gillam
The University of Texas at Austin

Diane Frome Loeb
The University of Kansas, Lawrence

Sandy Friel-Patti
The University of Texas at Dallas

" The collective results of our studies suggest that improvements in language abilities after FFW training did not result from changes in temporal processing. It is possible that similar improvements in language may be obtained from a variety of interventions that are presented on an intensive schedule, that focus the child's auditory and visual attention, that present multiple trials, that vary task complexity as a function of response accuracy, and that reward progress. "

American Journal of Speech-Language Pathology • Vol. 10 • 269–273 • August 2001

Neural deficits in children with dyslexia ameliorated by behavioral remediation: Evidence from functional MRI

Elise Temple[†‡], Gayle K. Deutsch[§], Russell A. Poldrack[¶], Steven L. Miller[‖], Paula Tallal[‖††], Michael M. Merzenich[‖‡‡], and John D. E. Gabrieli[†§]

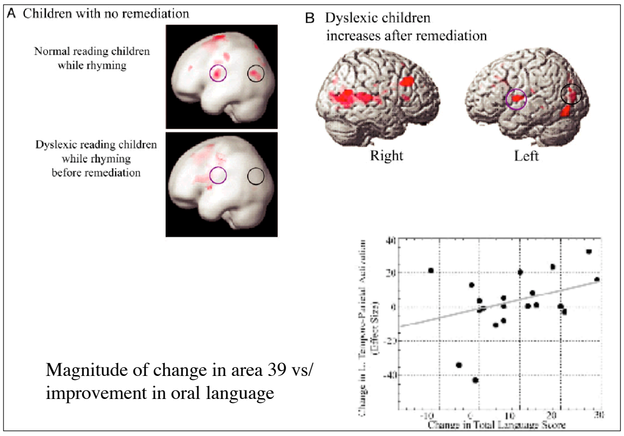
[†]Program in Neuroscience and [§]Department of Psychology, Stanford University, Stanford, CA 94305; [¶]Department of Psychology, University of California, Los Angeles, CA 90210; [‖]Scientific Learning Corporation, Oakland, CA 94612; [††]Center for Molecular and Behavioral Neuroscience, Rutgers University, Newark, NJ 07102; and [‡‡]Keck Center Integrative Neuroscience, University of California, San Francisco, CA 94143

Contributed by Michael M. Merzenich, January 3, 2003

Table 2. Behavioral measures of reading and language

	Dyslexic-reading children				Normal-reading children			
	Pretraining	Posttraining	T-stat	*P*	1st scan	2nd scan	T-stat	*P*
Reading: WJ-RMT								
Word ID	78.2 (56–95)	86.0 (72–99)	3.9	0.0005	109.0 (95–120)	108.3 (97–126)	0.6	0.6
Word Attack	85.5 (72–102)	93.7 (82–109)	6.8	0.0001	112.3 (99–132)	109.4 (99–125)	1.1	0.3
Passage Comp	83.3 (51–103)	88.9 (77–107)	2.9	0.005	112.8 (104–120)	110.3 (100–122)	1.8	0.03
Language: CELF-3								
Receptive	92.5 (69–120)	101.3 (75–122)	3.6	0.001	118.6 (108–135)	121.8 (108–139)	1.5	0.2
Expressive	95.0 (61–125)	102.2 (80–150)	2.8	0.006	112.3 (102–125)	113.8 (92–139)	0.5	0.6
Rapid Naming	79.1 (35–97)	86.5 (67–103)	2.8	0.006	106.8 (94–121)	104.3 (82–124)	0.9	0.4

Range is given in parentheses. T-stat for paired *t* test. *P* value: one tailed for dyslexics, two tailed for controls. WJ-RMT, Woodcock–Johnson Reading Mastery Test; CELF, Comprehensive Evaluation of Language Fundamentals.

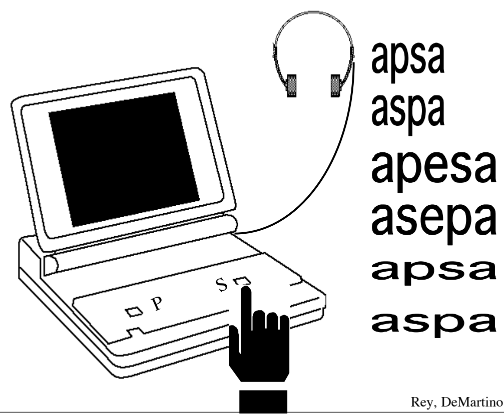


Magnitude of change in area 39 vs/ improvement in oral language

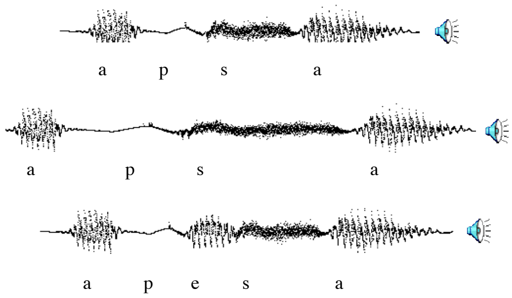
Déficit du traitement temporel évaluation expérimentale

- La perception de l'ordre est-elle liée à la durée?
- Quelle relation avec les diconsonnes (si problématiques pour les dyslexiques francophones)?

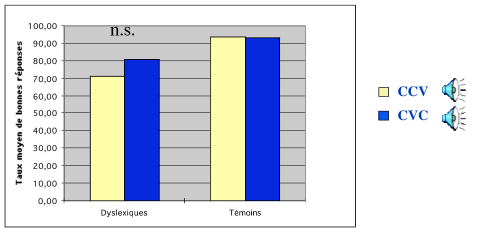
➡ Jugement d'ordre temporel au sein d'un complexe consonantique : /ps/ ou /sp/
  - Durée normale
  - Ralentissement des stimuli
  - Espacement des stimuli



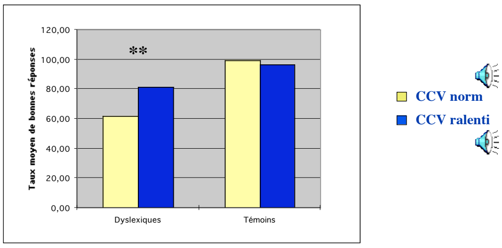
Rey, DeMartino, et al., 2001



Comparaison du jugement d'ordre des consonnes dans les structures CCV (apsa) & CVC (apesa)



Impact de la modification du signal sur la perception de l'ordre des consonnes



	Jamais	Rarement	Parfois	Souvent	Très souvent
1- Il (Elle) se souvient difficilement des jours / m ois / année que nous sommes.					
2- Il (Elle) confond les moments de la journée matin / après-midi / soirée.					
3- Un événement qui est survenu le matin, il (elle) peut le placer la veille.					
4- Pour un événement qui est survenu il y a quelques jours, il (elle) peut dire : "il y a très longtemps".					
5- Il lui est difficile de comprendre les relations existantes entre les membres de la famille : grands-parents, tantes, neveux, beau-frère.					
6- Il (Elle) a du mal à comprendre les notions de hier, demain ou après-demain.					
7- Il (Elle) a des difficultés à li re l'heure sur un cadran.					
8- Il (Elle) se trompe lorsque il (e lle) doit évaluer la durée d'un film, la durée d'une activité, voire même la durée d'une nuit de sommeil.					
9- Vous avez besoin de lui donner des indices pour qu'il (elle) se repère dans une semaine (lundi : école ; mercredi : activités extra-scolaires ; dimanche : repos …).					

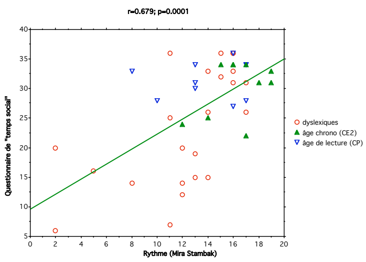


Figure 3 : corrélation ches 23 enfants dyslexiques et 20 témoins (appariés en âge de lecture : CP ou selon l'âge chronologique : CE2) entre la performance à un test d'imitation de rythmes et le résultats d'un questionnaire de « temps social » (Daffaure et al., 2002).

Corrélation entre reproduction de rythmes et questionnaire de « temps social »

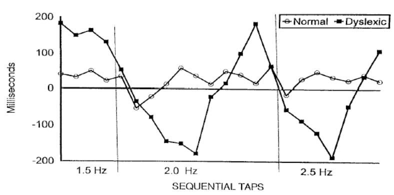
Reading and Writing: An Interdisciplinary Journal **15:** 179–206, 2002.

Timing precision and rhythm in developmental dyslexia

PETER H. WOLFF
Children's Hospital and Harvard Medical School, Boston MA 02115, USA

Outcome measure	Dyslexic students Mean (SD)	Normal readers Mean (SD)
A. Absolute difference (ms) tap onset and metronome signal		
Stable rate – 2Hz		
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)**

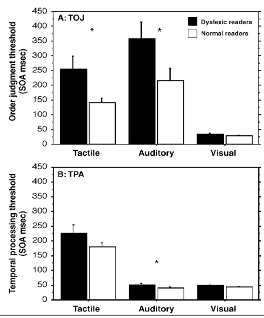
**$p < 0.01$ Mann-Whitney U-Test.



Cognitive, Affective, & Behavioral Neuroscience
2001, 1 (4), 394-410

Temporal order and processing acuity of visual, auditory, and tactile perception in developmentally dyslexic young adults

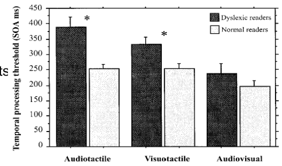
MARJA LAASONEN, ELISABET SERVICE, and VEIJO VIRSU
University of Helsinki, Helsinki, Finland

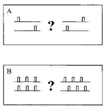


Brain and Language **80**, 340–354 (2002)
doi:10.1006/brln.2001.2593, available online at http://www.idealibrary.com on IDEAL

Crossmodal Temporal Order and Processing Acuity in Developmentally Dyslexic Young Adults

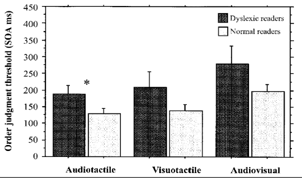
Marja Laasonen, Elisabet Service, and Veijo Virsu





J.O.T. : lequel des deux stimuli est perçu en premier?

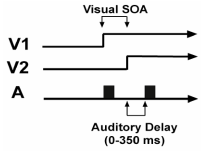
Acuité du traitement temporel : les triplets sont-ils simultanés (par exemple 3 indentations ressenties à la main vs 3 tons)?

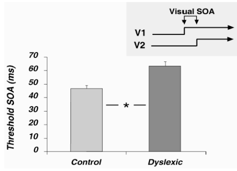


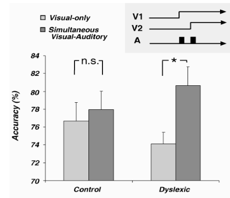
Altered Temporal Profile of Visual-Auditory Multisensory Interactions in Dyslexia

(in press)

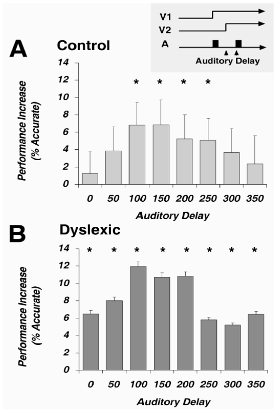
W. David Hairston[1]
Jonathan H. Burdette[2]
D. Lynn Flowers[3]
Frank B. Wood[3]
Mark T. Wallace[1]







Exp Brain Res, 2005, 166:474–480



Dyslexic subjects' performance differed significantly from that of control subjects, specifically in that they integrated the auditory and visual information over longer temporal intervals. Such a result suggests an extended temporal "window" for binding visual and auditory cues in dyslexic individuals.

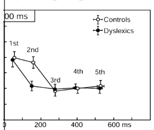
Abnormal Response Recovery in the Right Somatosensory Cortex of Dyslexic Adults

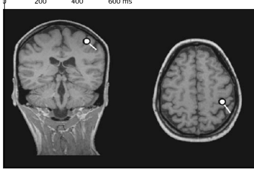
Cerebral Cortex Advance Access published August 18, 2004

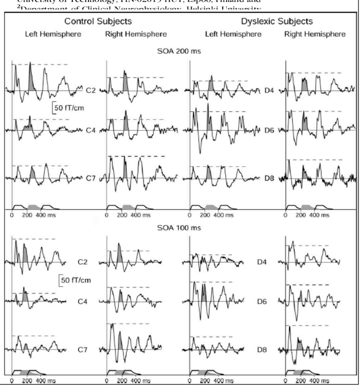
Hanna Renvall[1], Reetta Lehtonen[1] and Riitta Hari[1,2]

[1]Brain Research Unit, Low Temperature Laboratory, Helsinki University of Technology, FIN-02015 HUT, Espoo, Finland and

Stimulation cutanée répétée alternée des deux mains : PES en MEG
Déficit en pariétal droit chez les dyslexiques pour la 2e stimulation







Brain and Language 85 (2003) 166–184

www.elsevier.com/locate/b&l

Speed of lower-level auditory and visual processing as a basic factor in dyslexia: Electrophysiological evidence☆

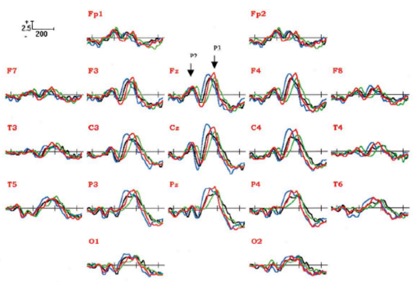
Zvia Breznitz* and Ann Meyler

The Test of Visual, Auditory, and Cross-Modal Speed of Processing (Breznitz, 1995) was administered. This task comprises 150 stimuli: 50 beeps occurring alone (1000 Hz), 50 flashes occurring alone, and 50 beeps and flashes occurring simultaneously. The subject pressed one button of the joystick when either the beep or the flash occurred separately (100) and another button when they occurred simultaneously (50).

Table 3
Reaction time and accuracy for stimuli in the cross-modal task: Dyslexic versus normal readers

Stimulus	Measure					
	Reaction time			Accuracy		
	Dyslexics	Controls		Dyslexics	Controls	
	M (*SD*)	*M* (*SD*)	*F*	*M* (*SD*)	*M* (*SD*)	*F*
Visual	566 (73.2)	521 (52.3)	NS	47 (4.1)	50 (6.2)	NS
Auditory	506 (79.3)	490 (67.5)	NS	40 (9.1)	47 (6.8)	NS
Cross-modal	757 (62.7)	546 (58.0)	16.9*	32 (5.6)	45 (4.0)	6.2*

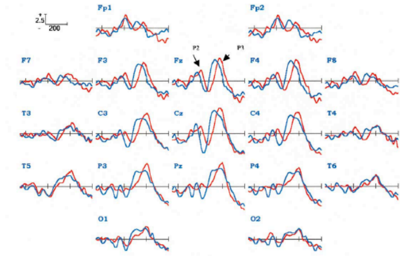
*$p < .001$.



Normal readers visual
Normal readers auditory
Dyslexic readers visual
Dyslexic readers auditory

Les ERP sont plus tardifs chez les dyslexiques dans les deux modalités, avec un retard du visuel sur l'auditif dans les deux populations

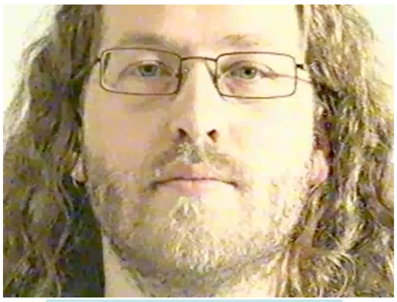
Fig. 5. ERP waveforms for auditory and visual non-linguistic single stimuli in the cross-modal task: Dyslexic versus normal readers.



Normal readers
Dyslexic readers

Fig. 6. ERP waveforms for simultaneous stimuli in the cross-modal task: Dyslexic versus normal readers.

Essais simultanés : retard des dyslexiques dès P2.
« It is proposed that delayed speed of processing in the auditory and visual modalities may affect dyslexics ability to integrate information »



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/).

ELSEVIER Neuroscience Letters 351 (2003) 46–50
www.elsevier.com/locate/neulet

Integration of heard and seen speech: a factor in learning disabilities in children

Erin A. Hayes[a,*], Kaisa Tiippana[b], Trent G. Nicol[a], Mikko Sams[b], Nina Kraus[a,c,d]

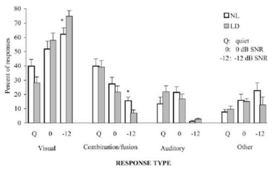


Fig. 1. Response types averaged across the four incongruent stimulus pairs. Presented here are the adjusted means for the response type, calculated with audio-alone and visual-alone scores as covariates; error bars represent one standard error of the mean. At − 12 dB SNR, LD children reported a higher proportion of visual responses to incongruent stimuli. Conversely, combinations/fusions were more likely to be reported by NL children. A similar pattern of results can be seen at 0 dB SNR, but the differences were not statistically significant. In addition, there was an interaction between noise level and diagnostic group such that LDs exhibited a greater increase in perception of the visual component of incongruent stimuli with increased noise level. Auditory and other responses did not differ between groups at any noise level.

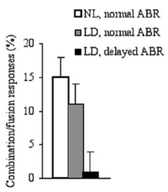
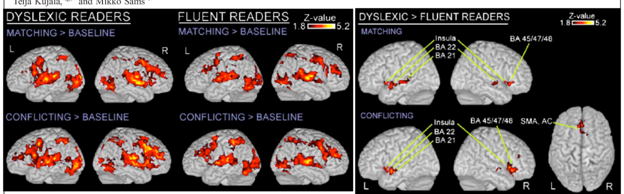


Fig. 2. Combination and fusion responses to incongruent stimuli at − 12 dB SNR for children grouped according to brainstem latency elicited by /da/. Presented here are the adjusted means calculated with audio-alone and visual-alone scores as covariates; error bars represent one standard error of the mean. LD children with delayed latencies reported fewer combination and fusion responses to incongruent audiovisual stimuli than NL children with a normal latency. The frequency of combination/fusion responses in LD children with a latency within normal limits was intermediate between the other two groups.

ELSEVIER
NeuroImage
www.elsevier.com/locate/ynimg
NeuroImage 29 (2006) 797 – 807

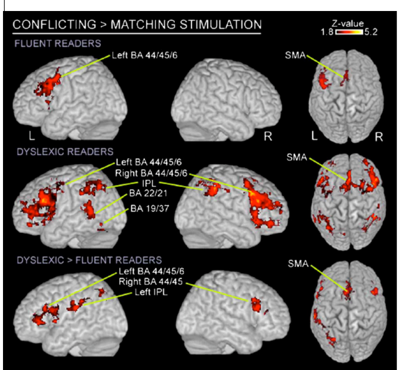
Perception of matching and conflicting audiovisual speech in dyslexic and fluent readers: An fMRI study at 3 T

Johanna Pekkola,[a,b,c,*] Marja Laasonen,[d,e] Ville Ojanen,[a,c] Taina Autti,[b] Iiro P. Jääskeläinen,[a,c] Teija Kujala,[f,g,h] and Mikko Sams[a,c]



Principale observation : augmentation d'activité dans les régions temporales moyennes (STS) chez les dys par rapport aux témoins

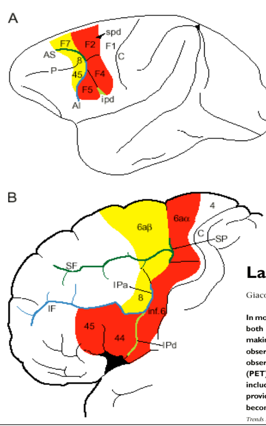
« This central node in audiovisual speech integration is suggested to mediate the convergence of visual speech input to the auditory cortex »



Suractivation du cortex prémoteur lors d'incongruence. Plus forte activation cortex prémoteur chez dys :

« We suggest our findings to reflect dyslexic readers' heightened reliance on motor-articulatory and visual strategies during processing of audiovisual speech ».

Résultats globalement opposés à l'habituelle sous-activation lors de la lecture : 2 manifestations opposées d'une même dysfonction?



segments. Thus, we suggest that the human homolog of the monkey arcuate sulcus is formed by SF plus SP (dark green) and by the IF plus IPa (blue). The descending branch of inferior precentral sulcus (IPd, pale green) corresponds, in this view, to the inferior precentral dimple of the monkey. In humans it abuts IF. The proposed sulcal equivalence fits well the available data on the anatomical and functional organization of the premotor cortices in the two species. The equivalence between human IPd and monkey ipd is well supported by the fact that this sulcus marks the border between F4 and F5 in monkey and the border between inferior area 6 (inf. 6) and area 44 in humans. Abbreviations: 4, cortical area 4; C, central sulcus; F1, cortical area F1; P, principal sulcus; spd, superior precentral dimple.

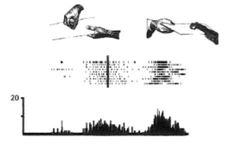
Language within our grasp

Giacomo Rizzolatti and Michael A. Arbib

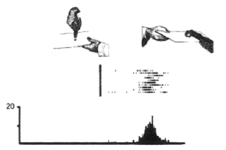
In monkeys, the rostral part of ventral premotor cortex (area F5) contains neurons that discharge, both when the monkey grasps or manipulates objects and when it observes the experimenter making similar actions. These neurons (mirror neurons) appear to represent a system that matches observed events to similar, internally generated actions, and in this way forms a link between the observer and the actor. Transcranial magnetic stimulation and positron emission tomography (PET) experiments suggest that a mirror system for gesture recognition also exists in humans and includes Broca's area. We propose here that such an observation/execution matching system provides a necessary bridge from 'doing' to 'communicating', as the link between actor and observer becomes a link between the sender and the receiver of each message.

Trends Neurosci. (1998) 21, 188–194

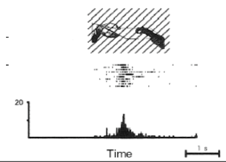
Activité d'un neurone miroir de l'aire M5 du singe



Le singe observe puis agit

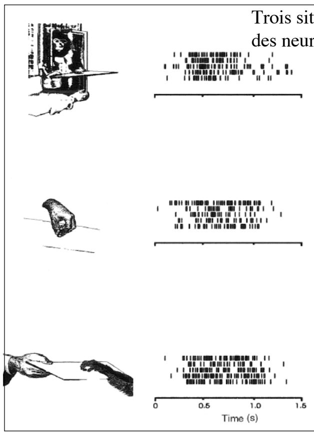


L'expérimentateur attrape avec une pince



Le singe attrape dans l'obscurité

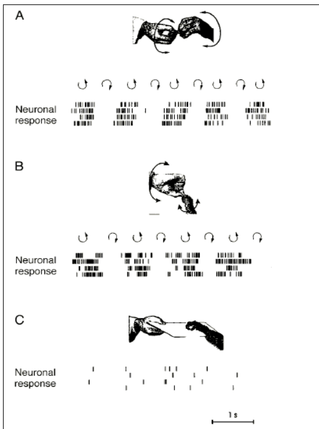
Trois situations provoquant la mise en action des neurones miroir



a) Observer un autre singe attraper la nourriture

b) Observe un humain

c) Attrape lui-même

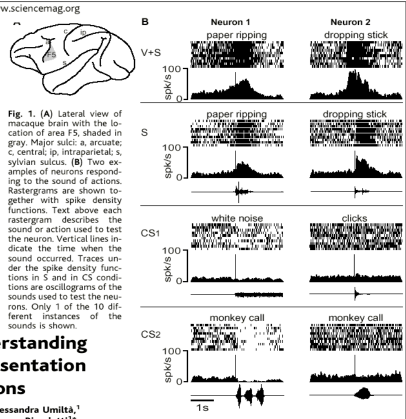


Spécificité des neurones miroir

a) Le singe observe l'expérimentateur briser un objet par double rotation des mains : le neurone décharge seulement pour le mouvement en sens anti-horaire

b) La même réponse s'observe si le singe tient l'objet , seulement lors de la rotation en sens anti-horaire

c) Le neurone n'a aucune activité lors d'une action différente

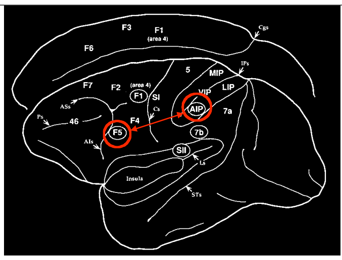


2 AUGUST 2002 VOL 297 SCIENCE www.sciencemag.org

Fig. 1. (A) Lateral view of macaque brain with the location of area F5, shaded in gray. Major sulci: a, arcuate; c, central; ip, intraparietal; s, sylvian sulcus. **(B)** Two examples of neurons responding to the sound of actions. Rastergrams are shown together with spike density functions. Text above each rastergram describes the sound or action used to test the neuron. Vertical lines indicate the time when the sound occurred. Traces under the spike density functions in S and in CS conditions are oscillograms of the sounds used to test the neurons. Only 1 of the 10 different instances of the sounds is shown.

Hearing Sounds, Understanding Actions: Action Representation in Mirror Neurons

Evelyne Kohler,[1] Christian Keysers,[1] M. Alessandra Umiltà,[1] Leonardo Fogassi,[2] Vittorio Gallese,[1] Giacomo Rizzolatti[1]*



Beyond the Mirror System:
From Monkey-like Action Recognition to Human Language

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University of Southern California
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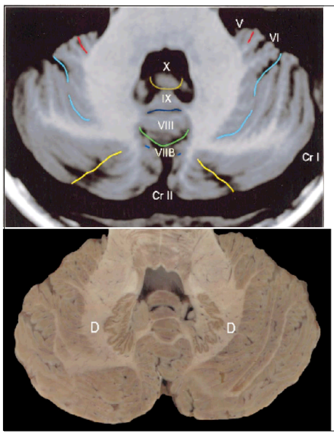
5eme piste

Dysfonction cérébelleuse



Finch et al., 2002

- Lobe antérieur : pas de différence de proportion de grandes cellules/petites
- Noyau dentelé : Pas d'anomalie

Cerebellum and Speech Perception: A Functional Magnetic Resonance Imaging Study

Klaus Mathiak, Ingo Hertrich, Wolfgang Grodd, and Hermann Ackermann

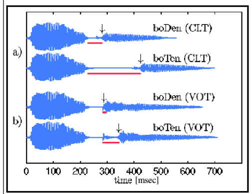
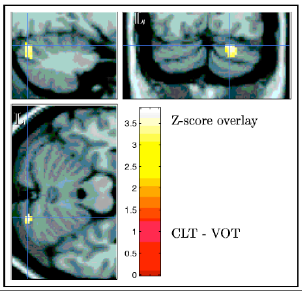
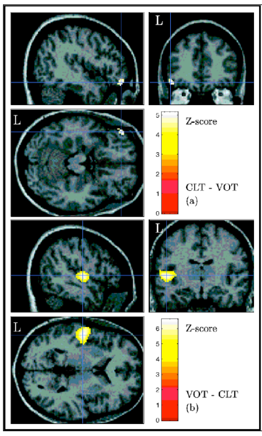


Figure 1. Prototypical examples of the two series of "Boden–Boten" utterances. (a) The first two waveforms differ in CLT, that is, the underlined pause signaling wordmedial "d" or "t," respectively, all the other components being identical (arrows = voice onset of the second syllable). The utterance with short CLT ([bodn]) is recognized as the word "Boden" and with long CLT ([botn]) as "Boten." (b) The lower two acoustic speech signals differ only in VOT, that is, the underlined noise segment extending from the burst to the beginning of the vocalic segment (= onset of the schwa vowel; see arrows). A series of equally

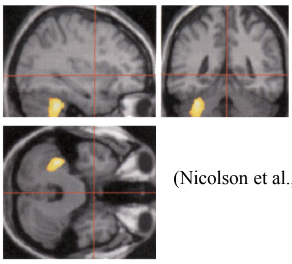




Developmental dyslexia: the cerebellar deficit hypothesis

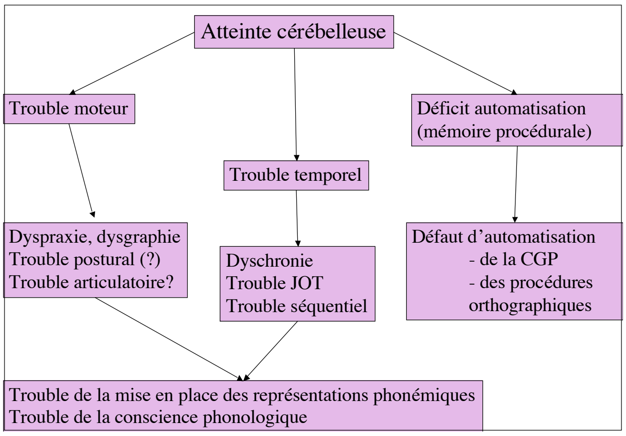
Roderick I. Nicolson, Angela J. Fawcett and Paul Dean

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)

Difference in activation between 6 dyslexics and 6 controls during learning of a motor sequence of the fingers: underactivation of the right cerebellum



EVIDENCE FOR A NEUROANATOMICAL DIFFERENCE WITHIN THE OLIVO-CEREBELLAR PATHWAY OF ADULTS WITH DYSLEXIA.

Andrew J Finch, Roderick I Nicolson and Angela J Fawcett

(Department of Psychology, University of Sheffield, UK)

Cortex, (2002) 38, 529-539

VIEWPOINT

DYSLEXIA AND THE CEREBELLAR DEFICIT HYPOTHESIS

Alan A. Beaton

(Department of Psychology, University of Wales, Swansea, U.K. SA2 8PP)

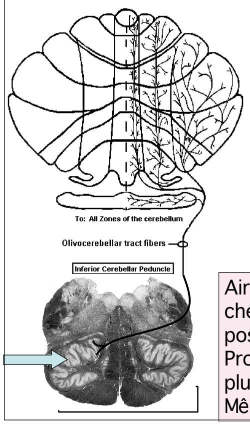
VIEWPOINT

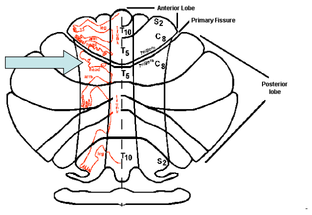
CEREBELLAR ABNORMALITIES IN DEVELOPMENTAL DYSLEXIA: CAUSE, CORRELATE OR CONSEQUENCE?

Dorothy V.M. Bishop

(Department of Experimental Psychology, University of Oxford, Oxford)

Cortex, (2002) 38, 491-498 Cortex, (2002) 38, 479-490





Finch et al., 2002

Aire totale cellulaire (Purkinje) plus vaste chez les dyslexiques dans le lobe postérieur (crus II et lobule paramédian)
Proportion de grandes cellules/petites : plus forte
Même tendance dans le noyau olivaire

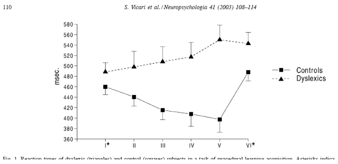
PERGAMON Neuropsychologia 41 (2003) 108–114 www.elsevier.com/locate/neuropsychologia

Implicit learning deficit in children with developmental dyslexia

Stefano Vicari[a,*], Luigi Marotta[a], Deny Menghini[a], Marco Molinari[b], Laura Petrosini[b,c]

Procédure : au centre d'un écran d'ordinateur apparaissent des séries de cercles colorés (vert, bleu et rouge).
6 blocs de 75 stimuli sont présentés : pour les blocs I et VI, l'ordre des stimuli est aléatoire, pour les blocs II à V, une séquence de 5 items (ROUGE, BLEU, VERT, ROUGE, BLEU) est répétée 15 fois. On s'assure que les enfants n'ont pas remarqué cette particularité.

18 enfants et adolescents dyslexiques
18 témoins appariés



Les temps de réaction diminuent progressivement des blocs II à V, prouvant l'apprentissage implicite de la séquence
Seulement chez les témoins

www.elsevier.com/locate/ynimg
NeuroImage xx (2006) xxx–xxx

Implicit learning deficits in dyslexic adults: An fMRI study

Deny Menghini,[a,b,*] Gisela E. Hagberg,[b] Carlo Caltagirone,[b,c] Laura Petrosini,[d,b] and Stefano Vicari[a,e]

[a]*IRCCS, Children's Hospital "Bambino Gesù", Santa Marinella, Rome, Italy*
[b]*IRCCS, Santa Lucia Foundation, Rome, Italy*
[c]*University Tor Vergata, Rome, Italy*
[d]*Department of Psychology, University "La Sapienza", Rome, Italy*
[e]*University LUMSA, Rome, Italy*

Received 5 July 2006; accepted 3 August 2006

The trials were presented in seven blocks (R1–R2), each consisting of 54 trials. During the first (R1) and seventh (R2) blocks the trials were presented in a pseudo-random order with the constraint that the same box could not be highlighted in two subsequent trials. In the remaining blocks (S1, S2, S3, S4 and S5) the trials were presented in a nine-element repeated sequence (position: 243413231) that recurred six times for a total of 54 trials.

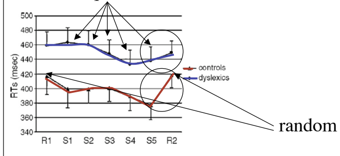
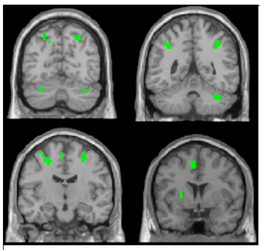
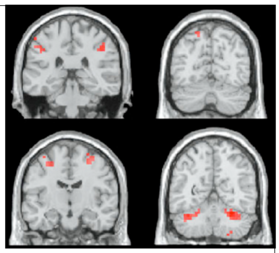


Fig. 1. Median reaction times obtained by fourteen developmental dyslexics and fourteen normal readers. The results reveal an implicit learning effect in the controls but not in the dyslexic group. In particular, in the control group reaction times increase, passing from S5 to R2, $P<0.01$, while in the dyslexic group reaction times remain practically unvaried. In R1 and R2, when the trials are presented in a pseudorandom order, no significant group differences are found. Vertical bars show standard errors pertaining to each group.

Les dyslexiques ne présentent pas l'effet d'apprentissage implicite (en particulier l'écart S5-R2)

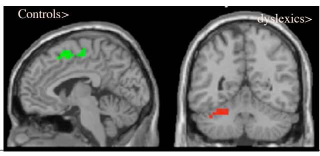


Controls R1-R2



Dyslexics R1-R2

Controls S1-S2



Dyslexics S4-S5

Evidence for an Articulatory Awareness Deficit in Adult Dyslexics

Sarah Griffiths, and Uta Frith*

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Table 1. Mean scores and Sds for dyslexic and control groups on standardized tests of intelligence and literacy

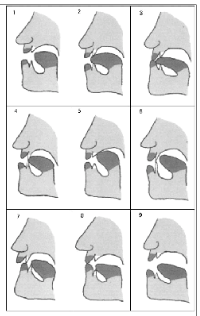
	Dyslexics ($N=17$)		Controls ($N=17$)		F
	Mean	S.D.	Mean	S.D.	
Age (years)	21.67	3.18	21.36	5.70	0.04
VESPAR spatial reasoning test†	11.06	1.25	11.65	0.86	2.56
VESPAR verbal reasoning test†	10.82	1.47	12.00	0.87	8.10**
WRAT reading†	97.94	6.46	113.53	6.53	48.99***
WRAT spelling†	93.00	13.92	113.24	8.24	26.60***

† = standard score.
Group differences significant at $^{**}p<0.01$.
$^{***}p<0.001$.

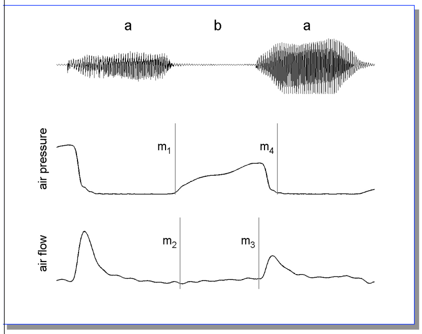
Table 2. Mean scores and Sds for dyslexic and control groups on tasks tapping phonological processing and articulatory awareness

Task	Dyslexics ($N=17$)		Controls ($N=17$)		F
	Mean	S.D.	Mean	S.D.	
Phoneme substitution (max = 10)	9.71	0.77	10.0	0.00	2.47
Digit span (standard score)	9.06	2.49	13.82	2.92	26.23***
Spoonerisms (max = 40)	27.88	8.37	34.18	5.14	6.98**
RAN digits (secs/50 items)	21.82	5.48	15.65	4.76	12.31***
RAN objects (secs/50 items)	36.03	9.10	29.36	5.67	6.58***
Articulatory awareness (max = 10)	5.06	1.98	7.24	1.52	12.88***

Group differences significant $^{*}p<0.05$.
$^{**}p<0.01$.
$^{***}p<0.001$.



DYSLEXIA 8: 14–21 (2002)
DOI: 10.1002/dys.201



duration of the closing phase ($m_2 - m_1$)

* duration of the full closure phase ($m_3 - m_2$)

* duration of the release phase ($m_4 - m_3$)

Articulatory aspects of developmental phonological dyslexia

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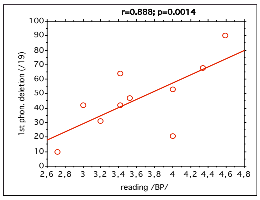
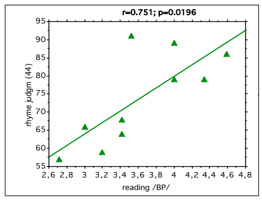


Suppression 1er phonème



Jugement de rimes

Significant correlation between judges' evaluation and performance on phonological tasks

Lalain et al., 2002

Neuropsychologia xxx (2006) xxx–xxx

Deviant neurophysiological responses to phonological regularities in speech in dyslexic children

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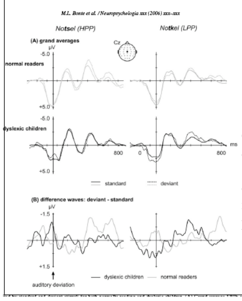
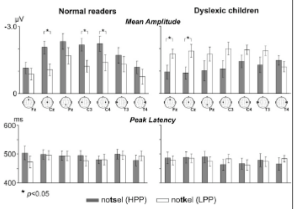
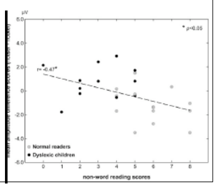
Received 26 October 2005; received in revised form 18 October 2006; accepted 16 November 2006





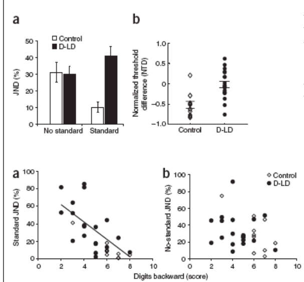
Comparaison par MMN de 12 dys et 14 temoins sur une tâche de discrimination de pseudo-mots soit à haute ou basse probabilité phonotactique



ARTICLES
nature neuroscience

Dyslexia and the failure to form a perceptual anchor

Merav Ahissar[1,2], Yedida Lubin[3], Hanna Putter-Katz[2,6] & Karen Banai[4,5]



Etude I : discriminer deux tons de hauteur différentes (lequel des deux est le plus haut?) soit en condition standard (hauteur fixe à 1000 Hz) soit non standard (pas de hauteur fixe)

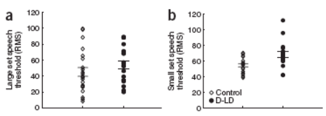


Figure 3 Speech perception thresholds of D-LDs and control individuals for large and small stimulus sets. **(a)** Individual thresholds for the large set in noise (Study I, D-LDs and Control-2 individuals). Thresholds of controls and D-LDs do not significantly differ. **(b)** Individual thresholds for the small set (Study II, D-LDs and Control-2 individuals) in noise. Most D-LDs perform worse than most control individuals.

Etude II : répétition de non-mots dans du bruit. Procédure adaptative (augmentation du bruit lorsque seuil de 80% de discrimination atteint). Si les non-mots proviennent d'un ensemble réduit (10) les contrôles sont meilleurs, pas les dyslexiques

DOI: 10.1093/brain/awg076 *Brain* (2003), **126**, 841–865

Theories of developmental dyslexia: insights from a multiple case study of dyslexic adults

Franck Ramus,[1,5] Stuart Rosen,[2] Steven C. Dakin,[3] Brian L. Day,[4] Juan M. Castellote,[4,6] Sarah White[1] and Uta Frith[1]

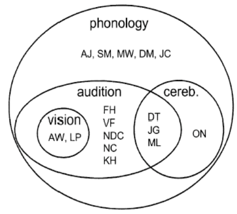


Fig. 4 Distribution of phonological, auditory, visual and cerebellar disorders in the sample of 16 dyslexic adults. Initials refer to individual dyslexic subjects.

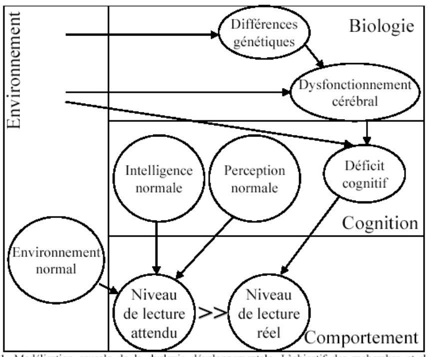
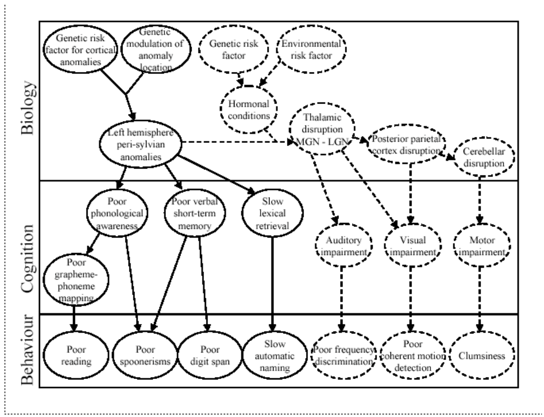


Figure 1. Modélisation causale de la dyslexie développementale. L'objectif des recherches et de préciser l'enchaînement des causes génétiques, cérébrales, cognitives et environnementales qui conduisent aux manifestations comportementales de la dyslexie.

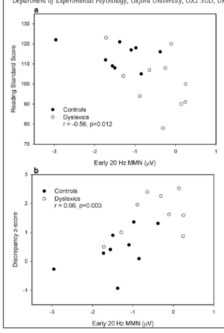


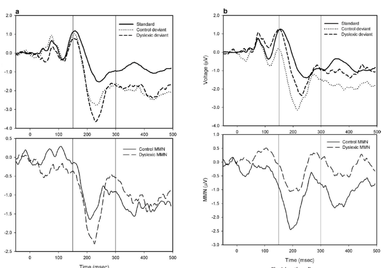
Research Report

Auditory event-related potentials differ in dyslexics even when auditory psychophysical performance is normal

Catherine J. Stoodley[a,], Penelope R. Hill[b], John F. Stein[a], Dorothy V.M. Bishop[b]*

[a]Department of Physiology, Anatomy and Genetics, Oxford University, OX1 3PT, UK
[b]Department of Experimental Psychology, Oxford University, OX1 3UD, UK





Grand average waveforms to the standard and deviant stimuli (top) and the MMN differential waveforms (bottom)for 5 (a), 20 (b) and 240 (c) Hz FM. Top: Standard stimuli (solid black) did not significantly differ between groups. Bottom: Control (solid black) and dyslexic (dashed line) MMNresponses differed in the 20 Hz FM condition (b). Vertical lines indicate theearly MMN range (150–300 ms) and late MMN range (300–500 ms).

European Journal of Neuroscience, Vol. 24, pp. 2420–2427, 2006 doi:10.1111/j.1460-9568.2006.05100.x

Speech- and sound-segmentation in dyslexia: evidence for a multiple-level cortical impairment

T. Kujala,[1,2,3,4] J. Halmetoja,[1] R. Näätänen,[1,3] P. Alku,[5] H. Lyytinen[6] and E. Sussman[1,7]
[1]Cognitive Brain Research Unit, Department of Psychology, University of Helsinki, PO Box 9, 00014 Helsinki, Finland

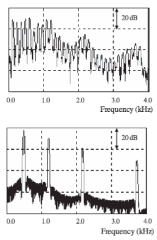
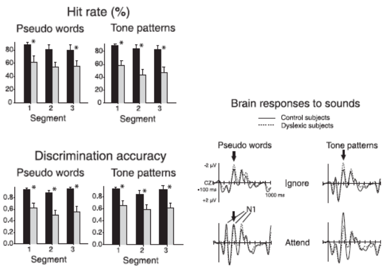


Fig. 1. Spectra of the stimuli illustrating the vowel segment of the pseudo-words (upper panel) and the corresponding tone-composite of the non-speech tone-pattern stimulus (lower panel).



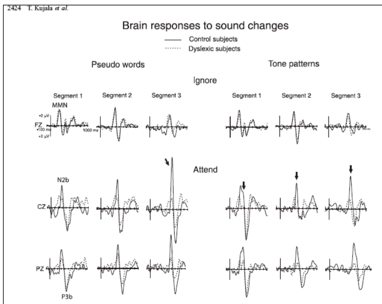
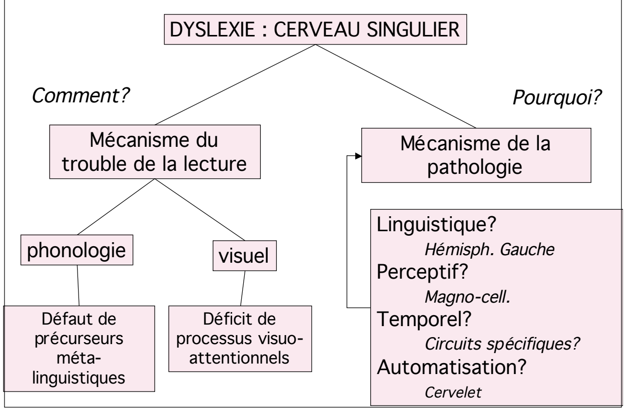
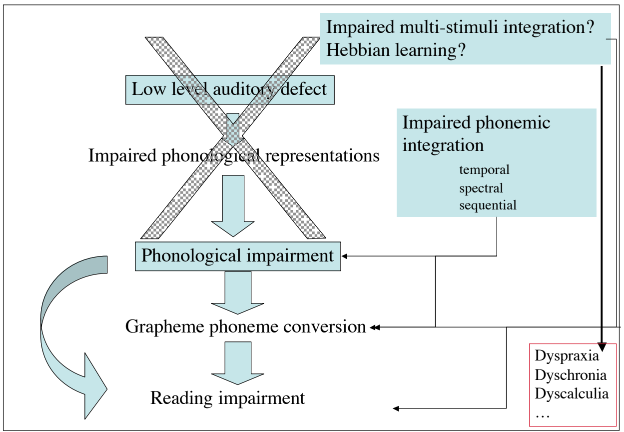


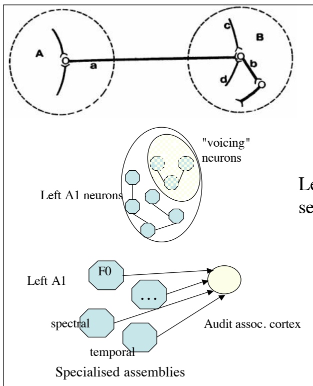
Fig. 4. Brain responses elicited by deviant pseudo-word and tone-pattern stimuli in the ignore (at frontal Fz electrode, at which the MMN is largest) and attend sessions (at central Cz electrode, at which the N2b is largest and at parietal Pz electrode, at which the P3b is largest). The responses are deviant-minus-standard difference waves. Segments 1, 2, and 3 refer to the corresponding position (first, middle and last, respectively) of the deviant sound in the pseudo-word/tone pattern. In the ignore session, an MMN is elicited by each deviant segment with a similar amplitude in both groups. In the attend session, the deviant segments elicit a prominent N2b and P3b. Significant amplitude differences were found between the groups for the N2bs elicited by the 3rd deviant speech segment and by all deviant tone pattern segments (marked with arrows).

The finding of group differences in response to deviants embedded both in speech- and in non-speech stimulus tokens (indicated by both behavioral and brain measures) suggests that dyslexic individuals have problems in both speech and non-speech sound processing….

… support the theory that auditory impairments in dyslexia are not specific to speech.







Hebb's synapse: if axon **a** fires when neuron **B** is being activated by c and d, then the connection between **A** and **B** will be increased

Learning voiced/unvoiced contrast : segregation of relevant neuron clusters

Integration of multiple auditory patterns (e.g. prosody)

Hebbian learning : some examples

Temporally asymmetric learning (Hebb, 1949) = spike-based temporal difference

- An input synapse to a given neuron that is activated slightly before the neuron fires is strengthened, whereas a synapse activated slightlyafter is weakened
- This window of plasticity ranges from -40 to +40 msec
- This mechanism would cause multiple neurons in the primary auditory cortex that fire nearly simultaneously to bind together

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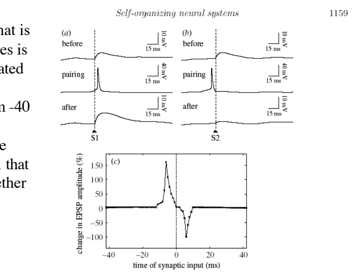
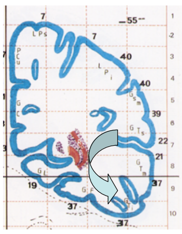
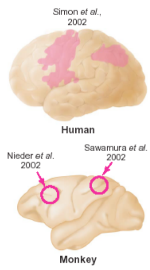


Figure 4. Synaptic plasticity in a model neocortical neuron. (*a*) EPSP in the model neuron evoked by a presynaptic spike (S1) at an excitatory synapse ('before'). Pairing this presynaptic spike with postsynaptic spiking after a 5 ms delay ('pairing') induces long-term potentiation ('after'). (*b*) If presynaptic stimulation (S2) occurs 5 ms after postsynaptic firing, the synapse is weakened, resulting in a corresponding decrease in peak EPSP amplitude. (*c*) Temporally asymmetric window of synaptic plasticity obtained by varying the delay between pre- and post-synaptic spiking (negative delays refer to presynaptic before postsynaptic spiking). (From Rao & Sejnowski (2001).)



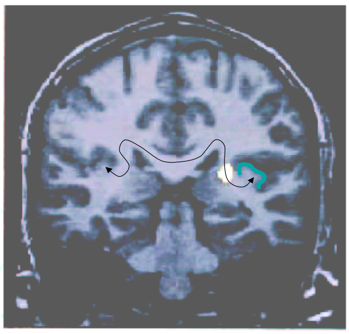
Visual word form (BA37)



Learning grapheme-phoneme conversion : the fundamental defect in dyslexia

Learning numerical value of quantities : the fundamental defect in dyscalculia

Hebbian learning : further speculations



Conclusion : la synapse de Hebb comme explication de la dyslexie et des troubles apparentés

- Explique à la fois les déficits auditifs et visuels de bas niveau et des déficit de niveau plus complexe, y compris des déficits multimodaux
- Peut expliquer la coexistence de signes visuels et auditifs
- A mené à des applications thérapeutiques (toutefois récentes et à confirmer)
- Explique que les résultats soient différents selon la nature linguistique ou non des stimuli
- Explique surtout la coexistence de déficits extra-linguistiques chez les dyslexiques (dyscalculie, dyspraxie…et même précocité intellectuelle)
- est compatible avec les constatations d'anomalies morphologiques intra- et inter-hémisphériques