Bases neurales del aprendizaje :
plasticidad y remediationes

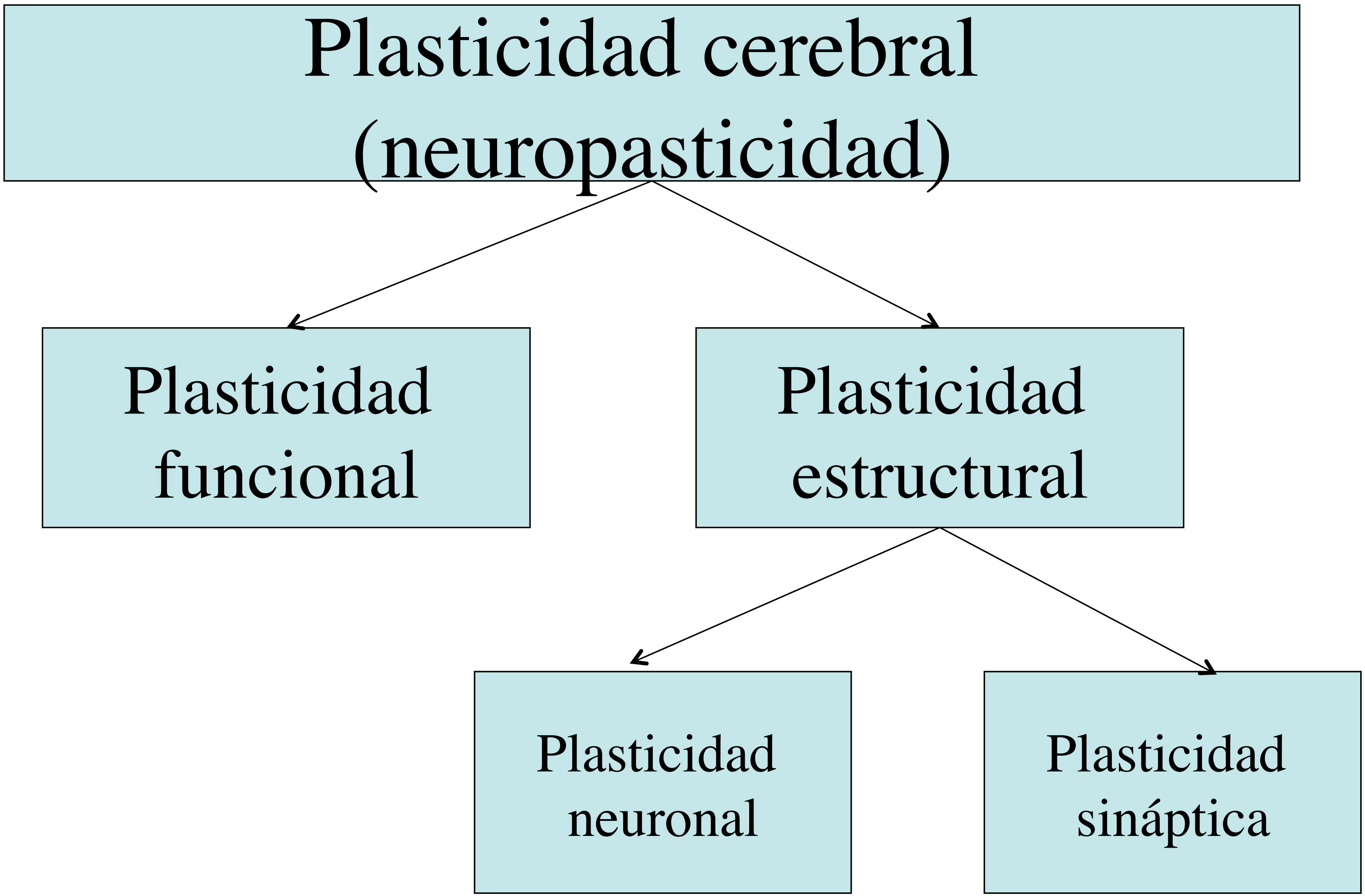
http://www.resodys.org

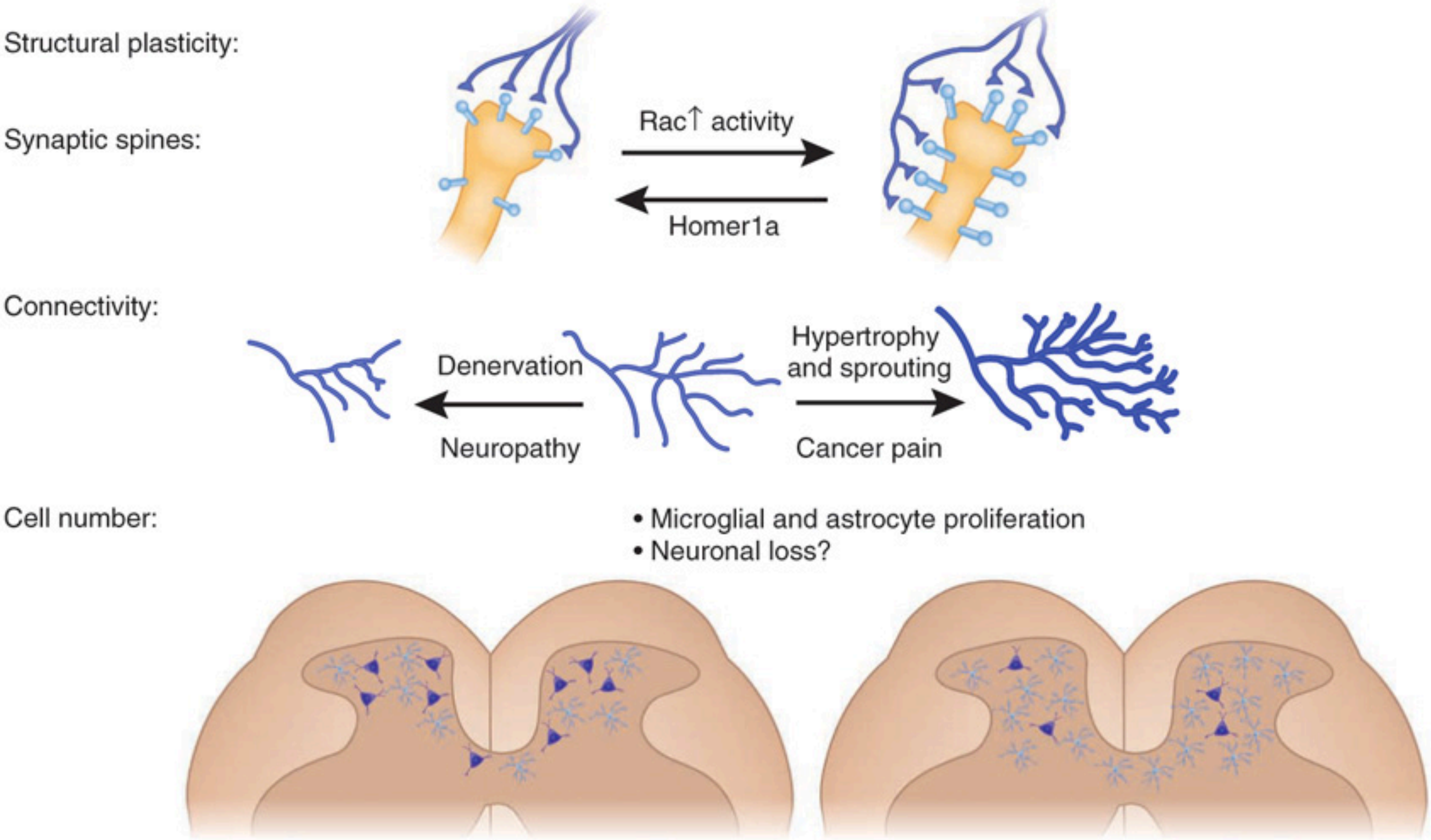
Plasticidad cerebral: definición

La plasticidad del cerebro (=neuroplasticidad =): la capacidad del sistema nervioso central (SNC) cambiar su estructura y función en respuesta a presiones ......

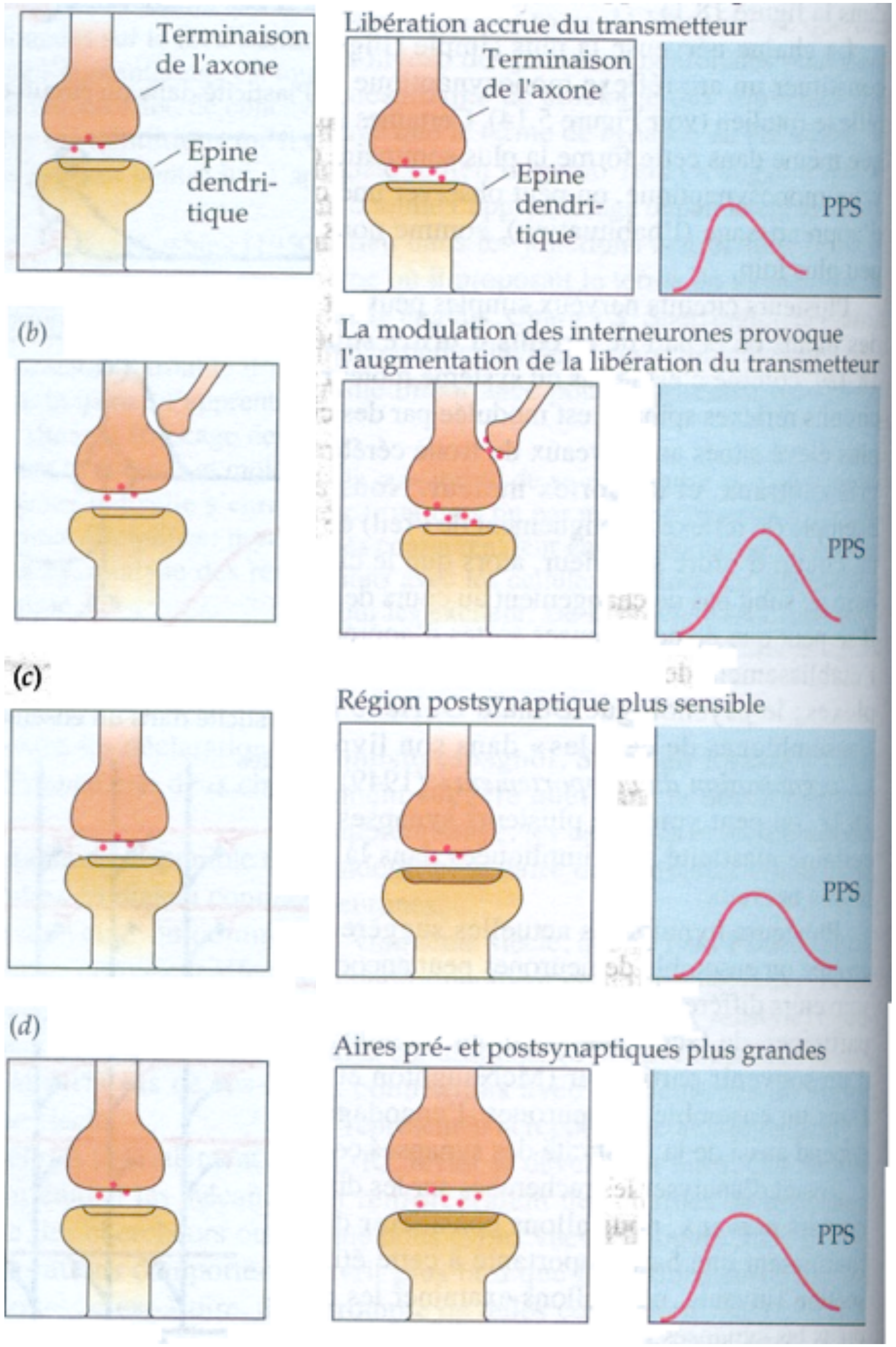
- Internas:
  - desarrollo, maduración, envejecimiento
  - experiencia
  - daños del SNC (lesiones).
- Externas:
  - nuevas adquisiciones (entranamiento)
  - enriquecimiento / privaciones sensoriales
  - sustancias farmacológicas

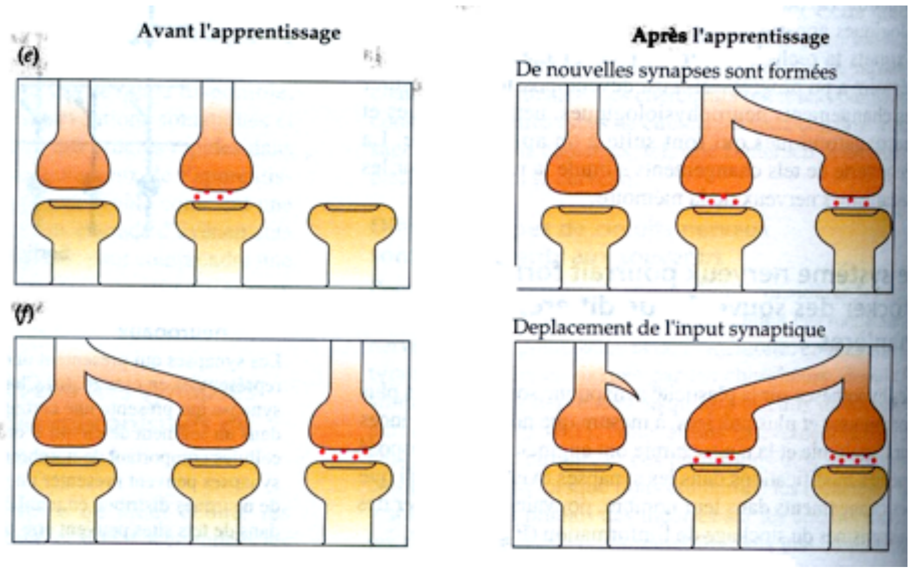
etc.…y esto durante toda la vida


Plasticidad cerebral (neuropasticidad)
Plasticidad funcional
Plasticidad estructural
Plasticidad neuronal
Plasticidad sináptica



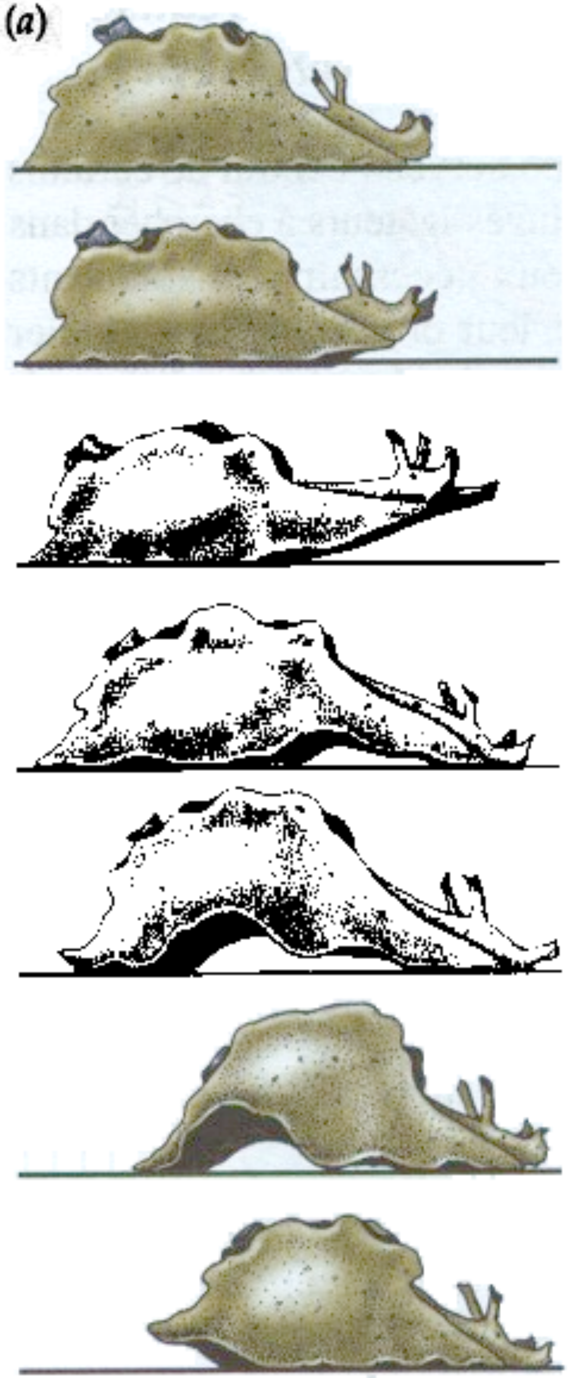
Structural plasticity:
Synaptic spines:
Rac↑ activity
Homer1a
Connectivity:
Denervation
Neuropathy
Hypertrophy
and sprouting
Cancer pain
Cell number:
• Microglial and astrocyte proliferation
• Neuronal loss?

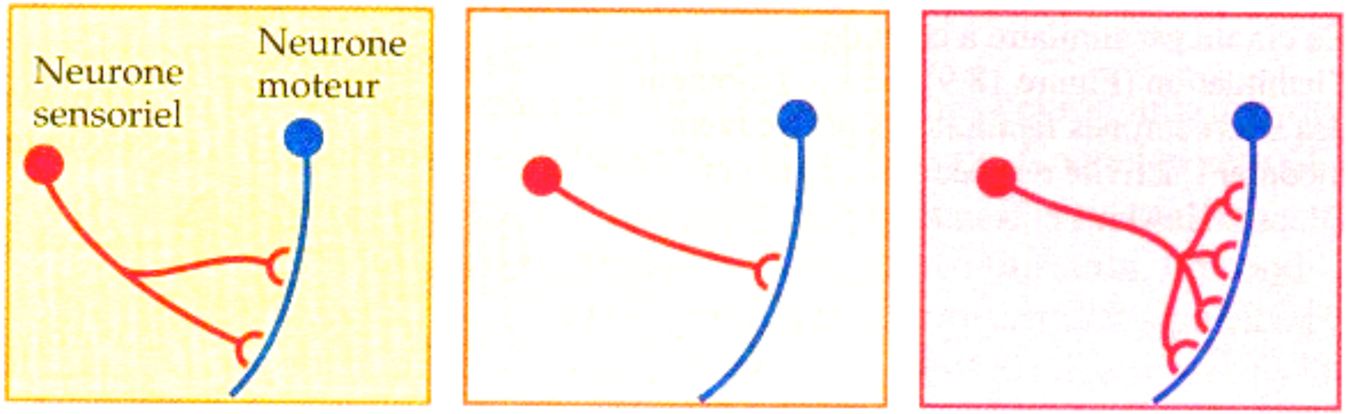




Varios cambios sinápticos asociados con el aprendizaje

(a)



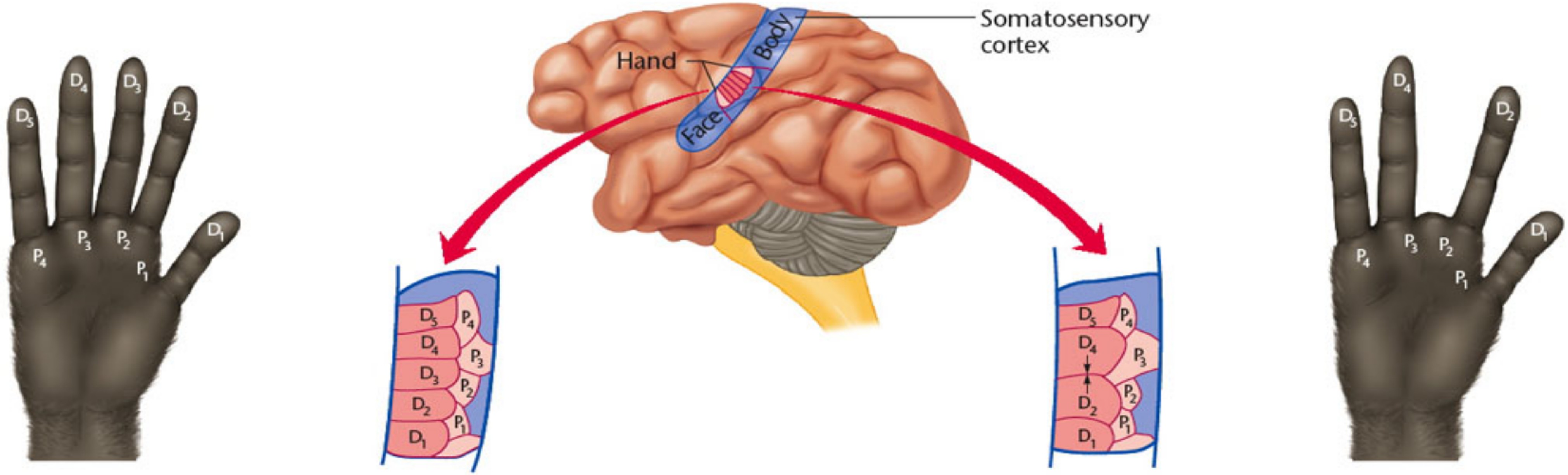


Control

habituación a largo plazo

sensibilisación a largo plazo

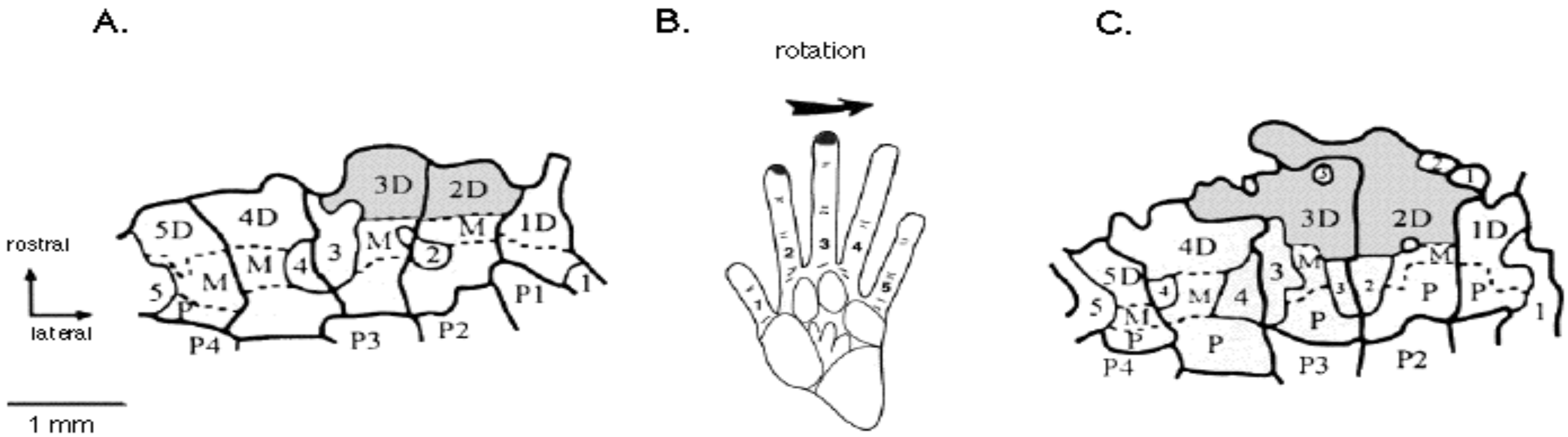
La aplysia : « star » de la neurociencia del aprendizaje



(a) Normal (before amputation)

(b) After amputation of 3rd digit

Fig. 5-17, p. 142



• Daily intensive training with sensory-motor task in monkey modifies brain functional maps (Jenkins et al., 1990)
• A few minutes/day practice is enough to significantly modify cortical surface (Xerri et al., 1999)

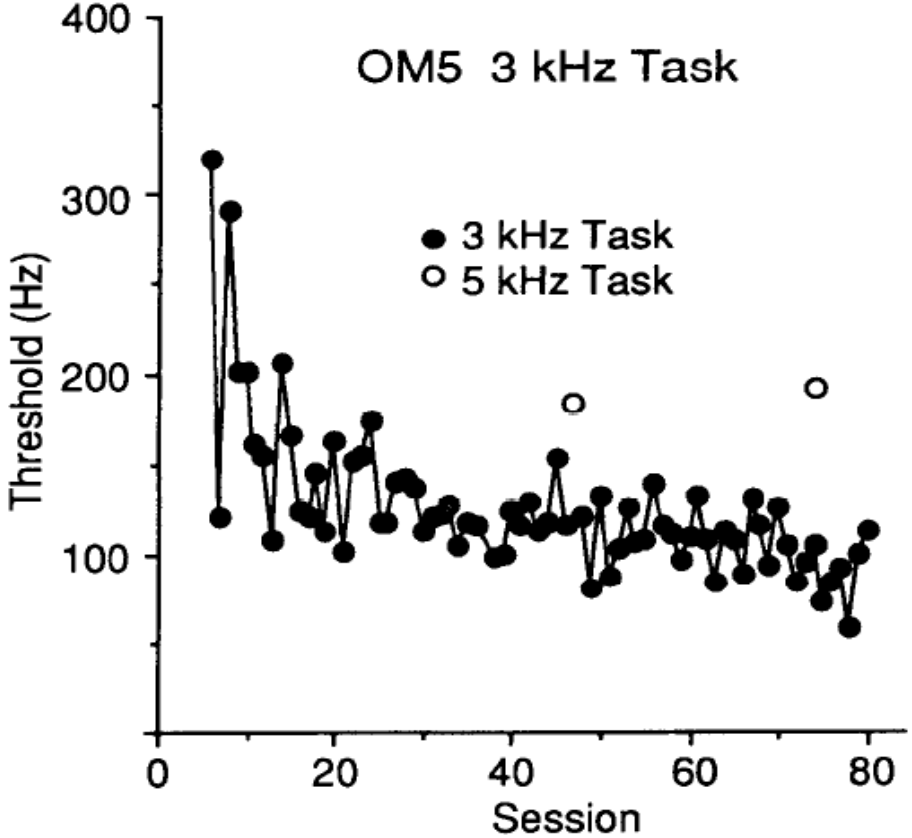
The Journal of Neuroscience, January 1993, 13(1): 87–103

Plasticity in the Frequency Representation of Primary Auditory Cortex following Discrimination Training in Adult Owl Monkeys

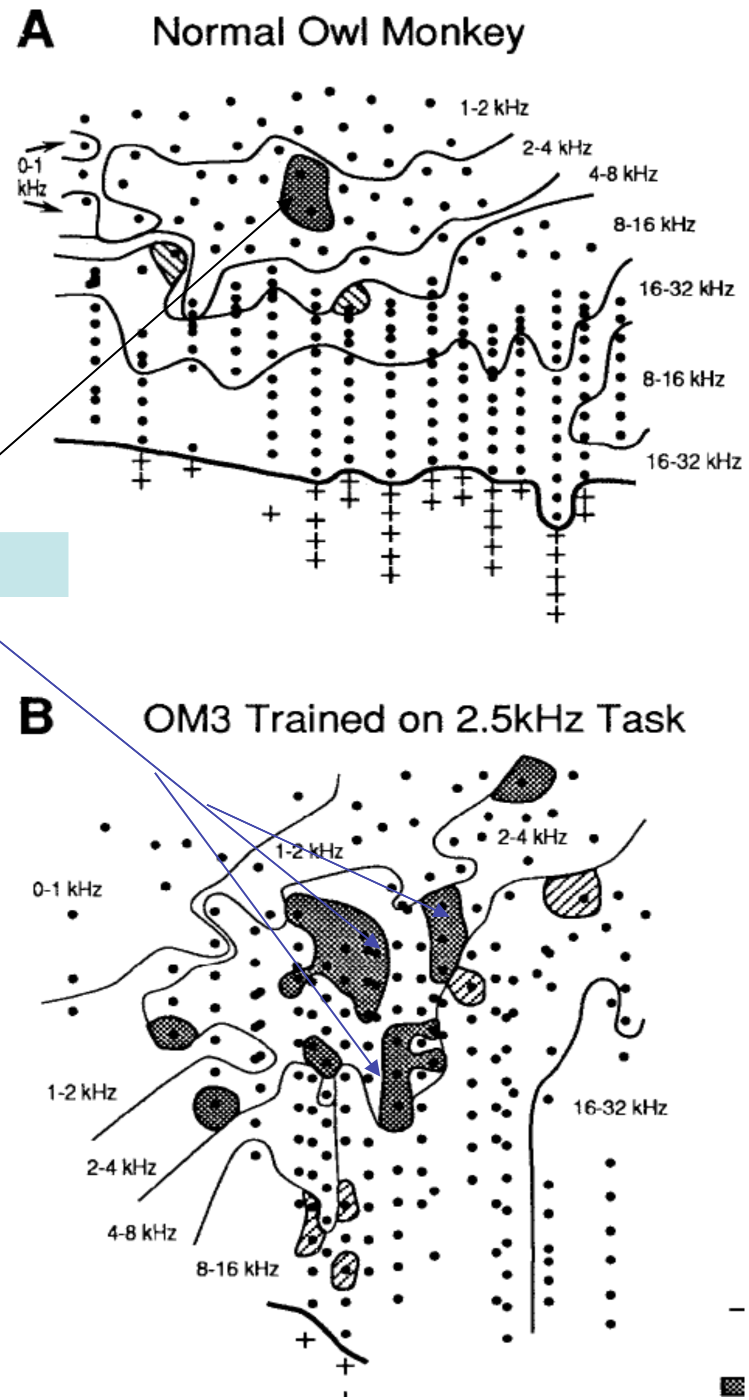
G. H. Recanzone,[1] C. E. Schreiner, and M. M. Merzenich

Coleman Laboratory, Departments of Otolaryngology and Physiology and Keck Center for Integrative Neuroscience, University of California at San Francisco, San Francisco, California 94143-0732

Tonotopic maps in the auditory cortex can also be modified by training specific frequencies



2.5 kHz frequencies



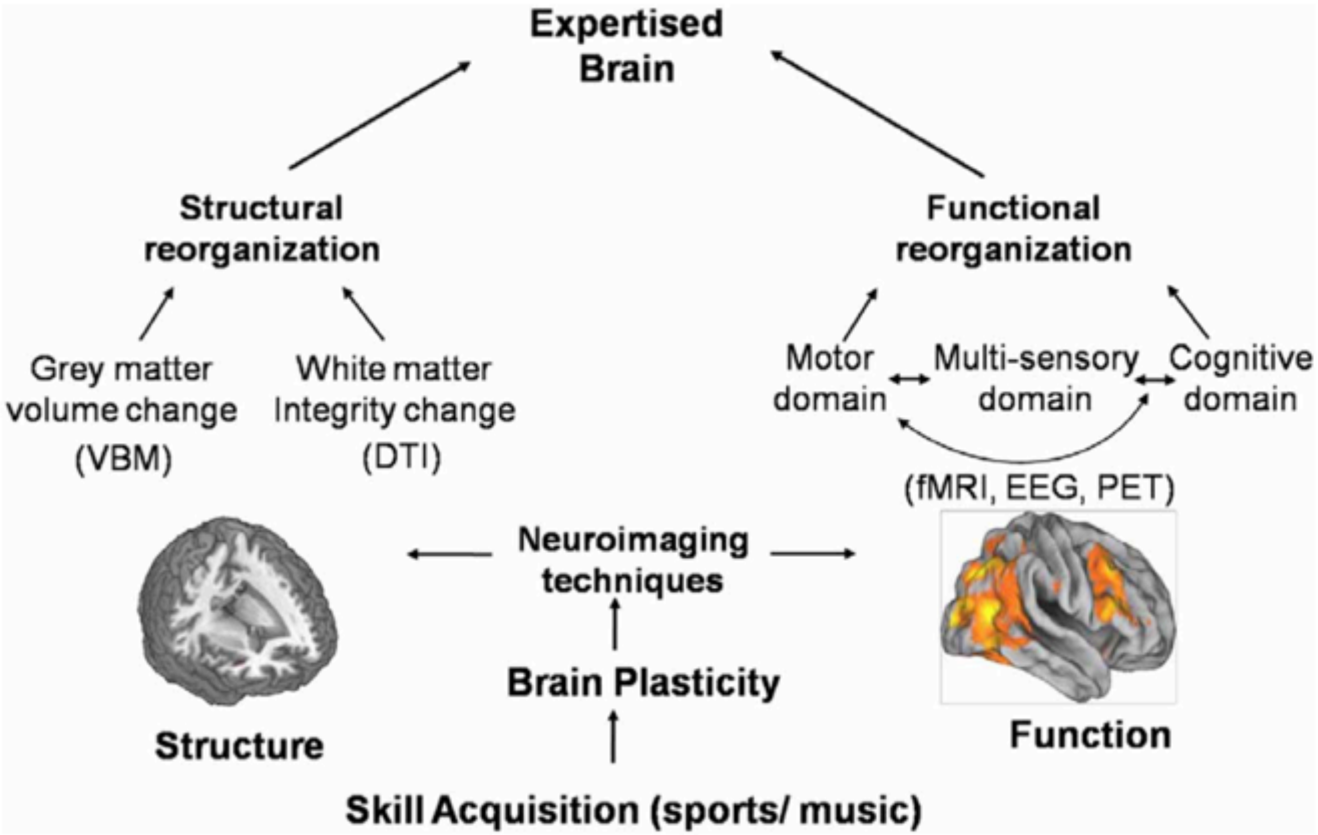
frontiers in
HUMAN NEUROSCIENCE

MINI REVIEW ARTICLE
published: 04 February 2014
doi: 10.3389/fnhum.2014.00035

Reorganization and plastic changes of the human brain associated with skill learning and expertise

Yongmin Chang*

Department of Molecular Medicine and BK21 Plus KNU Biomedical Convergence Program, Kyungpook National University School of Medicine, Daegu, South Korea



FUNCTIONAL PLASTICITY				
Pearce et al., 2000	Sports	Cross-sectional	TMS	Cortical representation of the hand used for playing is larger in professional racquet ball players
Milton et al., 2007	Sports	Cross-sectional	fMRI	Elite athletes showed neural efficiency in the cortical processes during the specific challenge in which they are highly practiced
Sekiguchi et al., 2011	Sports	Cross-sectional	fMRI	Elite rugby players differ in visuospatial abilities directly tied to their domain of expertise
Doyon et al., 2002	Sports	Longitudinal	fMRI	Shift of activation from the cerebellar cortex to the dentate nucleus during early learning, and from a cerebellar–cortical to a striatal–cortical network with extended practice
Cross et al., 2009	Sports	Longitudinal	fMRI	Emergence of action resonance processes in the human brain based on 5 day observational learning of dance sequence without physical practice
Lotze et al., 2003	Music	Cross-sectional	EMG	Professional violinists showed focused cerebral activations in the motor network as compared to amateur violinists during the imagination of violin-playing movements
Oechslin et al., 2013	Music	Cross-sectional	fMRI	Levels of musical expertise stepwise modulate higher order brain functioning
Bangert and Altenmüller, 2003	Music	Longitudinal	EEG	Auditory-sensorimotor co-activity occurred within only 20 min and the effect was enhanced after 5-week training, contributing elements of both perception and action to the mental representation of the instrument
Herdener et al., 2010	Music	Longitudinal	fMRI	Following the aural skills training, hippocampal responses to temporal novelty in sounds were increased

Study	Skill	Design	Method	Main findings
STRUCTURAL PLASTICITY				
Jacini et al., 2009	Sports	Cross-sectional	VBM	Judo players showed larger GM volume in frontal and prefrontal cortex
Jäncke et al., 2009	Sports	Cross-sectional	VBM, DTI	Golfers showed Larger GM volumes in premotor and parietal cortices; smaller FA along the internal and external capsule and the parietal operculum
Di Paola et al., 2013	Sports	Cross-sectional	VBM	Mountain climbers showed significantly larger vermian lobule volumes
Draganski et al., 2004	Sports	Longitudinal	VBM	Three months' practice-induced GM expansion in mid-temporal area and posterior intraparietal sulcus, followed by a decreased to baseline levels after 3 months with no practice
Bezzola et al., 2011	Sports	Longitudinal	VBM	Forty hours of golf training showed an association with gray matter increases in a task-relevant cortical network
Amunts et al., 1997	Music	Cross-sectional	MRI	Hand motor area was larger in professional musicians than in non-musicians
Gaser and Schlaug, 2003	Music	Cross-sectional	VBM	GM volume differences in sensorimotor cortex, premotor cortex, and cerebellum
Han et al., 2009	Music	Cross-sectional	VBM, DTI	Musician showed higher GM density in sensorimotor cortex and cerebellum; higher FA in internal capsule
Hyde et al., 2009	Music	Longitudinal	DBM	Fifteen months of musical training in early childhood showed structural change in brain areas which are known to be involved in control of playing a musical instrument

Training induces changes in white-matter architecture

Jan Scholz[1], Miriam C Klein[1,2], Timothy E J Behrens[1,2] &
Heidi Johansen-Berg[1]

Although experience-dependent structural changes have been found in adult gray matter, there is little evidence for such changes in white matter. Using diffusion imaging, we detected a localized increase in fractional anisotropy, a measure of microstructure, in white matter underlying the intraparietal sulcus following training of a complex visuo-motor skill. This provides, to the best of our knowledge, the first evidence for training-related changes in white-matter structure in the

Juggling training in naive adults

24 training → 24 control

MRI x3 : T0; 6 weeks; 4 weeks after training

Grey matter density | DTI anisotropy

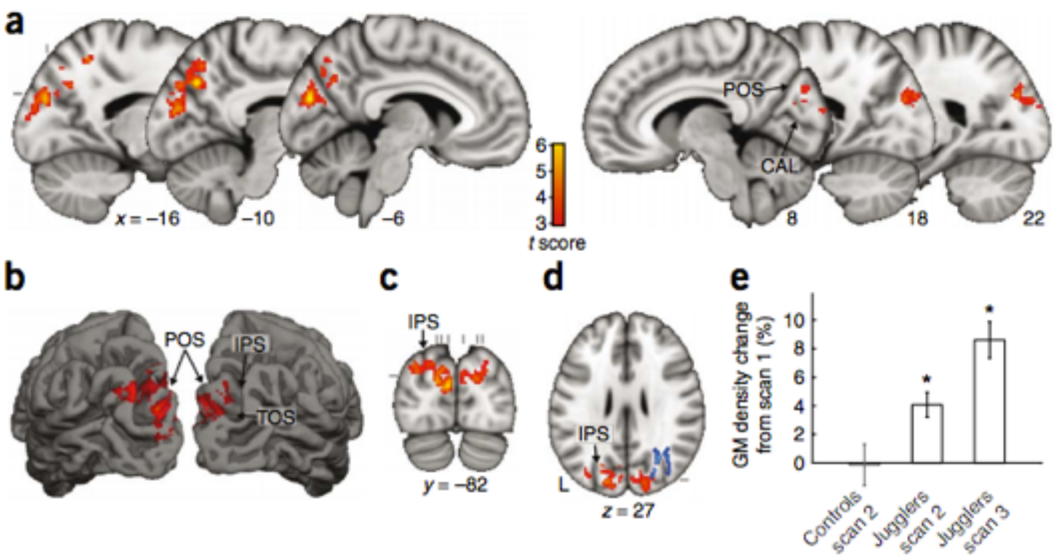


Figure 2 Gray-matter density increases after juggling training. (**a**–**d**) Red and yellow voxels represent clusters ($P < 0.05$, corrected) of significant gray-matter density increase from scan 1 to scan 2,

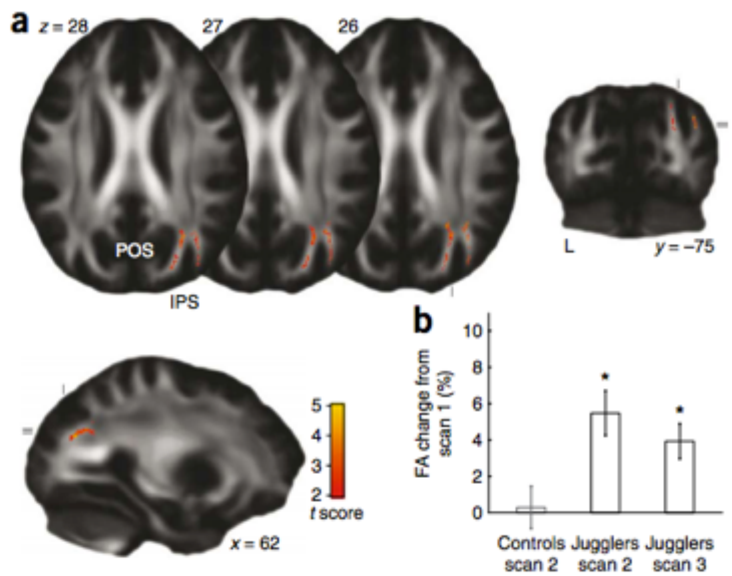


Figure 1 Fractional anisotropy increases after juggling training.

frontiers in
HUMAN NEUROSCIENCE
ORIGINAL RESEARCH ARTICLE
published: 04 July 2013
doi: 10.3389/fnhum.2013.00335

Structural changes in left fusiform areas and associated fiber connections in children with abacus training: evidence from morphometry and tractography

Yongxin Li[1], Yunqi Wang[2,3], Yuzheng Hu[1], Yurong Liang[4] and Feiyan Chen[1]*

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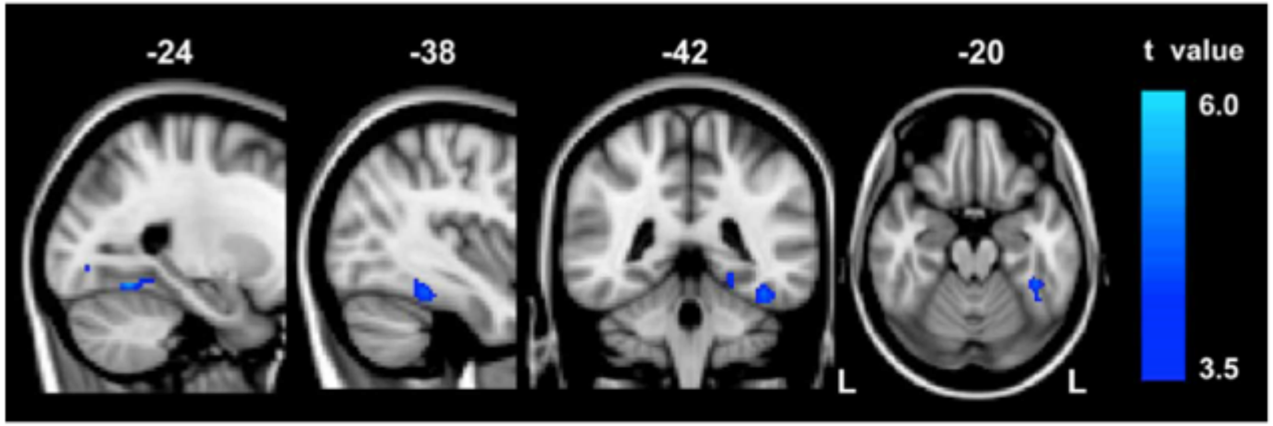
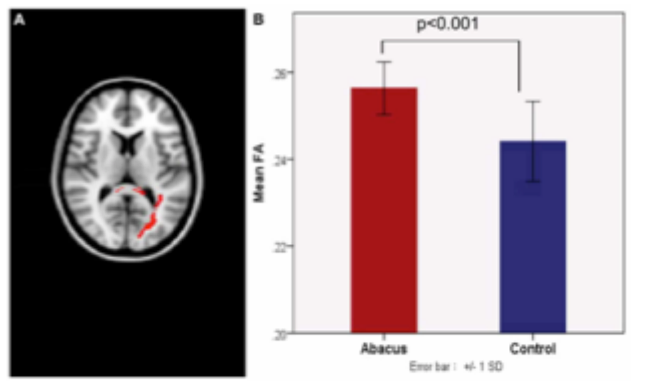
[2] School of International Studies, Zhejiang University, Hangzhou, P. R. China
[3] Department of Psychology and Behavioral Sciences, Zhejiang University, Hangzhou, P. R. China
[4] Heilongjiang Abacus Association, Haerbin, P. R. China





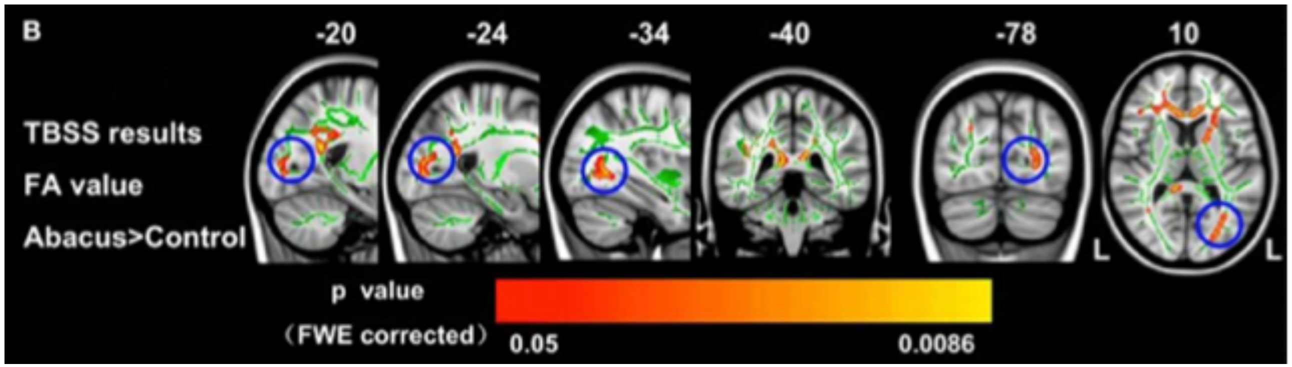
v tract projection pathway, such as left forceps formed from left FG to other brain regions in the This tract pathway was extracted as white matter

mask. **(B)** Mean fractional anisotropy within this whi was significantly increased in children with abacus tr deviation.

1°) Decreased GM in left fusiform

2°)Increased WM FA in left forceps major

3°) significant negative correlation was found in the the GM volume in left FG ar FA value in left forceps major



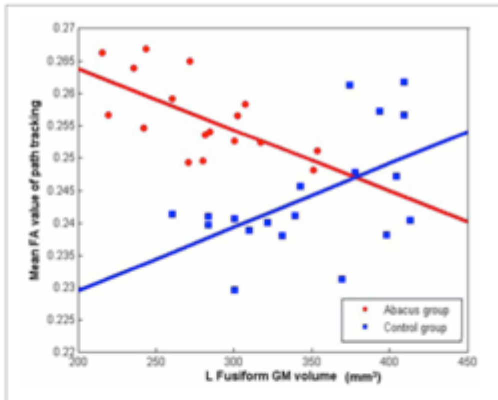
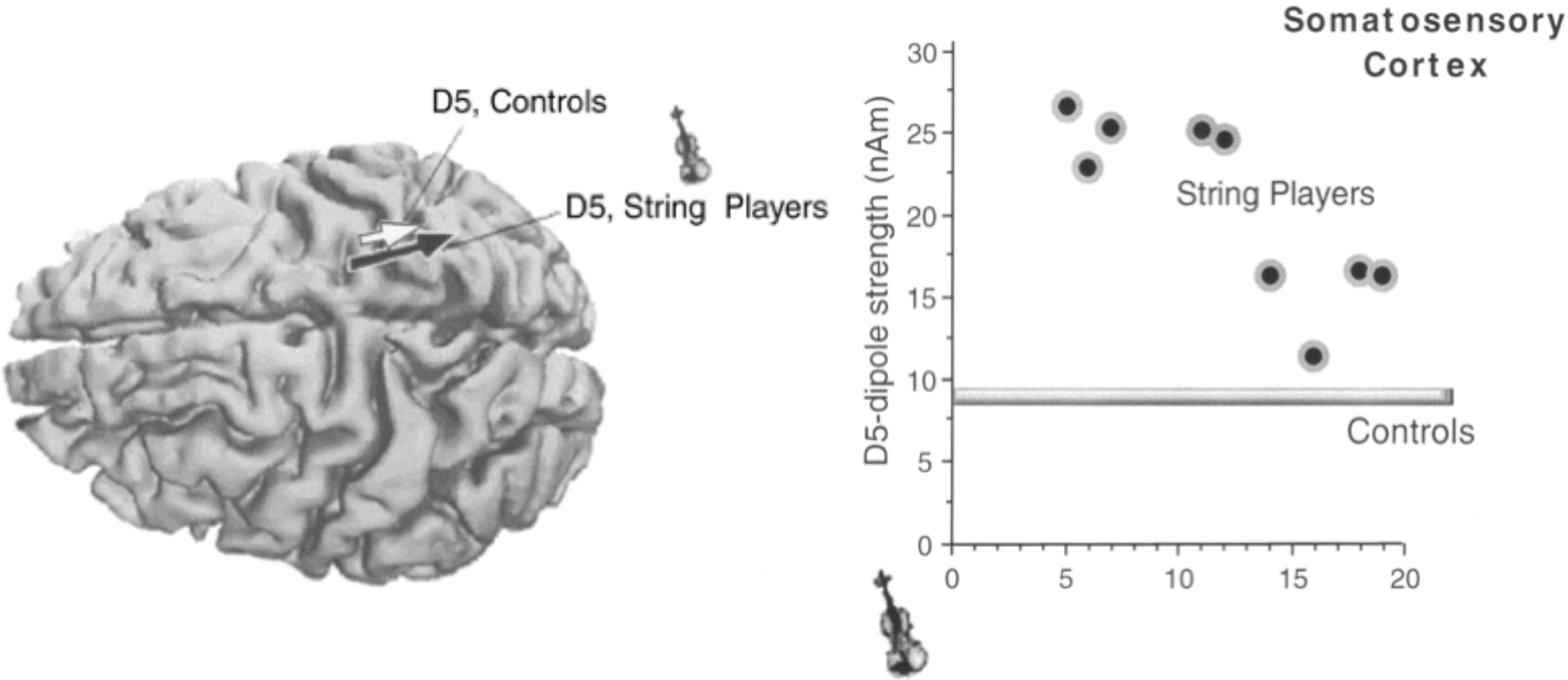


FIGURE 4 | The correlation between the mean FA value of left forceps major tracts and the GM volume in left FG. Mean FA values extracted



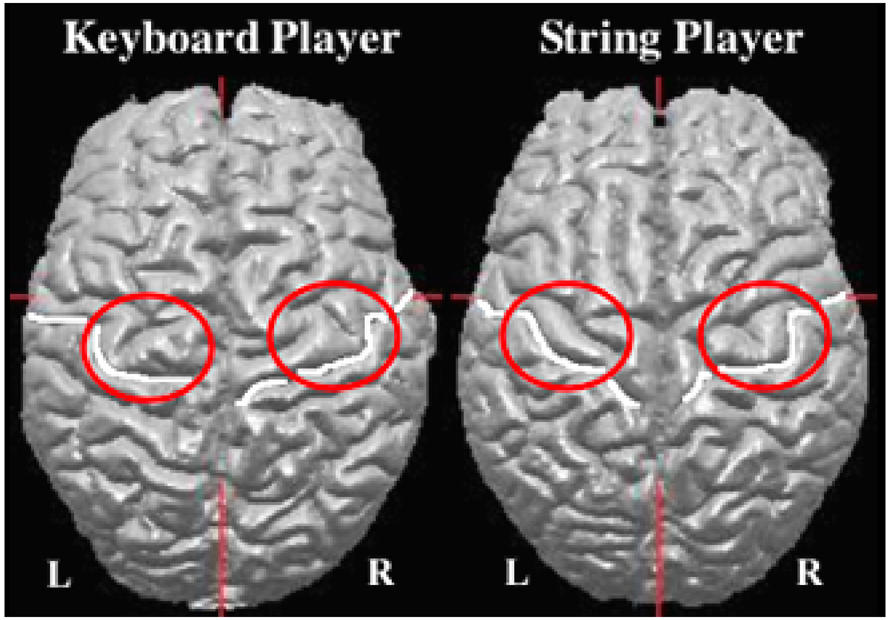
Left hand fifth finger in string instrument players (MEG study, Elbert et al., 1998). Larger dipole in right somatosensory area. Effect of learning age.

Effects of Music Training on the Child's Brain and Cognitive Development

GOTTFRIED SCHLAUG,[a] ANDREA NORTON,[a] KATIE OVERY,[a]
AND ELLEN WINNER[b]

[a]*Department of Neurology, Music and Neuroimaging Laboratory, Beth Israel Deaconess Medical Center/Harvard Medical School, Boston, Massachusetts 02215, USA*

[b]*Department of Psychology, Boston College, Boston, Massachusetts 02215, USA*



professional keyboard players, who reported approximately twice as much weekly practice time as the amateur musicians, have significantly more gray matter in several brain regions, including the primary sensorimotor cortex, the adjacent superior premotor and anterior superior parietal cortex bilaterally, mesial Heschl' s gyrus (primary auditory cortex), the cerebellum, the inferior frontal gyrus, and part of the lateral inferior temporal lobe, than either the amateur musicians or the nonmusicians.

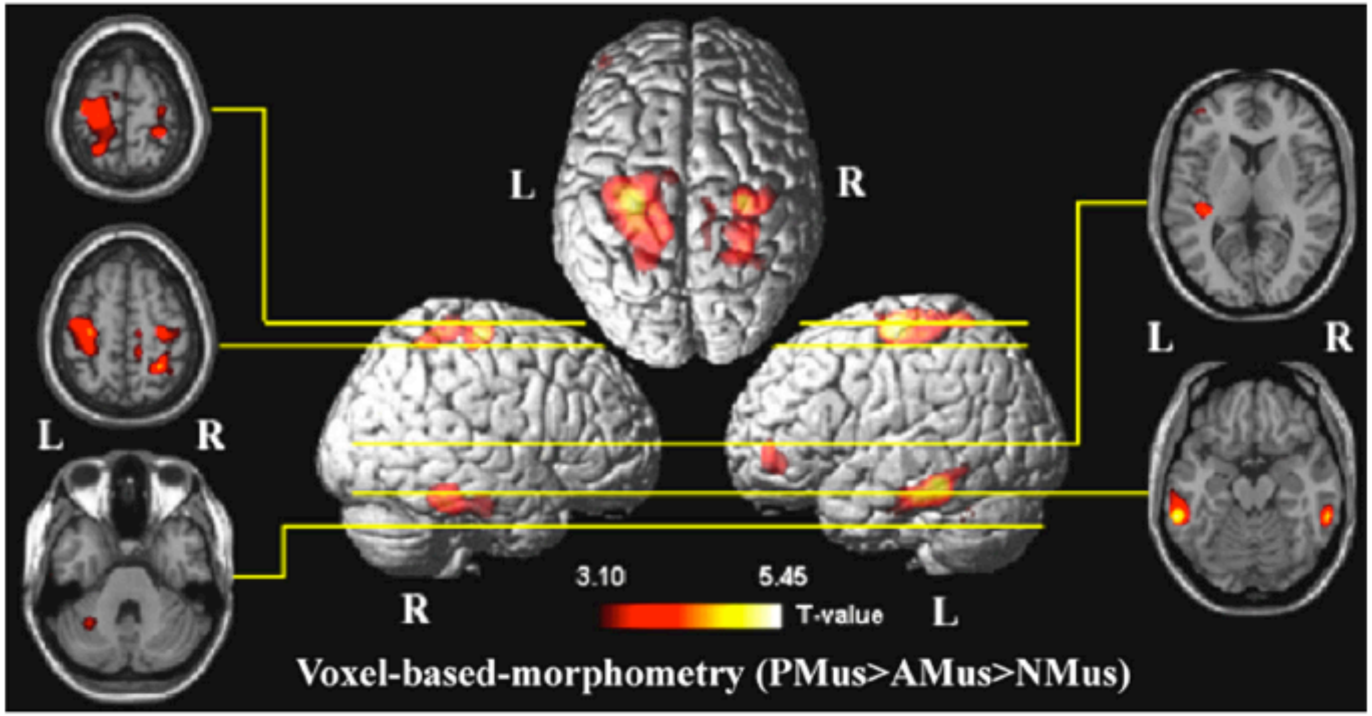
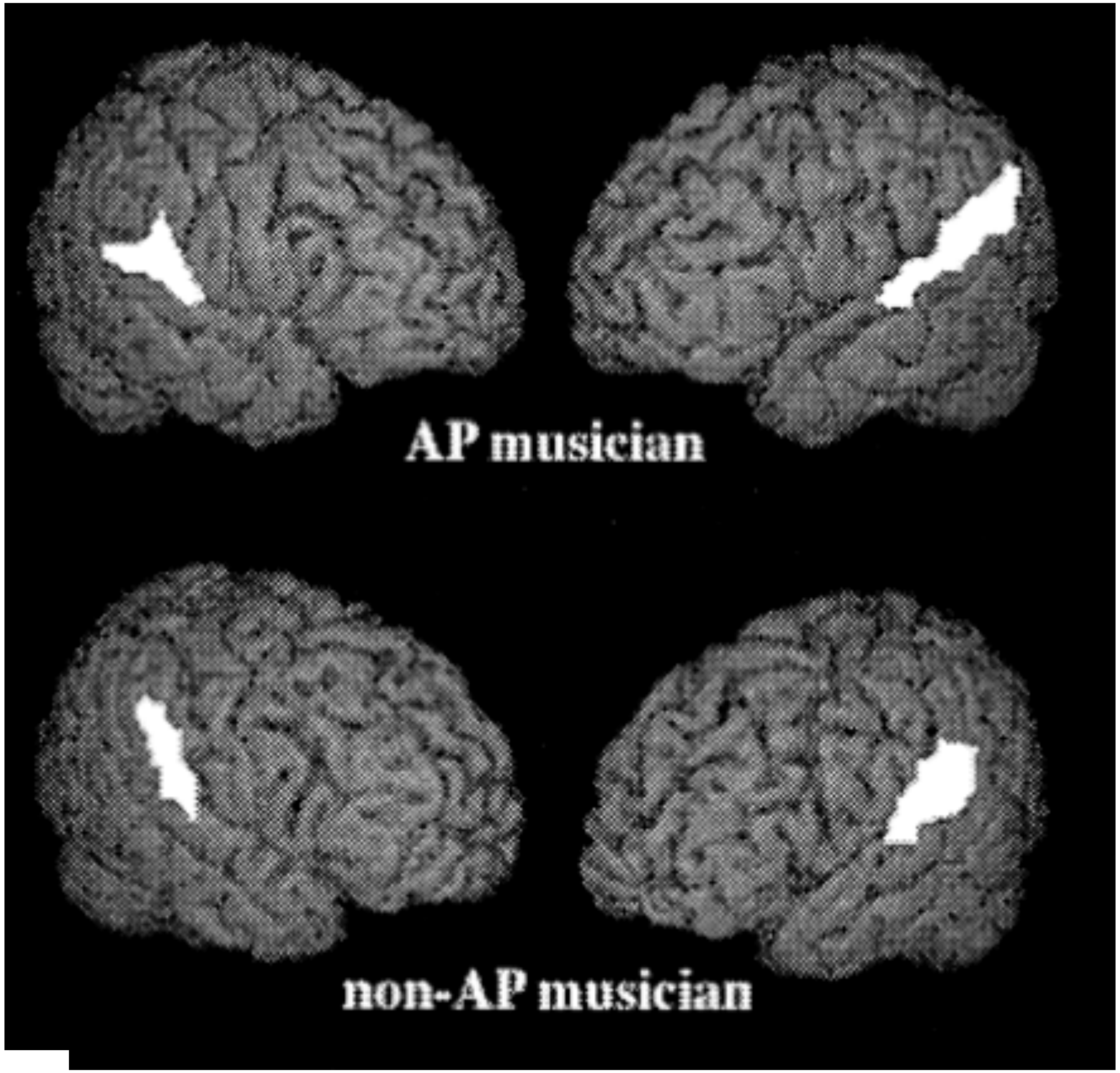


FIGURE 1. A voxel-based morphometric analysis of nonmusicians compared with amateur and professional musicians.

Planum asymmetry is larger in musicians with absolute pitch (AP)

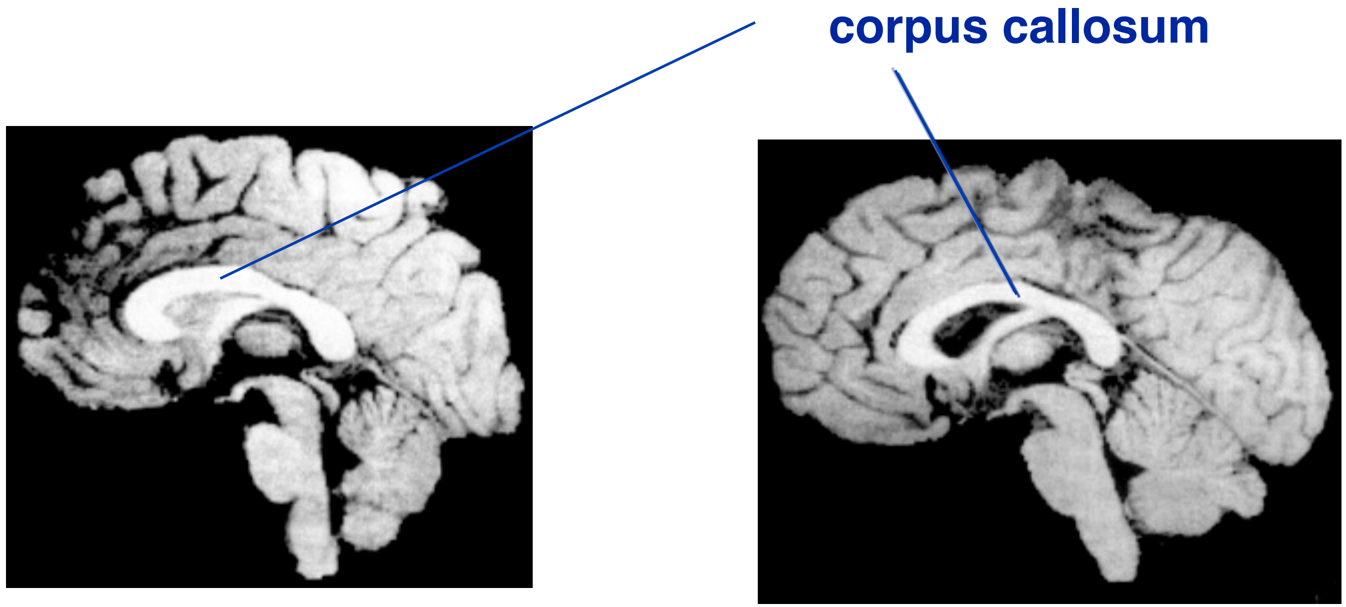


Subject	δPT	PT size (mm²)	
		Left	Right
AP musicians ($n = 27$)	−0.50 (0.27)[a]	1381 (449)	822 (236)
Non-AP musicians ($n = 24$)	−0.24 (0.14)	1350 (340)	1062 (267)
Nonmusicians ($n = 27$)	−0.28 (0.24)	1341 (306)	008 (285)

[a]Significant differences between AP musicians and non-AP musicians as well as between AP-musicians and nonmusicians.

GOTTFRIED SCHLAUG
The Brain of Musicians: A Model for Functional and Structural Adaptation
Ann NY Acad Sci 2001 930: 281-299.

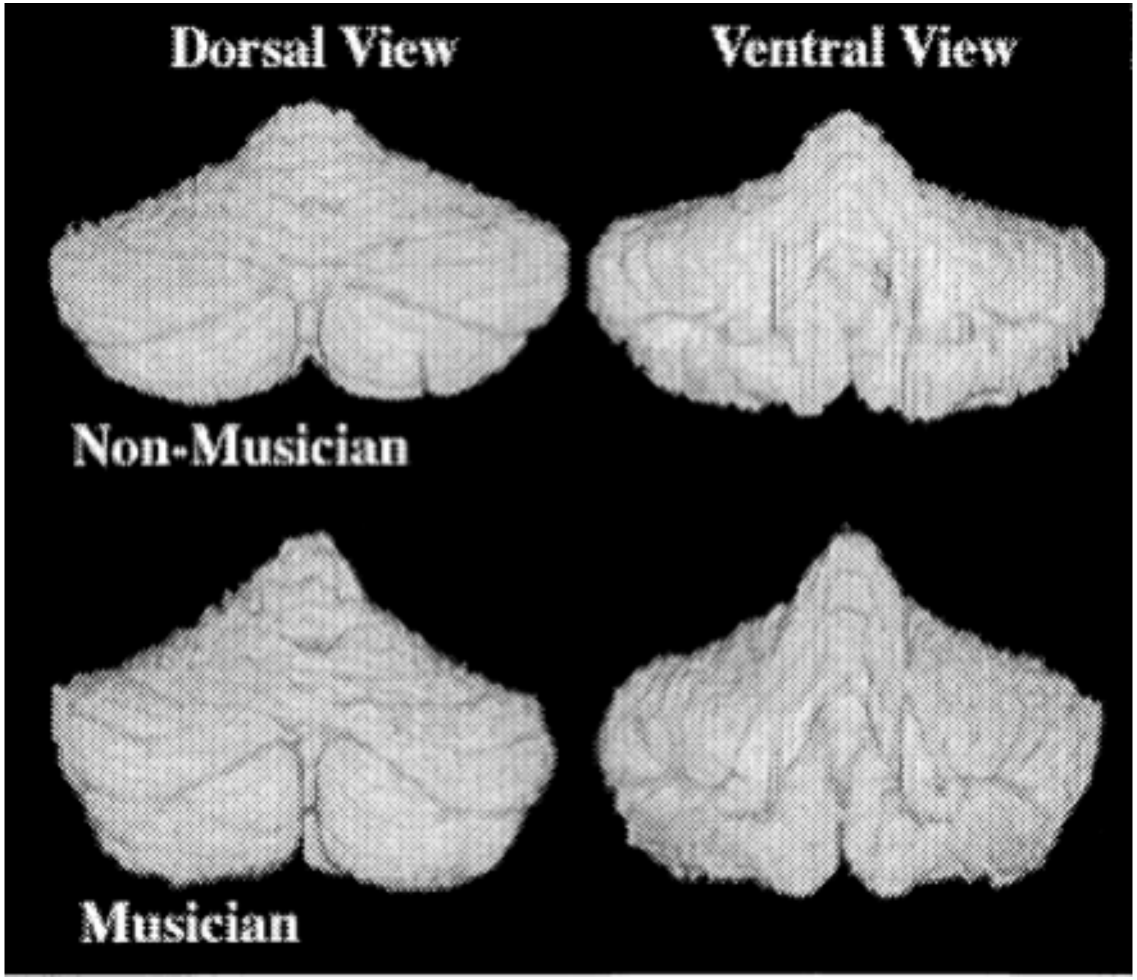
Anterior part of the callosum is larger in early-trained musicians



MUSICIAN **NON- MUSICIAN**

(Schlaug et al., 1995)

Le cervelet de musiciens (mâles) est plus volumineux de 5% (Schlaug et al., 2001)



	%CV	aCV (in cc)
Male musicians (*n* = 32)	10.30 (0.64)	145.3 (9.7)
Male nonmusicians (*n* = 24)	9.85 (0.68)*	139.6 (15.4)
Female musicians (*n* = 24)	10.43 (0.65)	134.7 (12.1)
Female nonmusicians (*n* = 15)	10.43 (0.82)	131.8 (12.9)
All males (*n* = 56)	10.11 (0.69)	142.8 (12.6)
All females (*n* = 34)	10.43 (0.72)	133.3 (12.3)

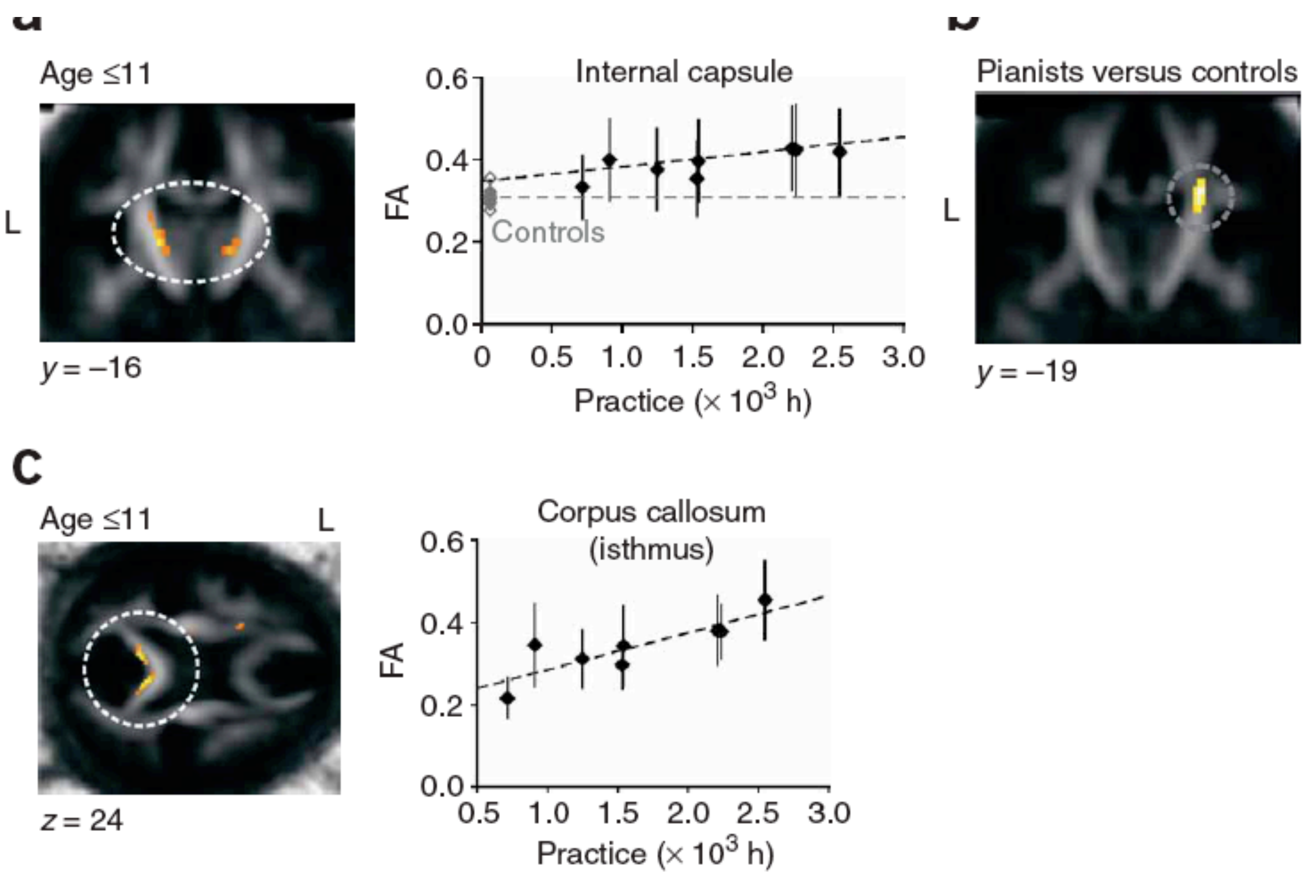
ABBREVIATIONS: %CV = % cerebellar volume of total brain volume; aCV = absolute cerebellar volume in cubic centimeters.
[a]Significant differences between the groups of male nonmusicians and musicians in relative cerebellar volume.

Extensive piano practicing has regionally specific effects on white matter development

Sara L Bengtsson[1], Zoltán Nagy[1,2], Stefan Skare[2], Lea Forsman[1], Hans Forssberg[1] & Fredrik Ullén[1]

Using diffusion tensor imaging, we investigated effects of piano practicing in childhood, adolescence and adulthood on white matter, and found positive correlations between practicing and fiber tract organization in different regions for each age period. For childhood, practicing correlations were extensive and included the pyramidal tract, which was more structured in pianists than in non-musicians. Long-term training within critical developmental periods may thus induce regionally specific plasticity in myelinating tracts.

VOLUME 8 | NUMBER 9 | SEPTEMBER 2005 NATURE NEUROSCIENCE



The Effects of Musical Training on Structural Brain Development

A Longitudinal Study

Krista L. Hyde,[a] Jason Lerch,[b] Andrea Norton,[c] Marie Forgeard,[c] Ellen Winner,[d] Alan C. Evans,[a] and Gottfried Schlaug[c]

[a]Montreal Neurological Institute, McGill University, Montreal, Quebec, Canada

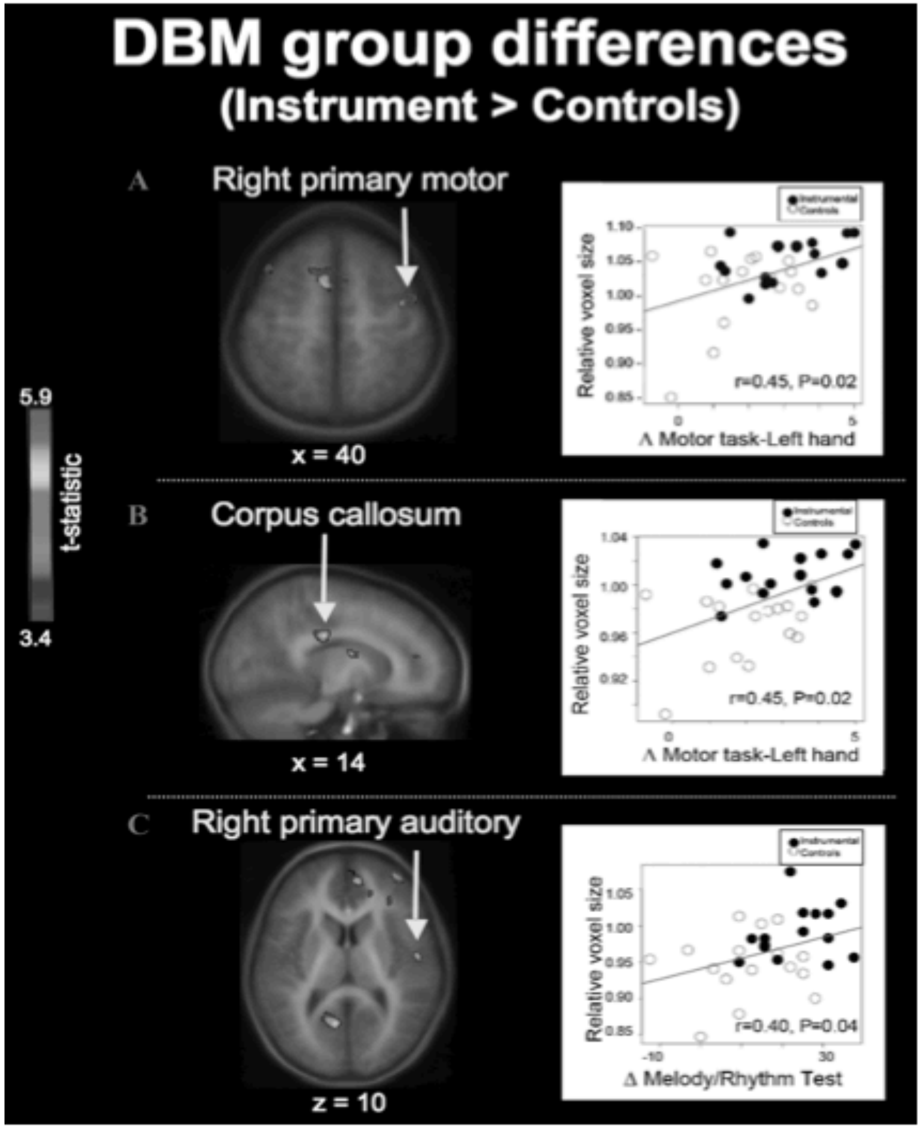
[b]Mouse Imaging Centre, Hospital for Sick Children, Toronto, Ontario, Canada

[c]Department of Neurology, Music and Neuroimaging Laboratory, Beth Israel Deaconess Medical Center and Harvard Medical School, Boston, Massachusetts, USA

[d]Department of Psychology, Boston College, Chestnut Hill, Massachusetts, USA

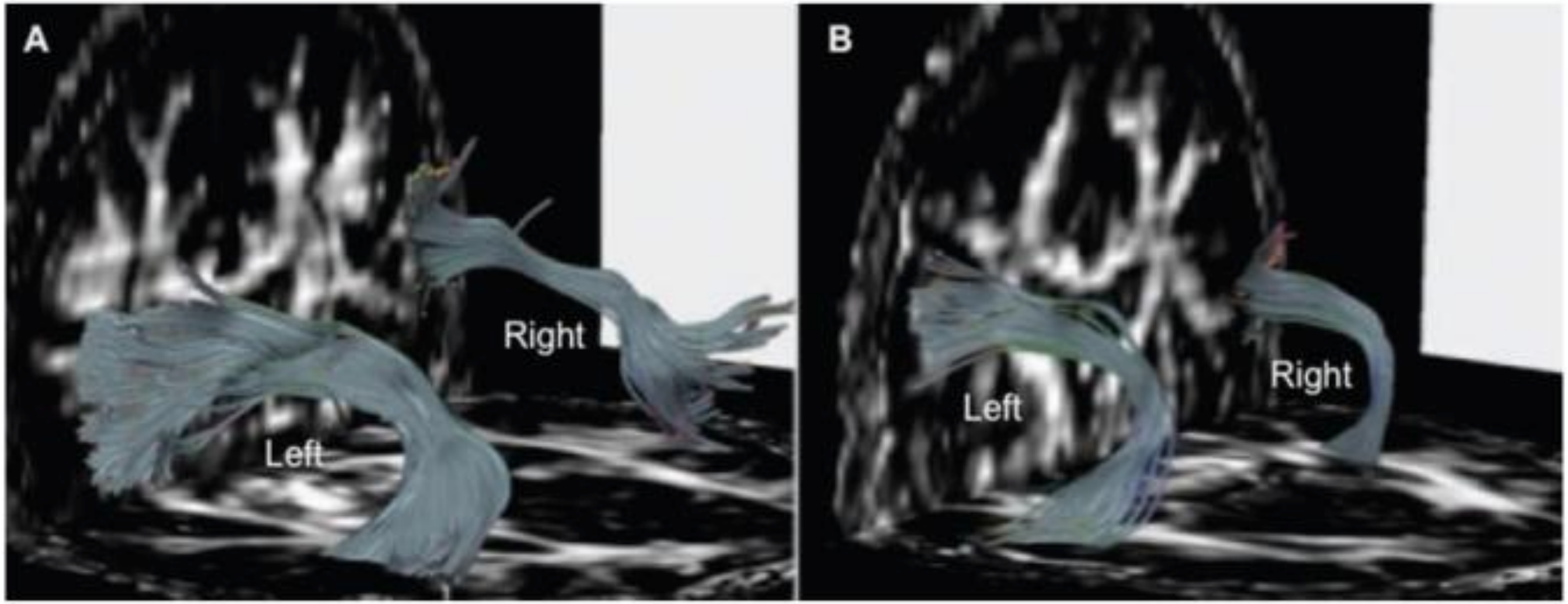
We investigated structural brain changes in relation to behavioral changes in young children (15 mean age at start of study: 6.32 years old) who received 15 months of keyboard training relative to 16 children who did not receive any instrumental music training during this 15-month period, but did participate in a weekly group music class in school (i.e., singing and drums). We used deformation-based morphometry (DBM), an unbiased and automated approach to brain morphology, to search throughout the whole brain on a voxel- wise basis for local brain size (voxel expansions or contractions) differences between groups over the 15 months

As predicted, Instrumental children showed greater behavioral improvements over the 15 months on the finger motor task and the melody/rhythmic tasks, but not on the non- musical tasks. In addition, Instrumental children showed areas of greater relative voxel size change over the 15 months as compared to Controls in motor brain areas, such as the **right precentral gyrus** (motor hand area, Fig. 1A), and the **corpus callosum** (4th and 5th segment/midbody, Fig. 1B), as well as in a **right primary auditory region** (Heschlís gyrus, Fig. 1C). These brain deformation differences are consistent with structural brain differences found between adult musicians and nonmusicians in the precentral gyri,2 the corpus callosum,20ñ22 and auditory cortex.2,4,23



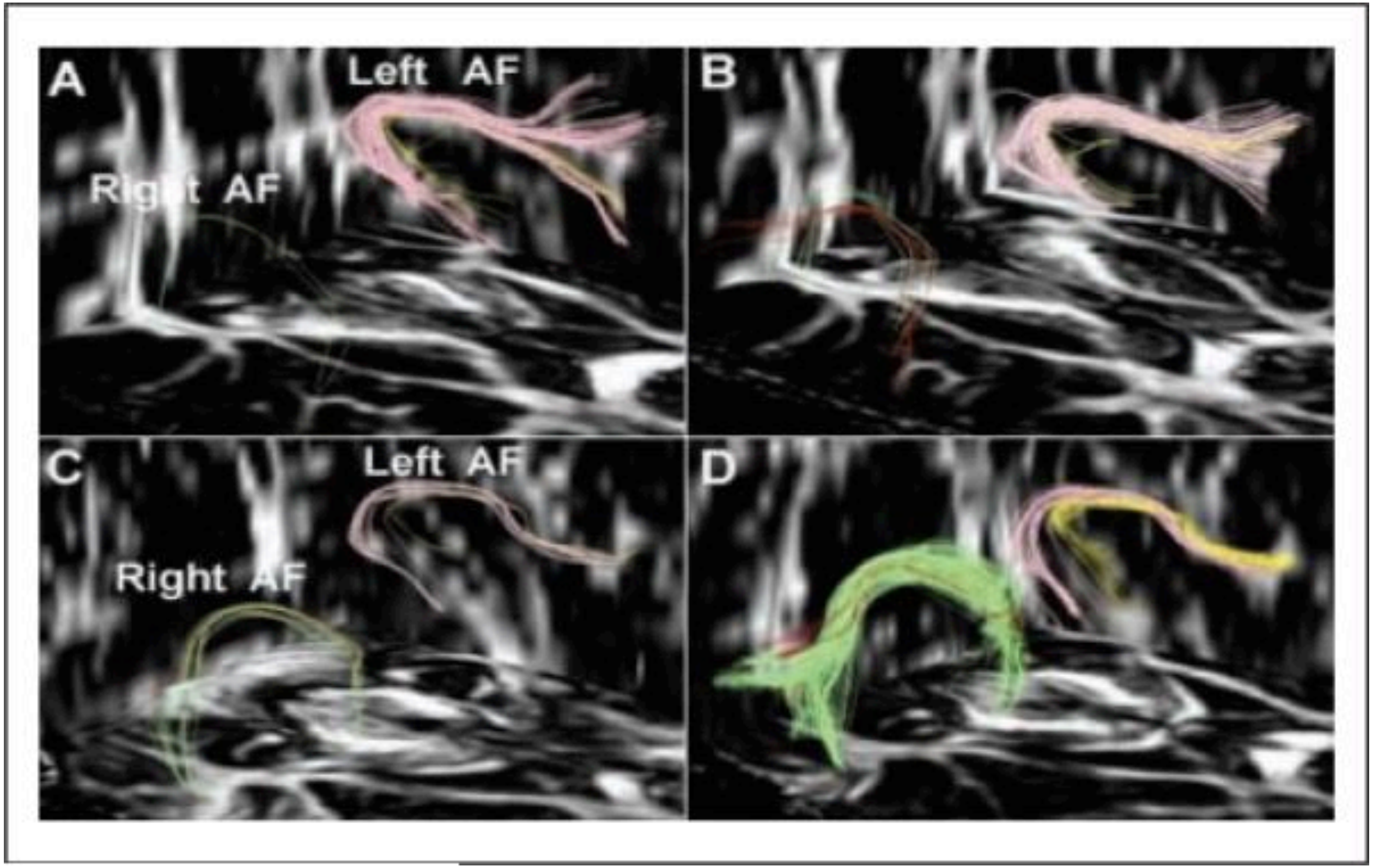
1. Group brain deformation differences. The brain images in panels

(A) The arcuate fasciculus of a healthy 65-year-old instrumental musician



(B) the arcuate fasciculus of a healthy 63-year-old nonmusician, otherwise matched with regard to their handedness, gender, and overall IQ

8-year-old child without instrumental music training scanned twice (A and B) 2 years apart



8-year-old child before (C) and 2 years after (D) instrumental music training involving a string instrument.

Changes in the arcuate fasciculus after instrumental music training

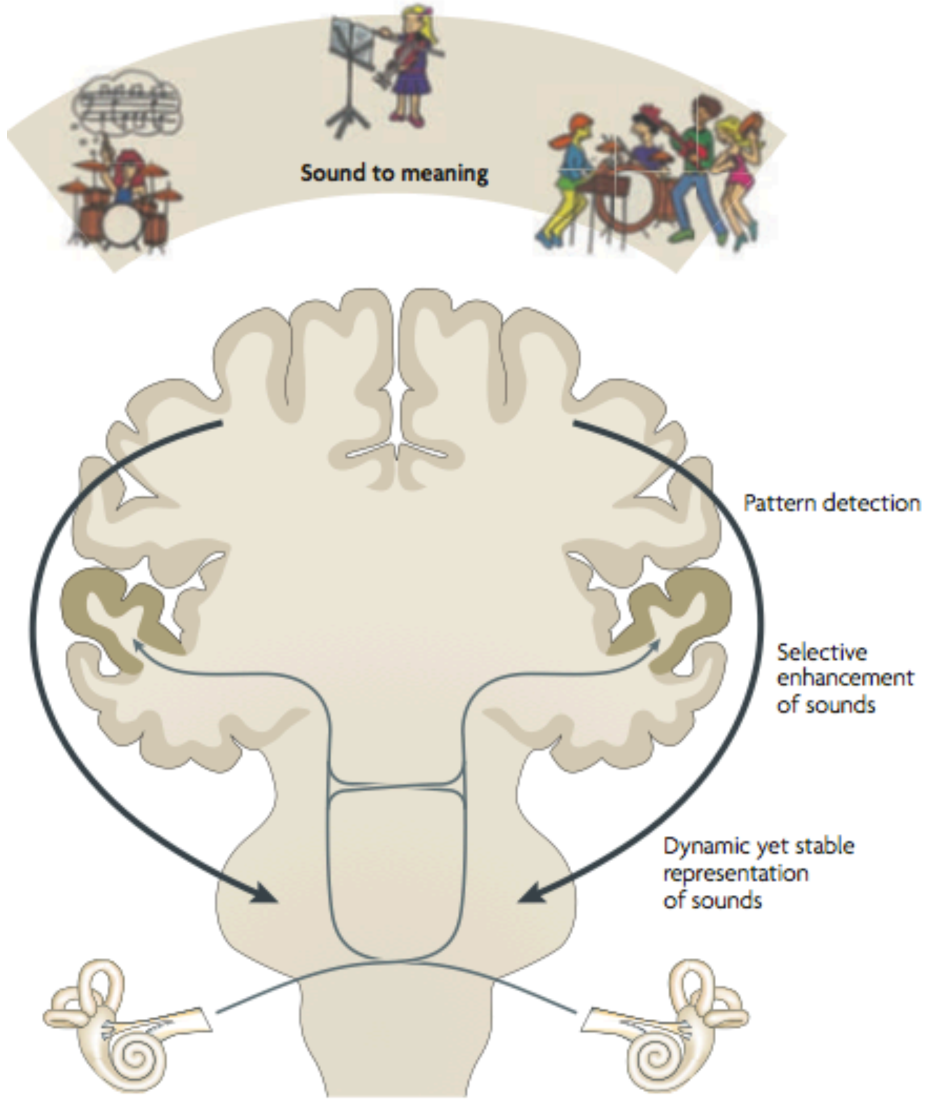
SCIENCE AND SOCIETY

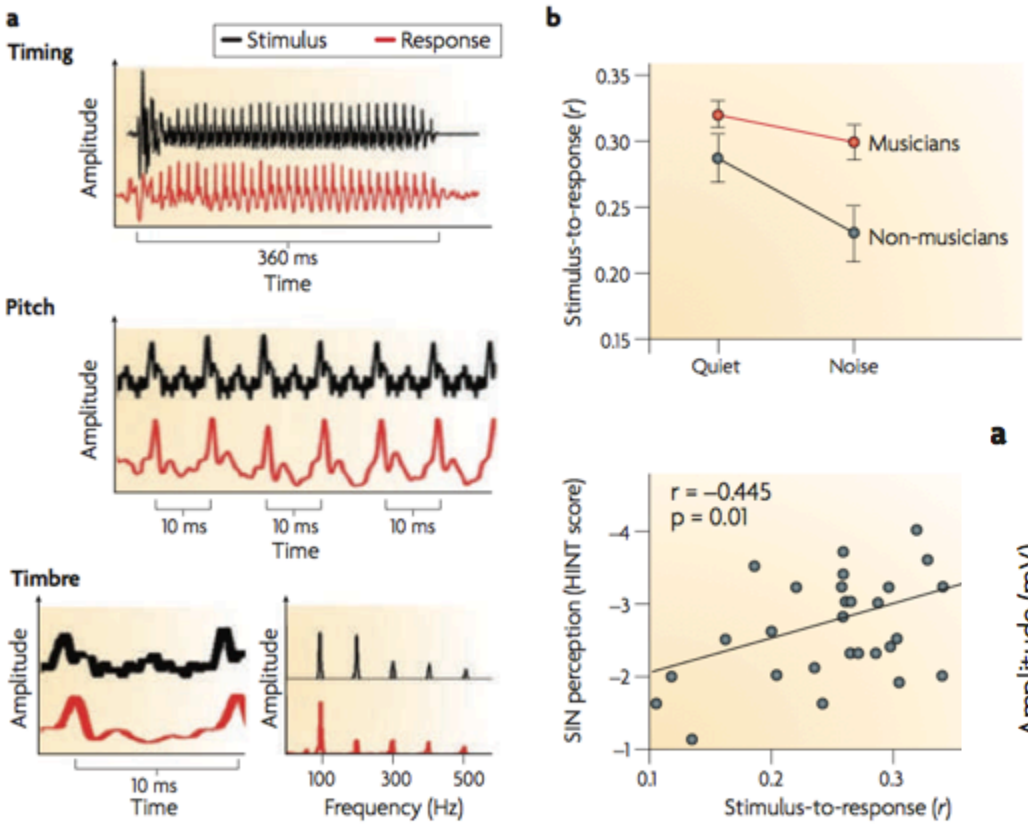
Music training for the development of auditory skills

Nina Kraus and Bharath Chandrasekaran

Abstract | The effects of music training in relation to brain plasticity have caused excitement, evident from the popularity of books on this topic among scientists and the general public. Neuroscience research has shown that music training leads to changes throughout the auditory system that prime musicians for listening challenges beyond music processing. This effect of music training suggests that, akin to physical exercise and its impact on body fitness, music is a resource that tones the brain for auditory fitness. Therefore, the role of music in shaping individual development deserves consideration.

Sur le cerveau des musiciens, des modifications neuroplastiques ont été observées tant au niveau cortical que dans le tronc cérébral auditif, sous l'influence de connexions corticofuges (topdown), expliquant leur capacité, modelée par l'expérience, à détecter très rapidement et encoder les séquences de sons.





Les séquences, hauteurs et timbres sont encodées dans le tronc cérébral sous une forme qui représente fidèlement les propriétés acoustiques du son d'origine

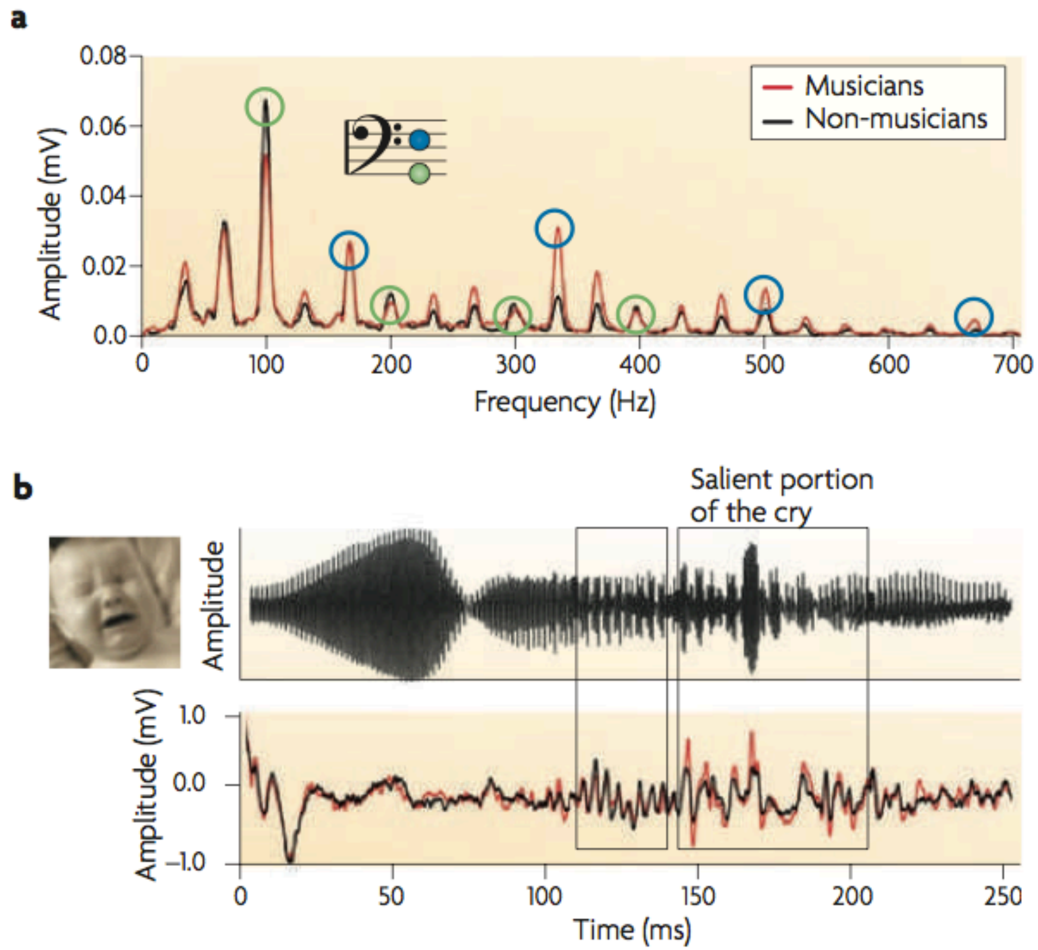
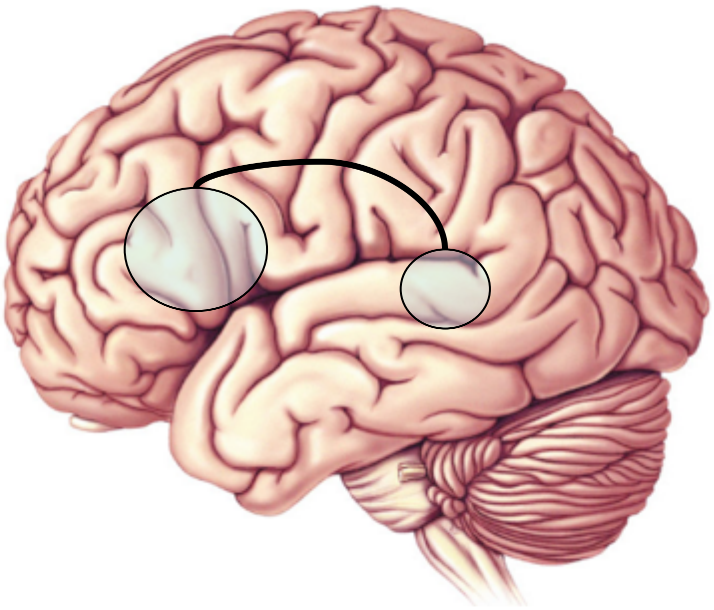


Figure 2 | **Transfer effect and selective enhancement in musicians. a** | Ens

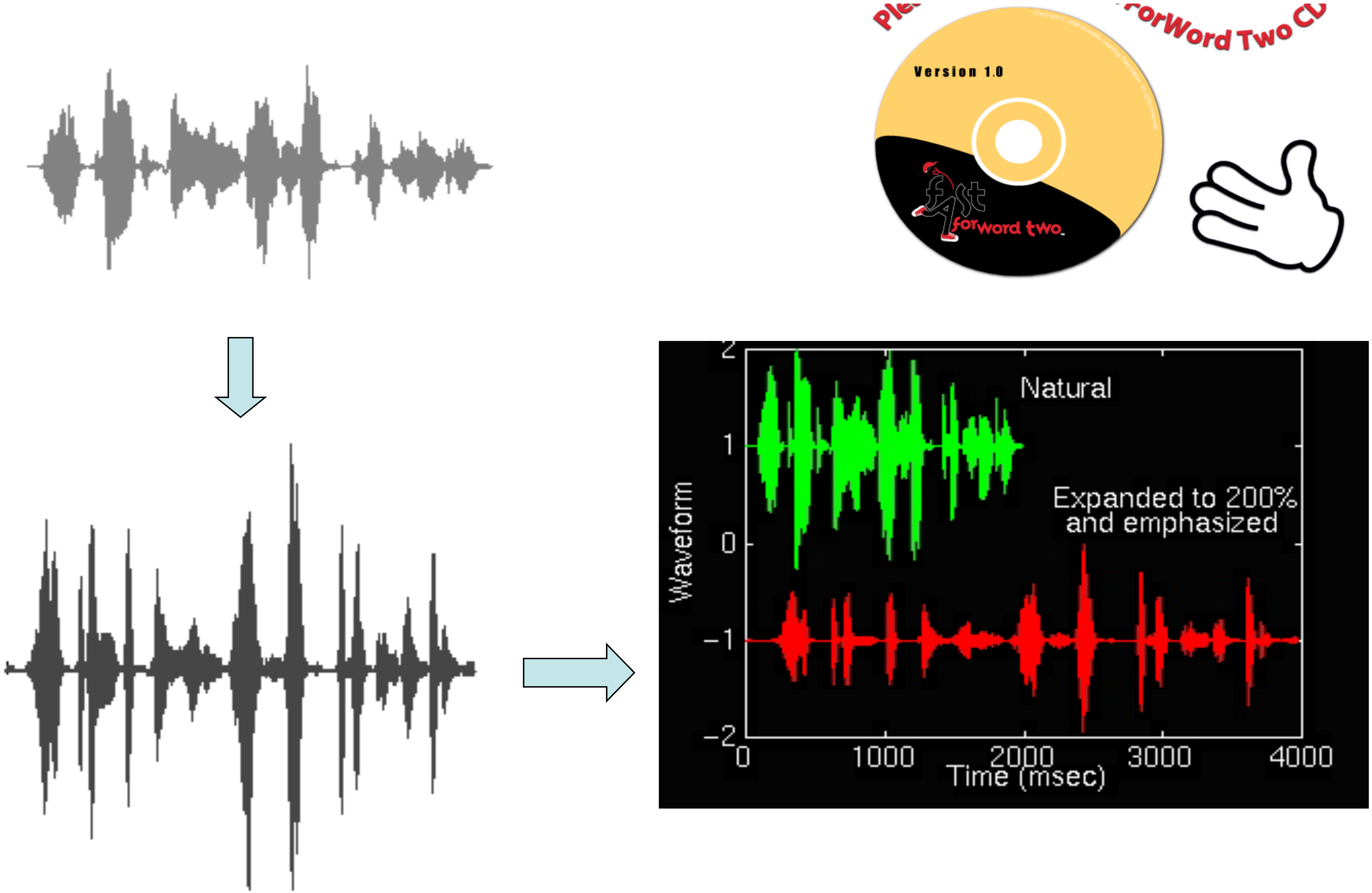
Le tronc cérébral des musiciens perçoit mieux les notes ayant une signification mélodique (note haute de l'accord). Cette meilleure perception se généralise aux sons non musicaux



Plasticidad reeducativa I : ejemplo del entranamiento fonológico

Entrenamiento temporo-fonológico : bases teóricas

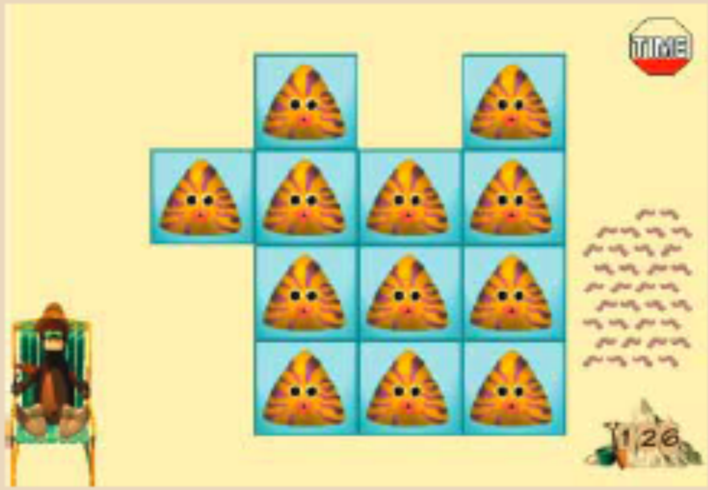
- La teoría del « déficit de procesamiento temporal »
  - Tallal & Piercy (1973) : déficit para percibir estímulos auditivos cortos y de cambio rápido
  - Tallal et al. (1974-76) : déficit en el juicio del orden temporal (J.O.T.) de una sucesión de sílabas
  - Eficacia en el método de tratamiento basada en en esta teoría (Tallal, Merzenich, and coll., 1996)


Version 1.0
Natural
Expanded to 200%
and emphasized
Waveform
Time (msec)
2
1
0
−1
−2
0
1000
2000
3000
4000

Box 1 | The Fast ForWord® neuroplasticity-based training approach

Circus Sequence

Phonic Match



Phonic Word

Language Comprehension Builder

Fast ForWord®, developed by Scientific Learning Corporation, is a series of neuroplasticity-based training programmes that are designed to improve fundamental aspects of oral and written language comprehension and fluency. The exercises incorporate two simultaneous

Special Forum on Fast ForWord

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

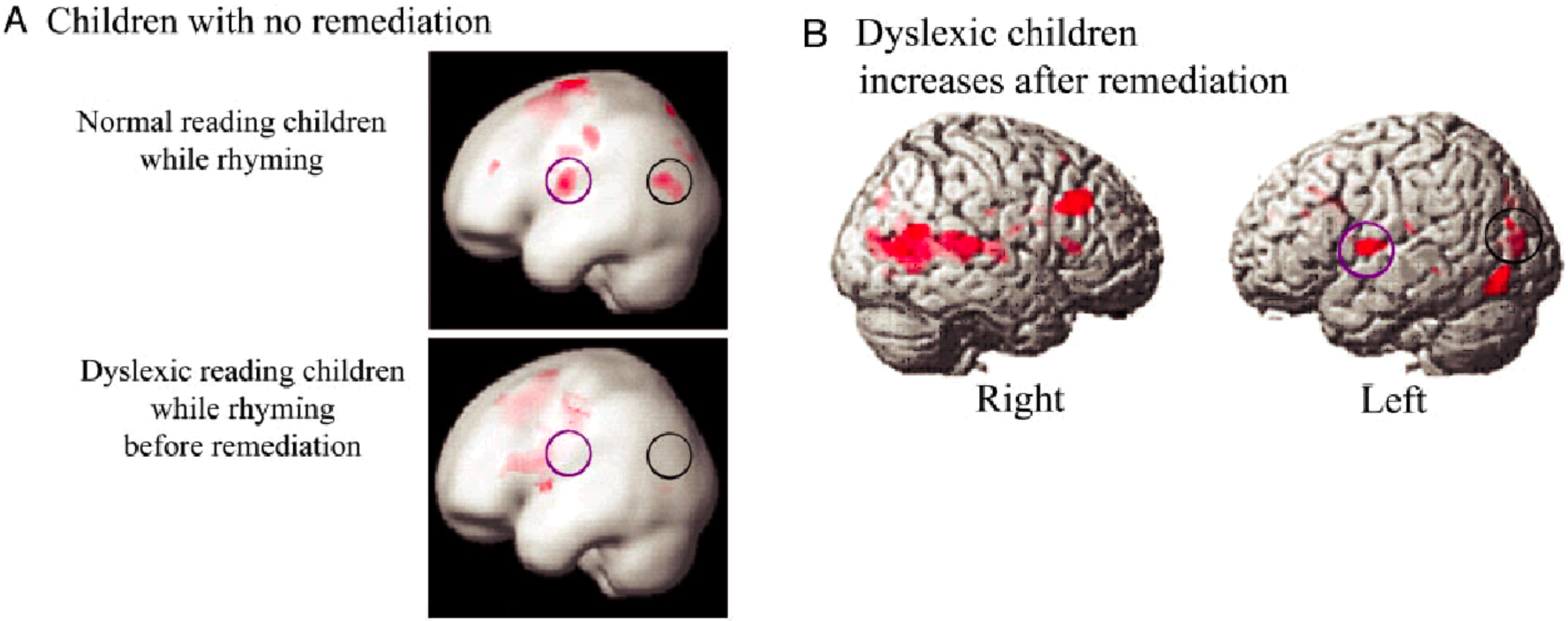
Ronald B. Gillam
The University of Texas at Austin

Diane Frome Loeb
The University of Kansas, Lawrence

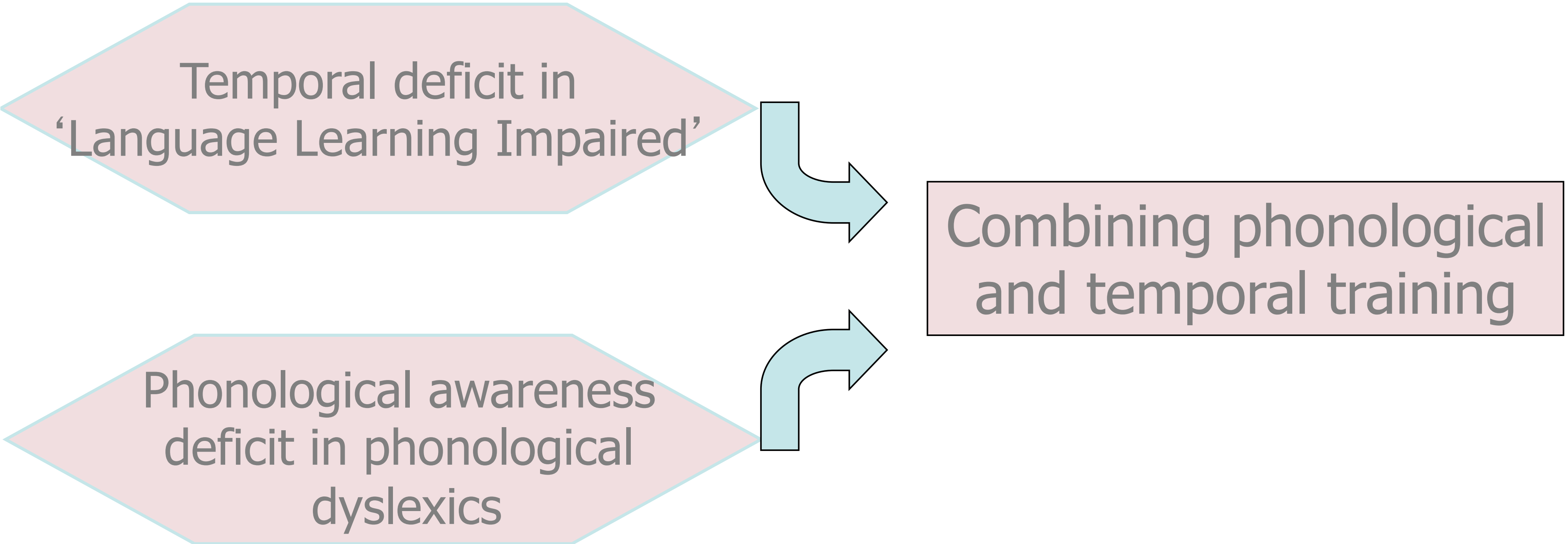
Sandy Friel-Patti
The University of Texas at Dallas

" 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

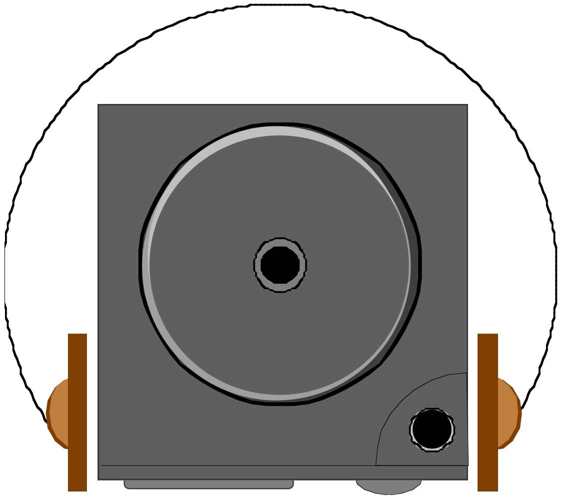

A Children with no remediation
Normal reading children while rhyming
Dyslexic reading children while rhyming before remediation
B Dyslexic children increases after remediation
Right
Left

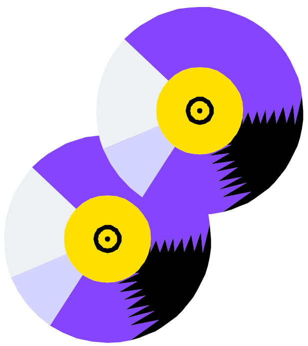
Temporo-phonological training : the « Lavande » programme

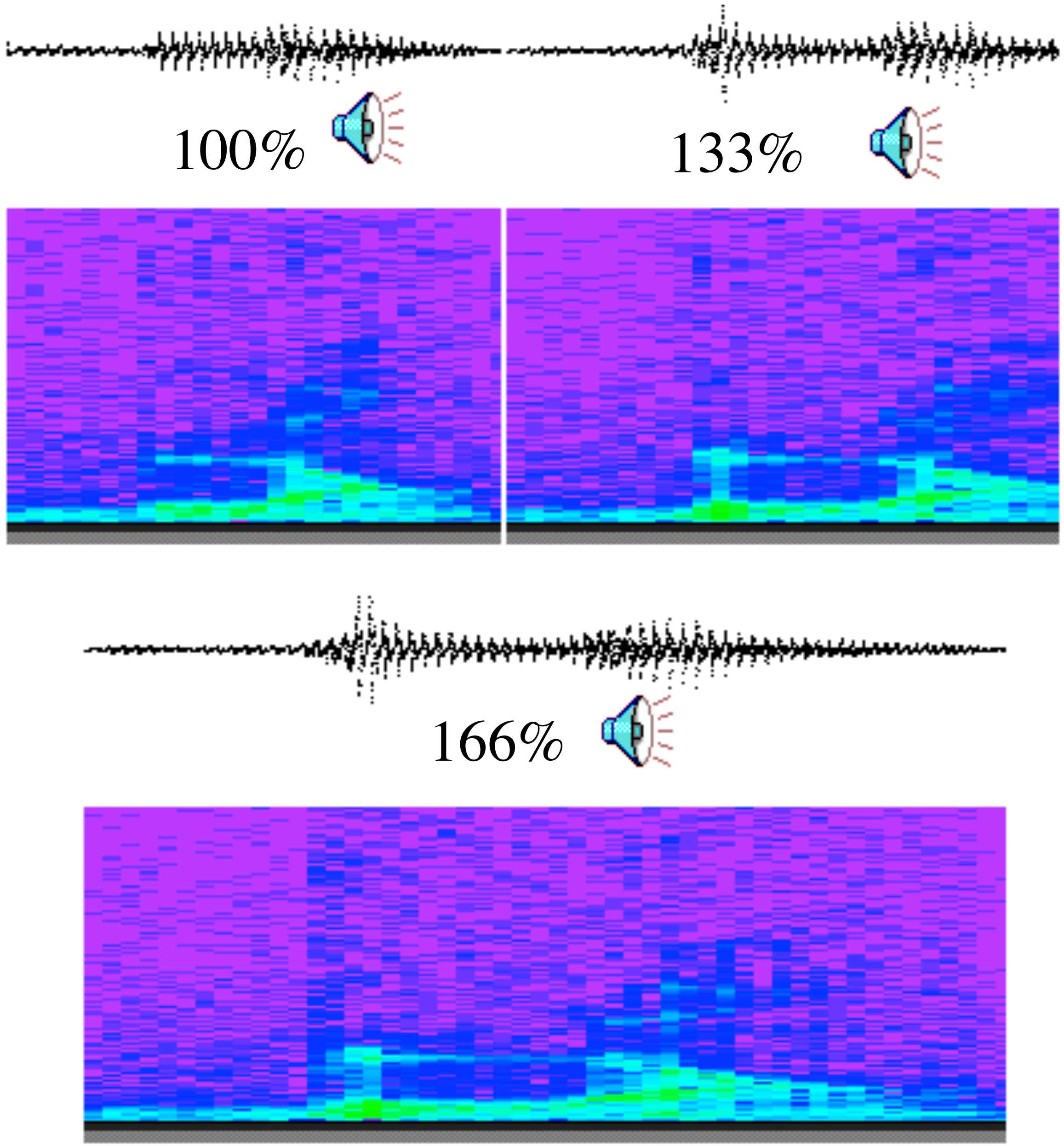


El programa “Lavande 1”
tratamiento fonológico con habla modificada acústicamente

- Población : 12 niños disléxicos (11-12 años)
- 2 grupos:
  - EXP = tratamiento con habla modificada
  - PLAC = los mismos ejercicios con habla natural normal
- Una sesión por día, 5 días a la semana, durante 5 semanas consecutivas
- Modificación del habla:
  - incremento de la intensidad proporcional con la inestabilidad espectral de la señal de habla
  - alargamiento temporal sobre los resultados del estadío previo



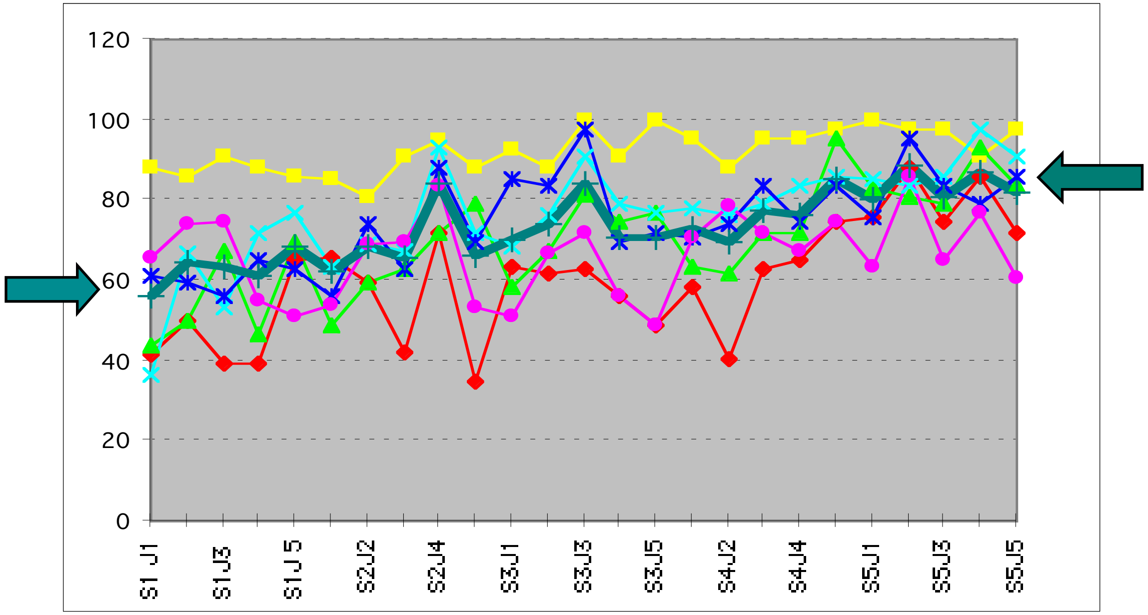



100%
133%
166%

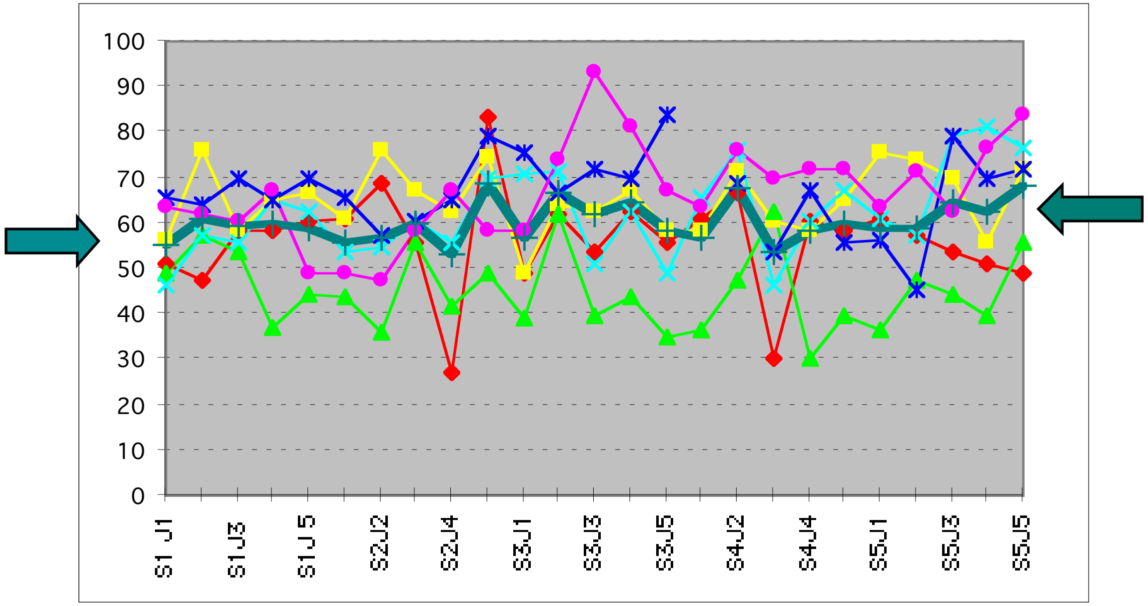
El programa “Lavande 1”

Diseño de los ejercicios de tratamiento

	Estructura silábica simple	**Estructura silábica compleja**
Identificar el distinto (primer fonema)	*e.g.:* dauphin-tonneau-démon	*e.g.:* /palto/-/plati/-/palty/
Identificar el distinto (no incluye una letra blanco)	*e.g.:* /t/ : pitou-body-mité-nintan	*e.g.:* /sp/: aspofil-apsofal-aspoful
Deletreo de no palabras (dictado)	*e.g.:* syjachi	*e.g.:* aclipsy



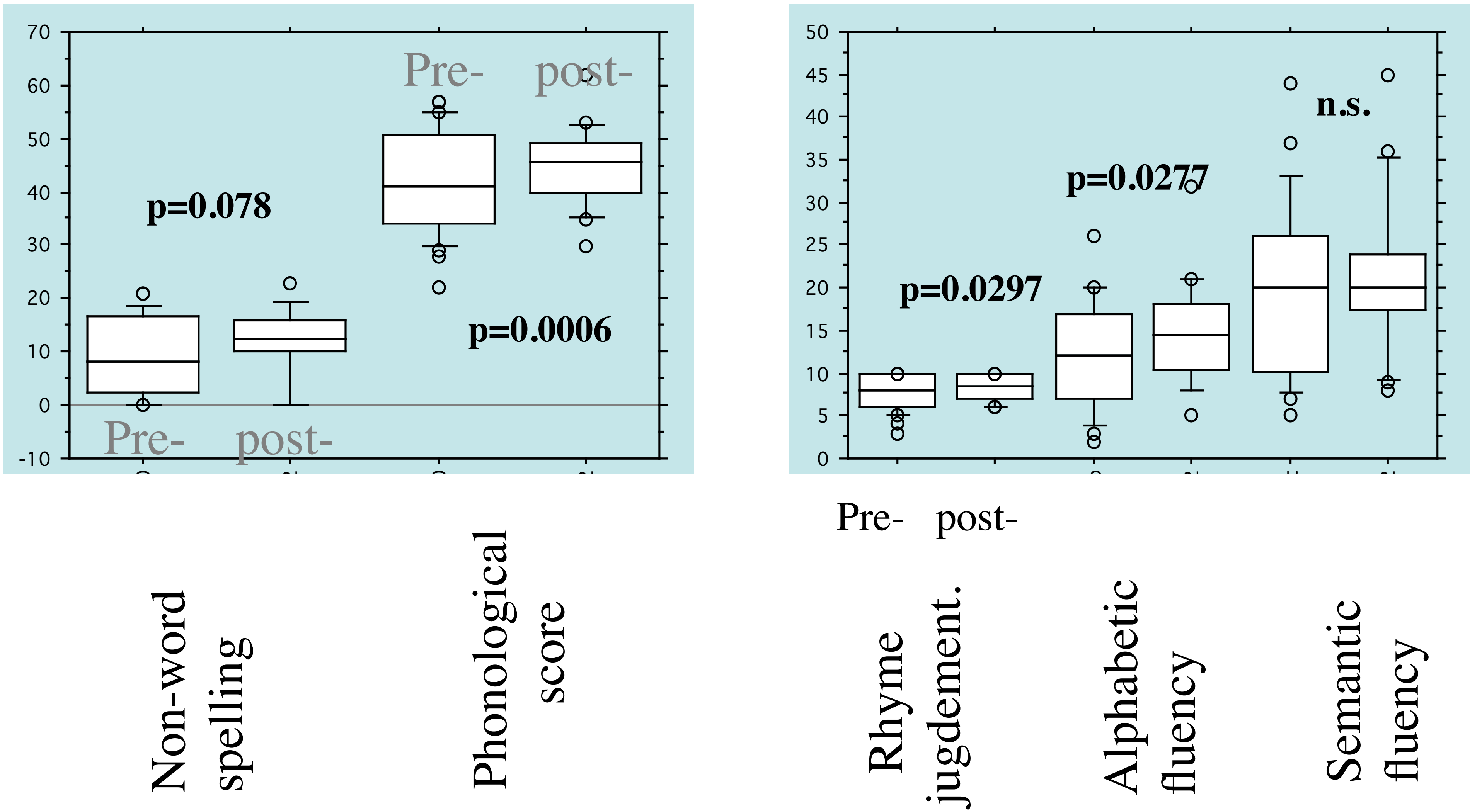
Groupe expérimental
(6 enfants avec parole modifiée)



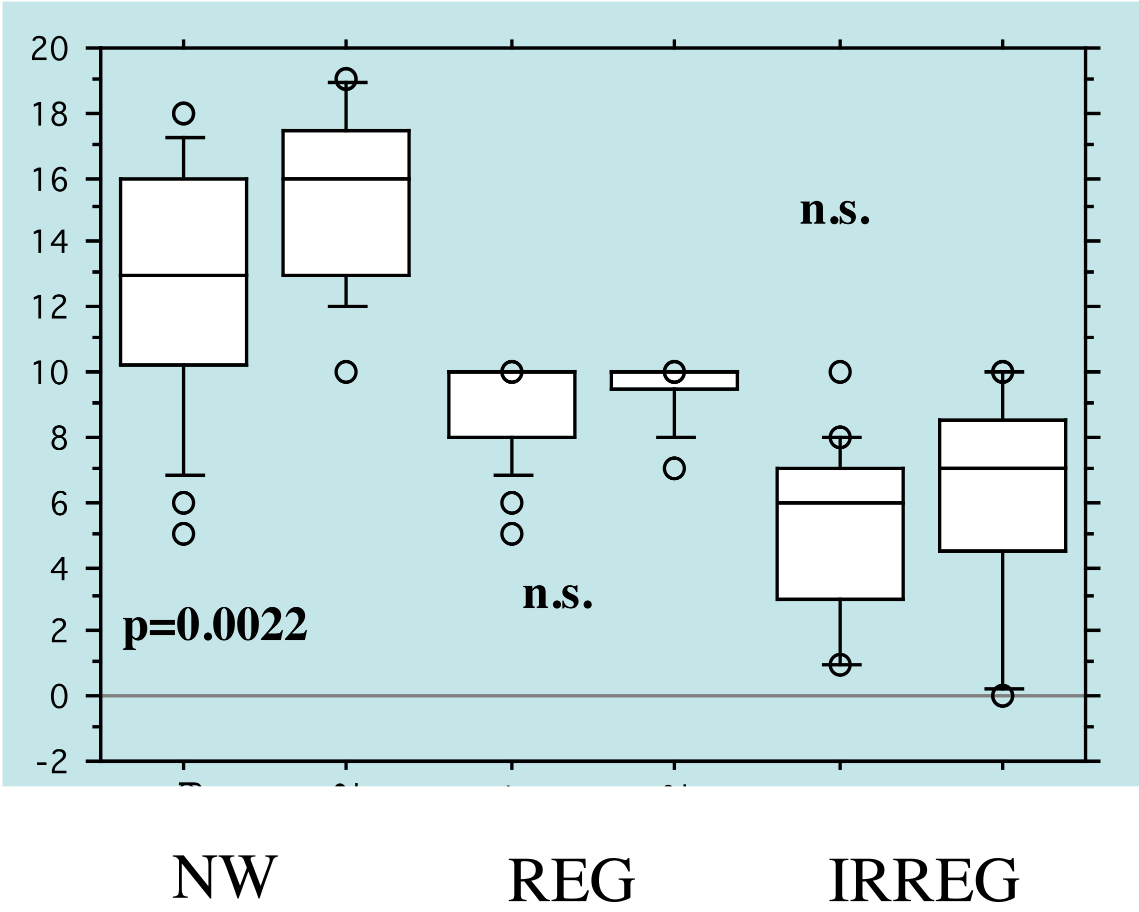
Groupe placebo
(6 enfants avec parole normale)

El programa “Lavande ” : estudio 2 = adaptar a practica profesional

- 23 nuevos niños disléxicos, edad 9;2 - 12;6
- Programa de entranamiento similar
- Pero sin diferenciar con y sin modificación temporal
- Con colaboración de audiofonologos y padres que débían controlar los ejercicios cotidianos
- Intentando diferenciar el tipo de efecto en lectura y expresión escrita, contrastando palabras regulares, iregulares, no-palabras



Improvement in phonological tasks

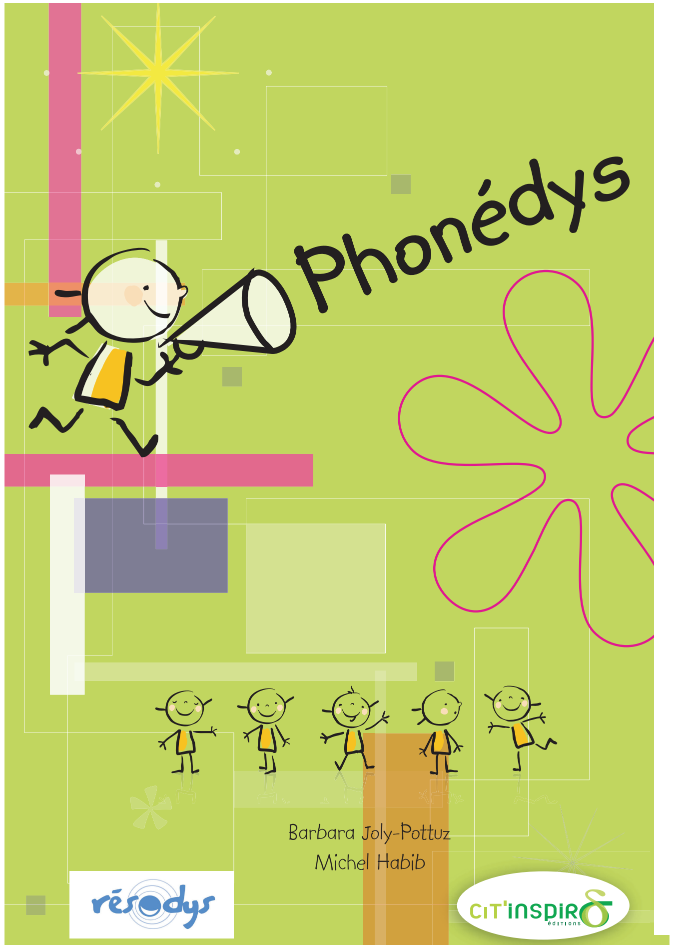


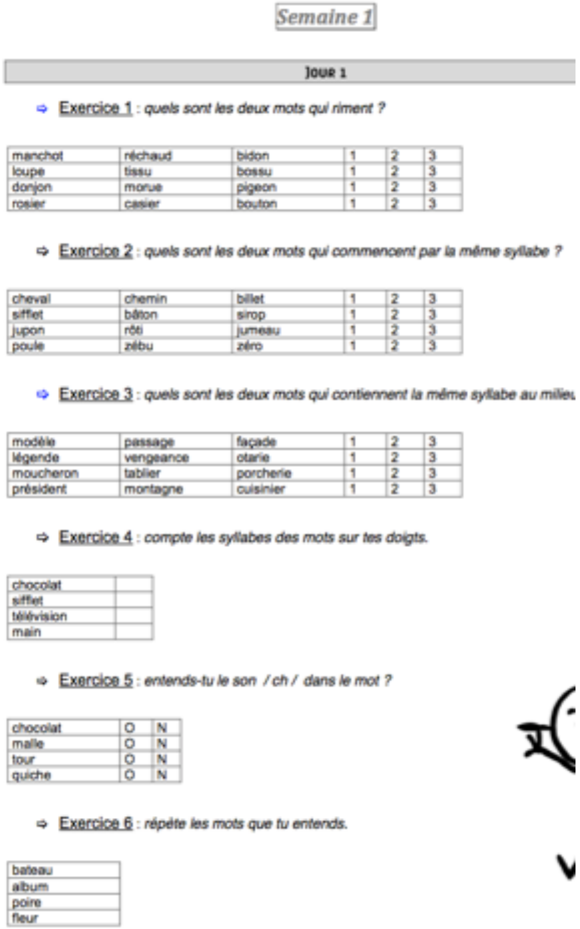
Word reading : improvement for non-word only

Entrenamiento con modificación acústica (Fastforword) : conclusiones (1)

- Modificar temporalmente el material verbal tiene
  - un efecto modesto sobre las variables fonológicas
  - y ningun efecto específico sobre la lecto-escritura
- Al contrario, el entrenamiento global, que sea con o sin modificación acustica, resultó muy eficiente sobre procesos sublexicales en lectura (pseudo-palabras)
- →Entrenar la fonología sobre un modo cotidiano y repetido parece el mejor medio actual de tratar el trastorno fonológico del niño disléxico
  - Modificar las cualidades acústicas de la habla no parece pertinente

Difusion del método: phonédys
(recien adaptado al español : fonodis)




Semaine 1

JOUR 1

Exercice 1 : quels sont les deux mots qui riment ?

manchot	réchaud	bidon	1	2	3
loupe	tissu	bossu	1	2	3
donjon	morue	pigeon	1	2	3
rosier	casier	bouton	1	2	3

Exercice 2 : quels sont les deux mots qui commencent par la même syllabe ?

cheval	chemin	billet	1	2	3
sifflet	bâton	sirop	1	2	3
jupon	rôti	jumeau	1	2	3
poule	zébu	zéro	1	2	3

Exercice 3 : quels sont les deux mots qui contiennent la même syllabe au milieu

modèle	passage	façade	1	2	3
légende	vengeance	otarie	1	2	3
moucheron	tablier	porcherie	1	2	3
président	montagne	cuisinier	1	2	3

Exercice 4 : compte les syllabes des mots sur tes doigts.

chocolat	
sifflet	
télévision	
main	

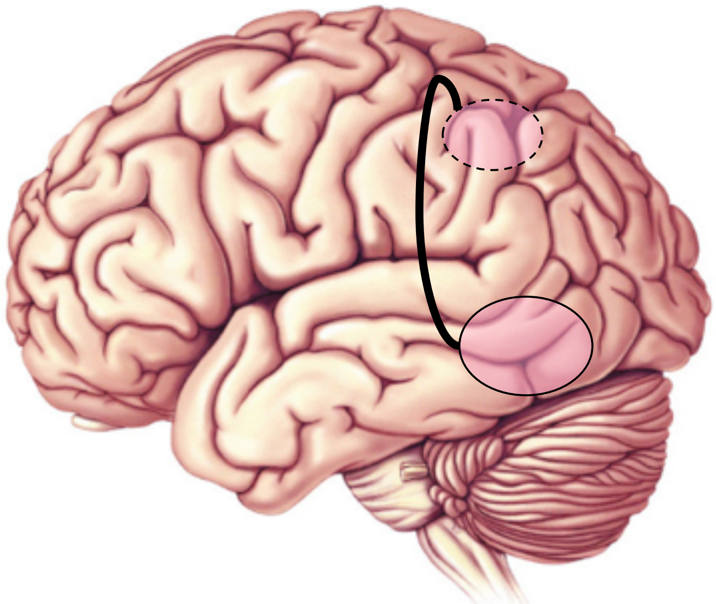
Exercice 5 : entends-tu le son / ch / dans le mot ?

chocolat	O	N
malle	O	N
tour	O	N
quiche	O	N

Exercice 6 : répète les mots que tu entends.

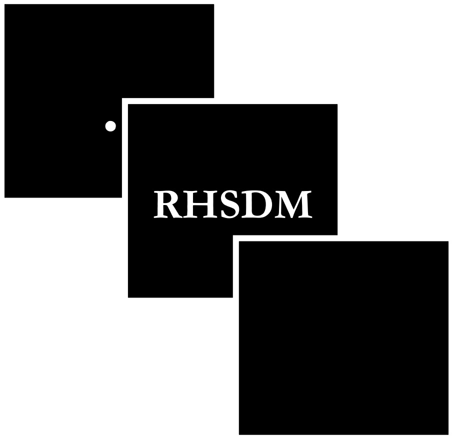
bateau
album
poire
fleur

- 2 CDs incluyendo los ejercicios cotidianos
- 6 semanas, cada día una pagina de ejercicios sobre control de los padres
- Con dificultad gradualmente creciente : de la sílaba hacia al fonema, controlando la complejidad fonológica

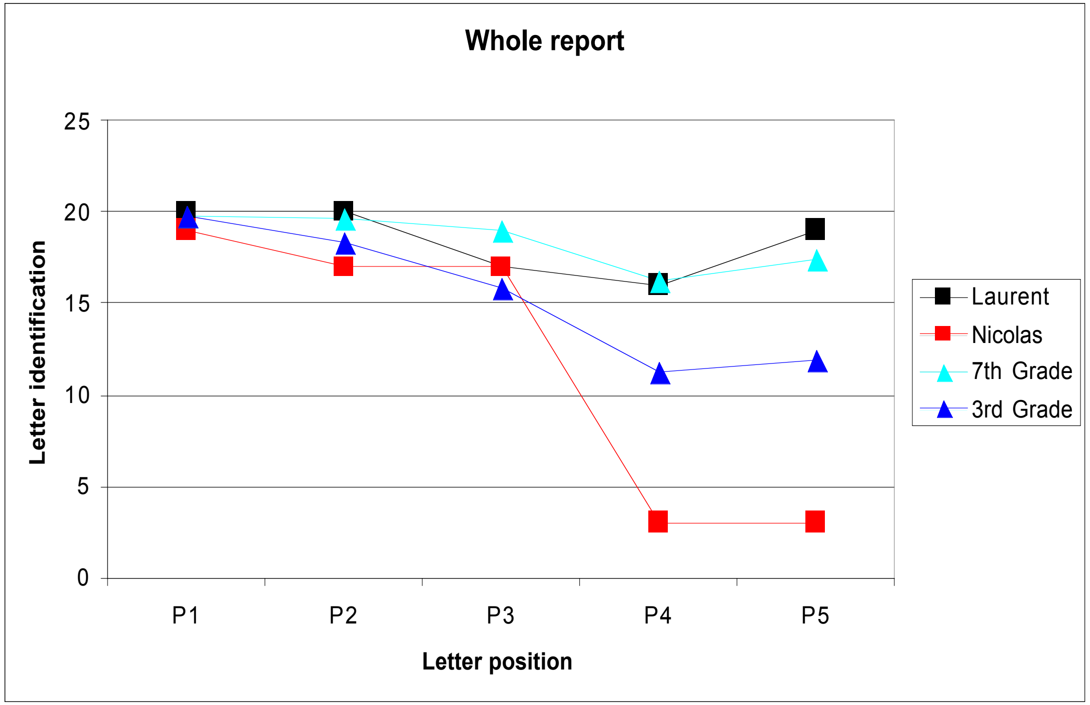


Plasticidad reeducativa II : actuar sobre las sistemas visuo-atencionales

Notion d'empan visuo-spatial (S. Valdois)



EMPAN



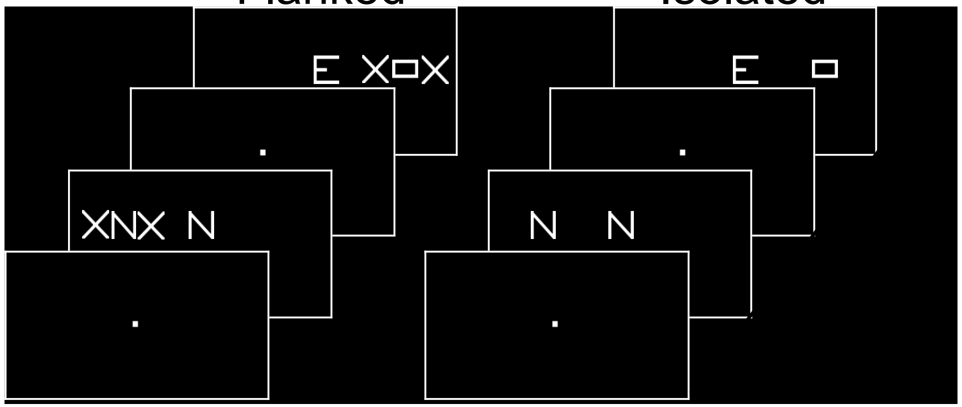
Brain & Language
journal homepage: www.elsevier.com/locate/b&l

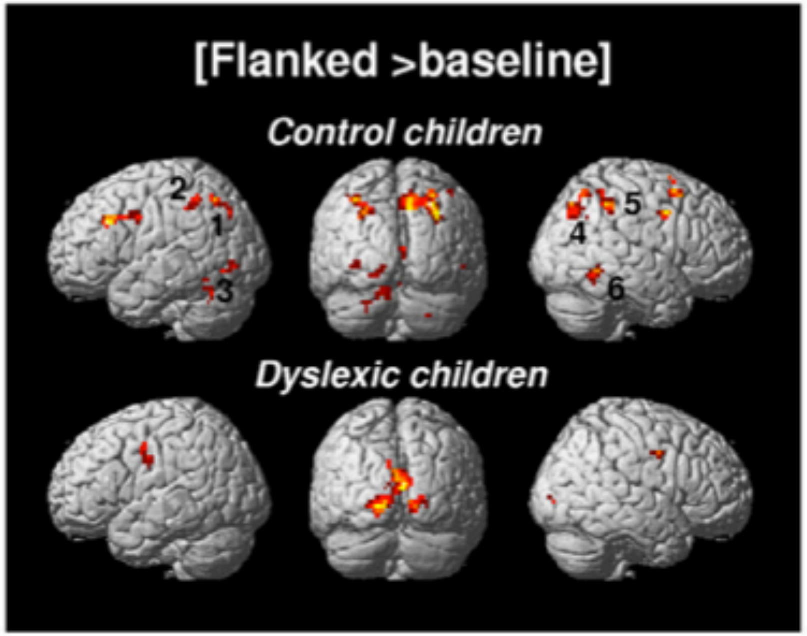
Superior parietal lobule dysfunction in a homogeneous group of dyslexic children with a visual attention span disorder

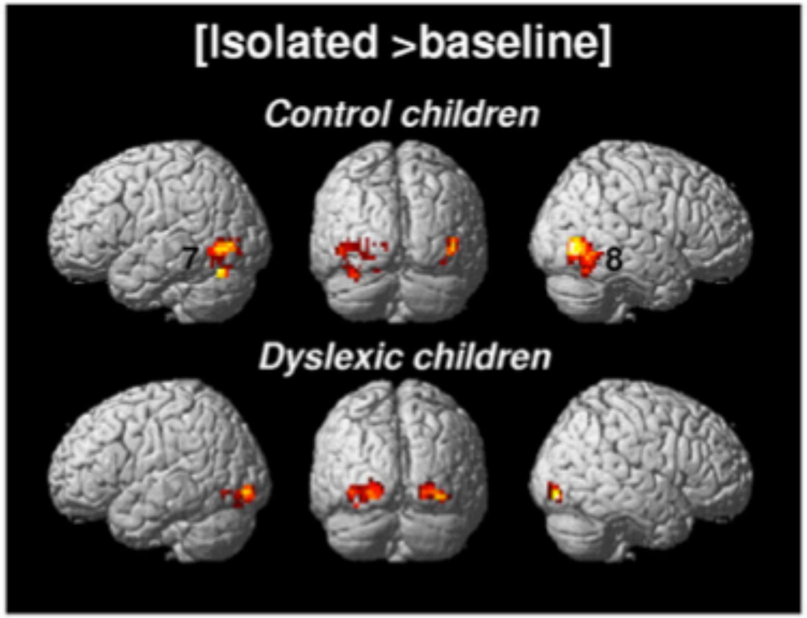
C. Peyrin [a], J.F. Démonet [b], M.A. N'Guyen-Morel [c], J.F. Le Bas [d], S. Valdois [a,*]

Tâche de catégorisation

Flanked Isolated







- 12 dyslexic
- 12 CTL children

IRMf

Entraînement de l'empan VA

LPNC CNRS

COREVA

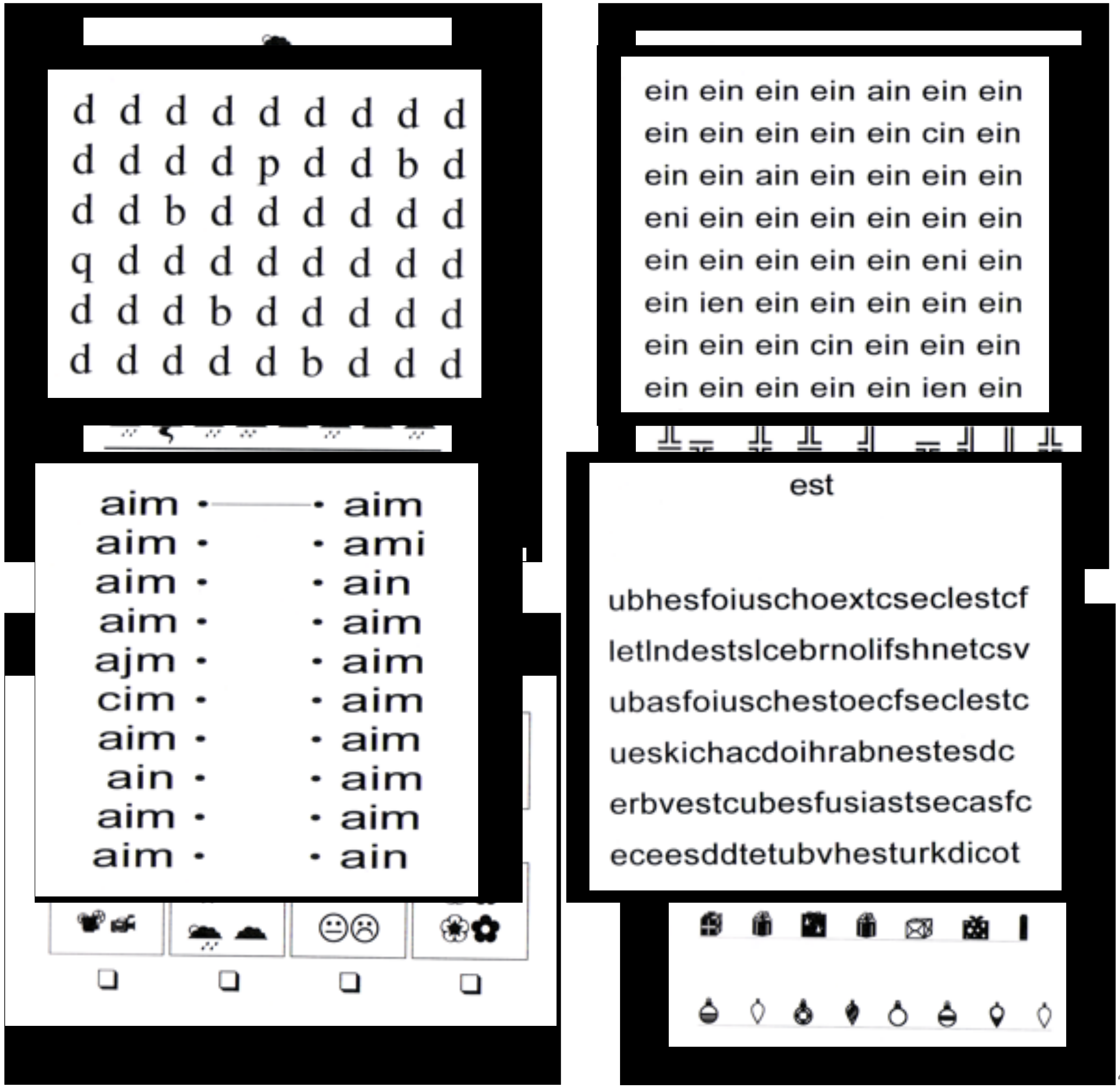
450 exercices

Identification
Discrimination
Recherche cibles

Progression

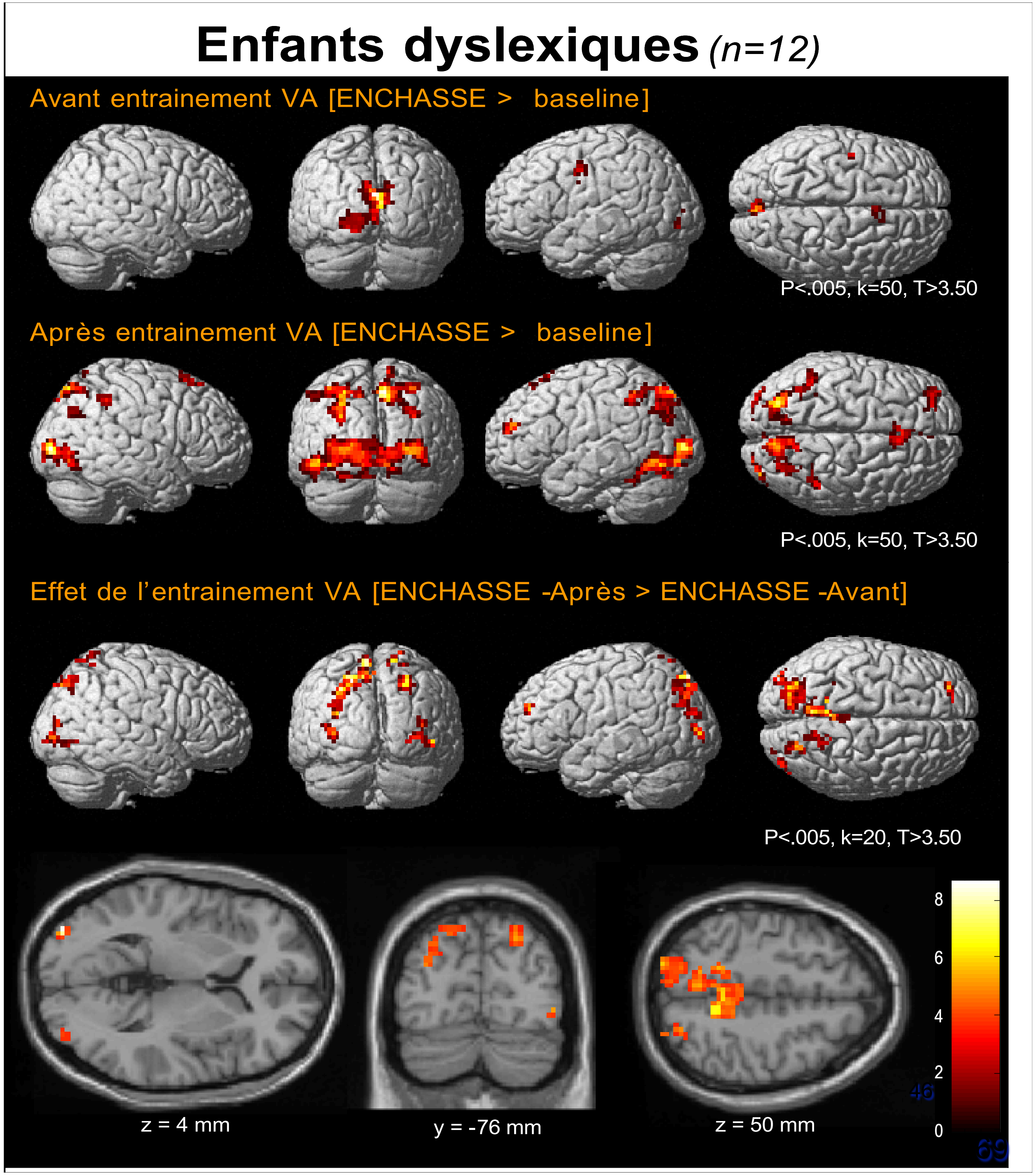
Non verbal → verbal
Un élément → 5 éléments

20 mn/jr 7 jr/semaine
6 semaines



Effet d' un entraînement VA

Réactivation des régions Pariétales après entraînement



Research report

Dyslexia in a French–Spanish bilingual girl: Behavioural and neural modulations following a visual attention span intervention

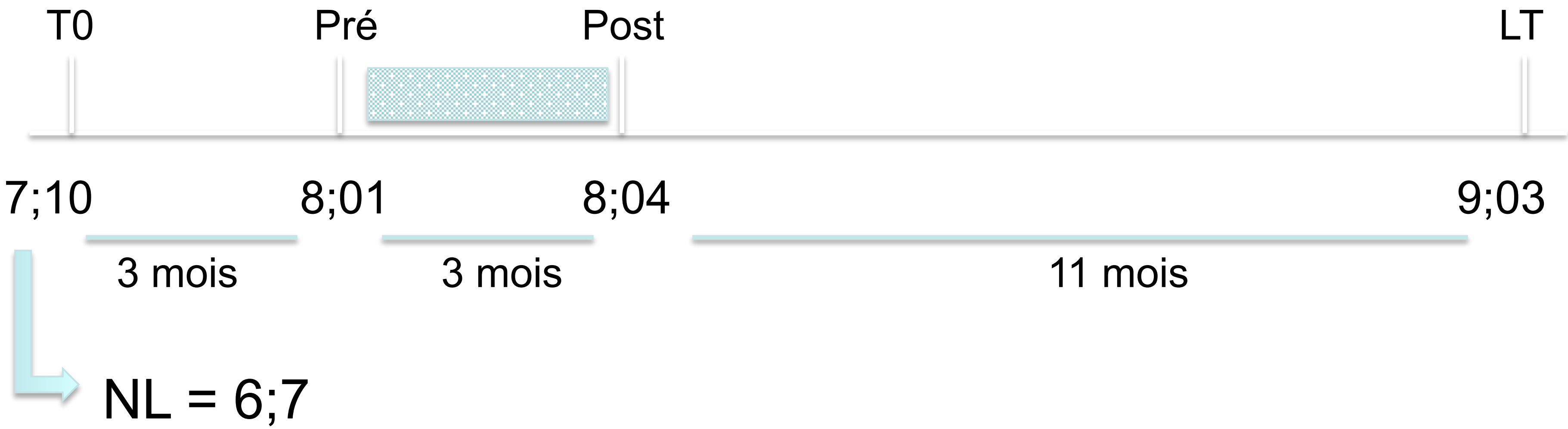
Sylviane Valdois[a,b,*], Carole Peyrin[a,b], Delphine Lassus-Sangosse[d], Marie Lallier[f], Jean-François Démonet[e] and Sonia Kandel[a,c]

MP es una bilingüe franco-española.
tenía 7 a10 m de edad en el momento de la primera visita. 9 a 3 meses en la última visita, 10 meses después al final del programa de remediación.
nació en México y habla francés y español en casa (normal fluidez en ambos idiomas). Su padre es un hablante bilingüe Frances-Español. Su madre es una hablante nativa de español. MP asistió al Liceo Franco-Mexicano en la Ciudad de México desde que tenía dos años y medio de edad y hasta su marcha a Francia, 5 meses antes del primer consulto. A su llegada en Francia, repitió su 2° grado, debido a dificultades en lectura, sin diagnostico formal de dislexia.

Cas MP

Valdois et al., in press, Cortex

LPNC CNRS



Enfant bilingue — Français Espagnol

Audiométrie + — Acuité visuelle +

QIT=92 ICV=96 IRP=92

Langage oral: phono + morpho synt + lexico-sémant+

Pas de trouble attentionnel : Conners, NEPSY

Cas MP

Valdois et al., in press, Cortex

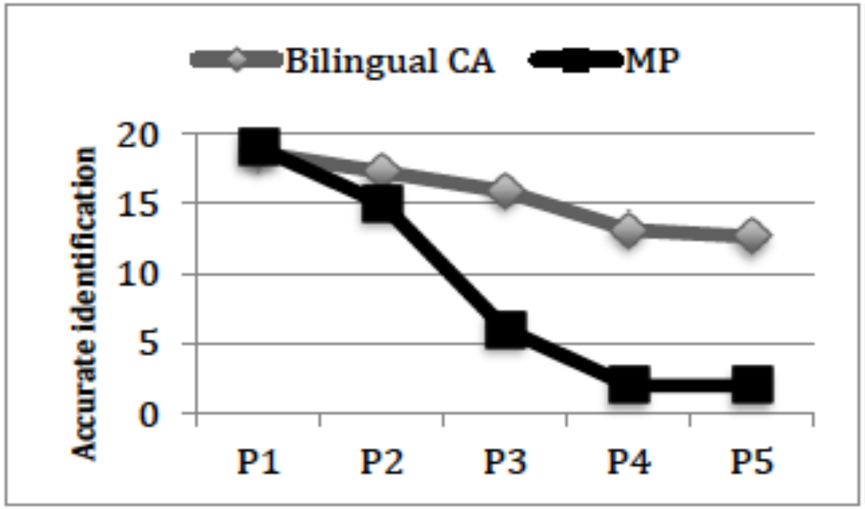
Français

Déficit en lecture tout type de mots (temps et score)

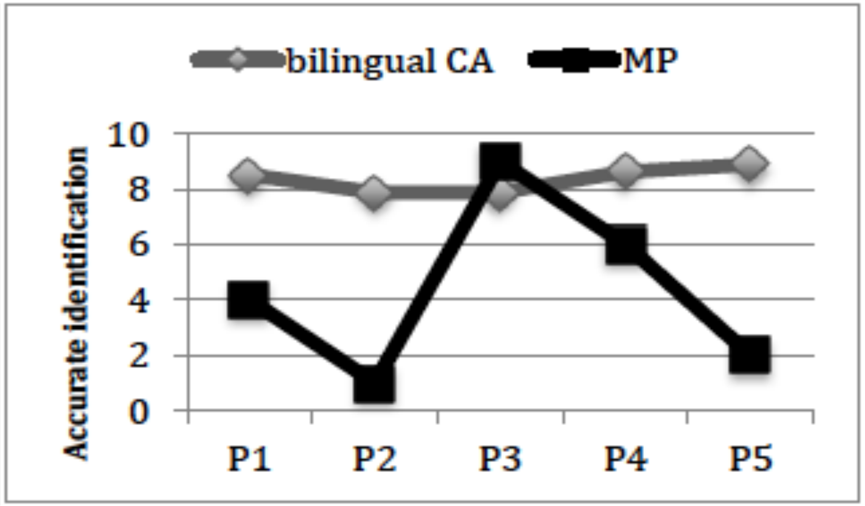
Espagnol

Lenteur de lecture

Déficit Empan VA uniquement



Report Global



Report Partiel

Dilexia bilingüe (Valdois et al., 2014) : lectura « el principito »

J'appris bien vite à mieux connaître cette fleur. Il y avait toujours eu, sur la planète du petit prince, des fleurs très simples, ornées d'un seul rang de pétales, et qui ne tenaient point de place, et qui ne dérangeaient personne. Elles apparaissaient un matin dans l'herbe, et puis elles s'éteignaient le soir. Mais celle-là avait germé un jour, d'une graine apportée d'on ne sais où, et le petit prince avait surveillé de très près cette brindille qui ne ressemblait pas aux autres brindilles. Ca pouvait être un nouveau genre de baobab. Mais l'arbuste cessa vite de croître, et commença de préparer une fleur.

Muy pronto aprendí a conocer mejor a esa flor. Siempre había habido en el planeta del principito flores sencillas, con sólo una hilera de pétalos que casi no ocupaban espacio y que a nadie causaban molestias ni llamaban la atención. Aparecían una mañana entre la hierba y morían en la tarde. Pero aquella había germinado de una semilla venida de algún lugar desconocido y el principito había cuidado muy de cerca a esa brizna y no tenía ninguna semejanza a las otras briznas.
Podía ser una nueva especie de baobab. Sin embargo el arbusto dejo pronto de crecer y dio una flor

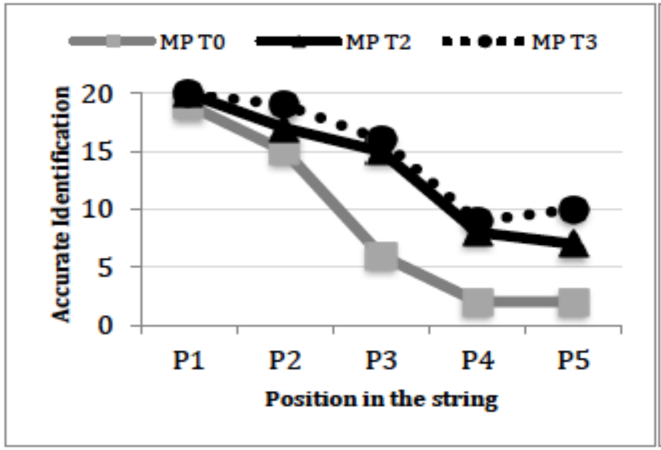
	MP	CA bilingual controls			Significance tests	
	Scores	*n*	Mean	SD	t	*p*
Text reading						
French						
Nb of errors	20	9	10.22	5.85	+1.58	.076
Time (sec)	293	9	84.78	20.81	+9.49	.00001
Wpm	17.20	9	71.32	19.58	−2.62	.015
Spanish						
Nb of errors	14	9	5.44	3.38	+2.40	.022
Time (sec)	281	9	101.67	23.41	+7.26	.00004
Wpm	19.22	9	62.44	17.38	−2.35	.023

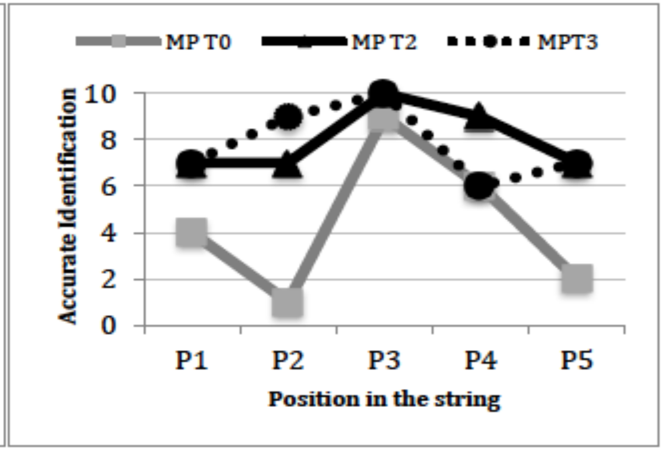
Cas MP

Valdois et al., in press, Cortex

Comparaison pré-post entraînement

LETTRES





CHIFFRES

Amélioration des capacités d'empan VA

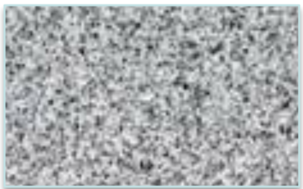
Mariana

LPNC CNRS

T0 — Pré — Post — LT

7;10 — 8;01 — 8;04 — 9;03

3 mois — 3 mois — 11 mois



NL = 6;7

NL = 6;7

NL = 6;11

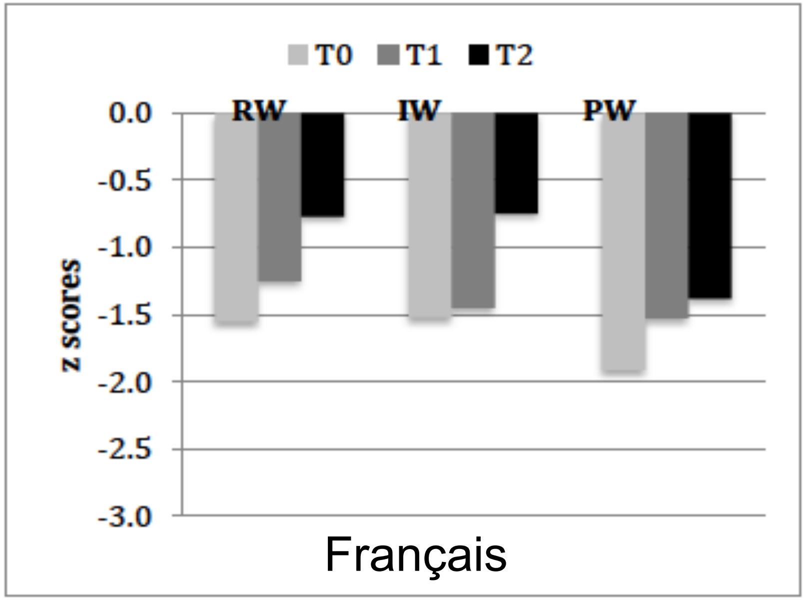
NL = 7;2

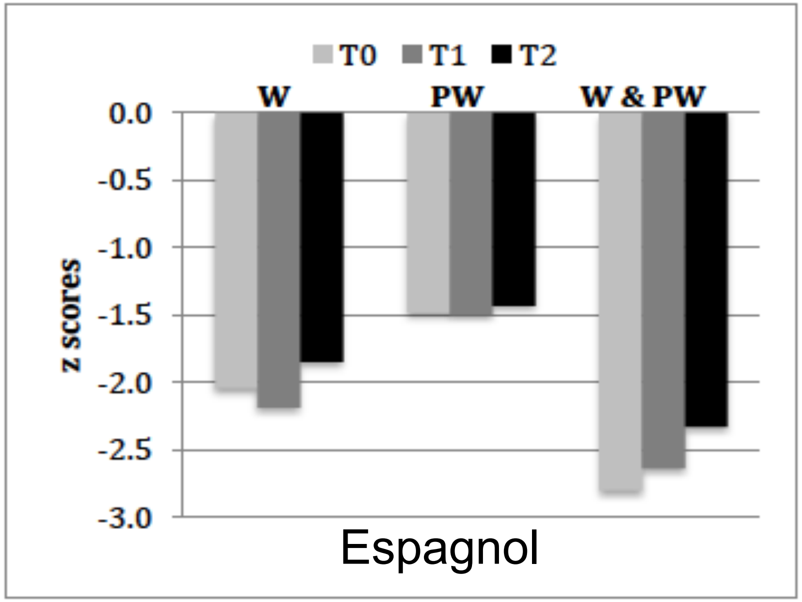
Niveau de lecture: + 4 mois en 6 semaines et 3 mois ensuite

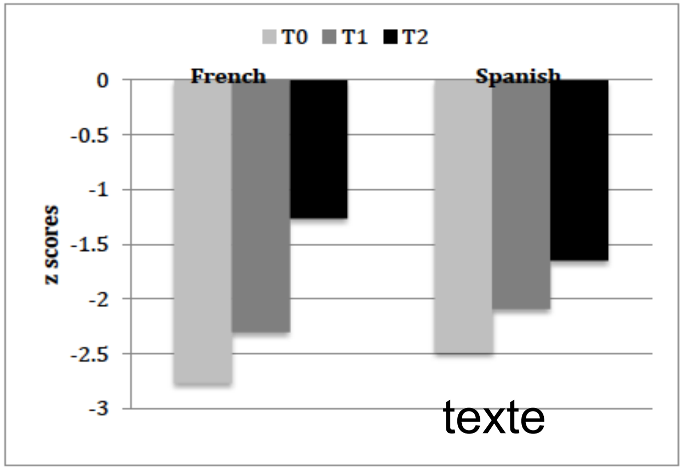
Cas MP

Valdois et al., in press, Cortex

Transfert en lecture





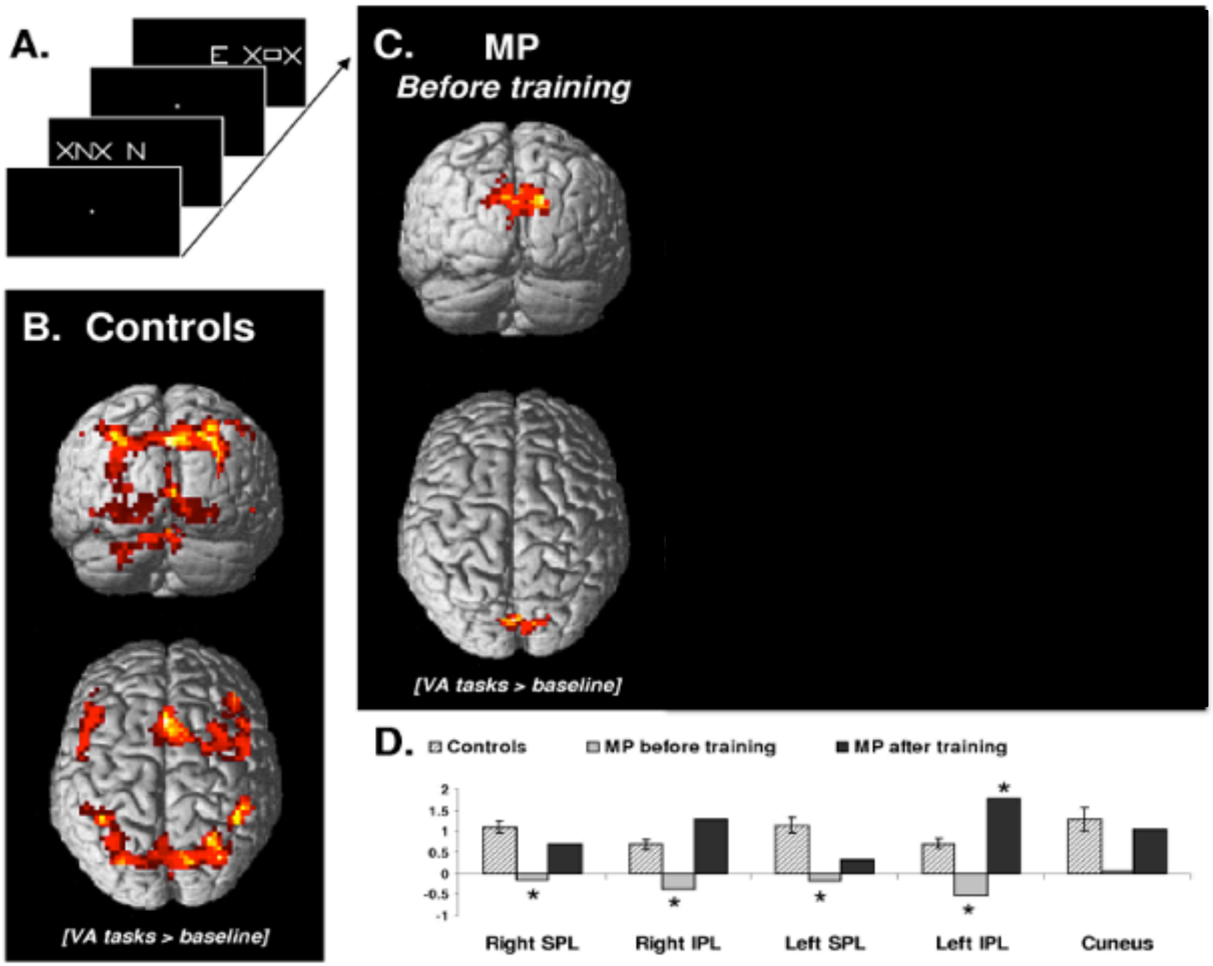


Effet plus marqué en français

Cas MP

Valdois et al., in press, Cortex

Modulations neuronales



- "A difficulty to process multi-letter strings should primarily impact whole word letter string processing, thus resulting in slow reading speed for words whatever the language transparency, … A VA span disorder would be all the more detrimental that the units to be processed are longer in number of letters, thus affecting processing in French more than in Spanish ".
- "a positive effect of intervention would more strongly affect a language like French that is characterized by multi-letter graphemes and long syllables than a one-letter grapheme language like Spanish. Accordingly, higher improvement was expected in French than Spanish following the intervention. As expected, the word reading speed improvement reported in French was not found in Spanish and MP read the French text faster than the Spanish text following the intervention. Overall, VA span intervention primarily resulted in faster and more accurate identification of words in French but no similar improvement in Spanish. This is not to say that a selective VA span intervention would not facilitate reading in Spanish."…

Valdois et al., 2014