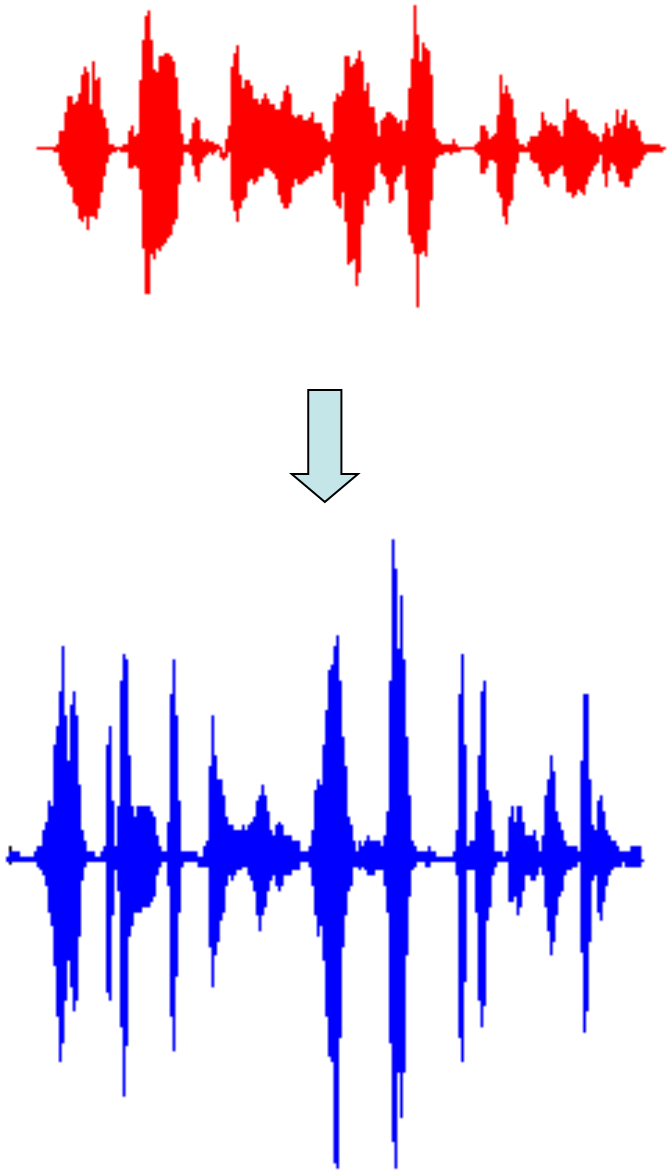
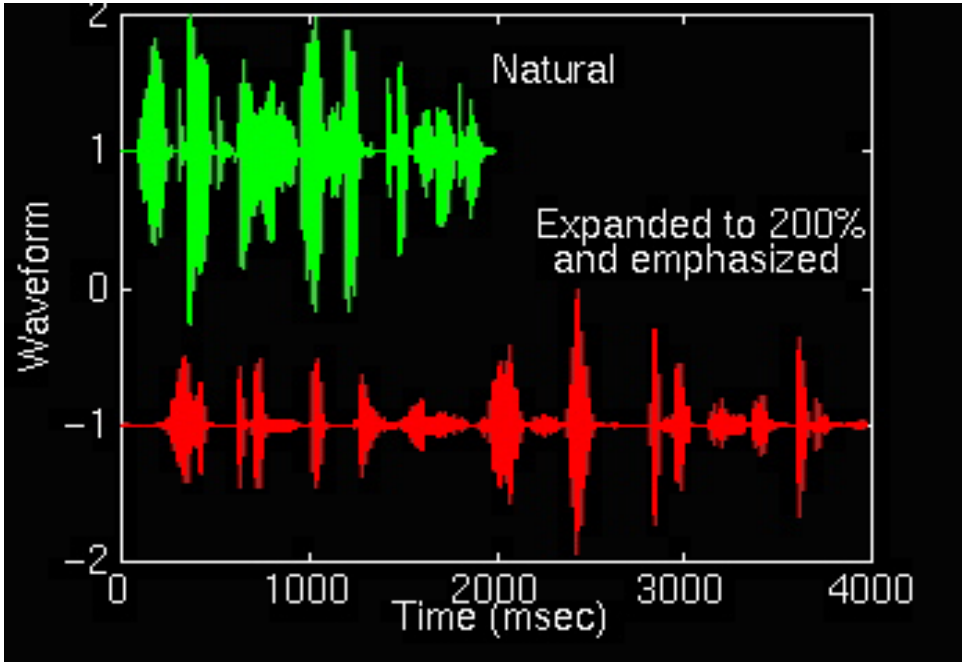
Les entraînements intensifs de la dyslexie

Une recherche thérapeutique graduée
à base théorique multi-dimensionnelle




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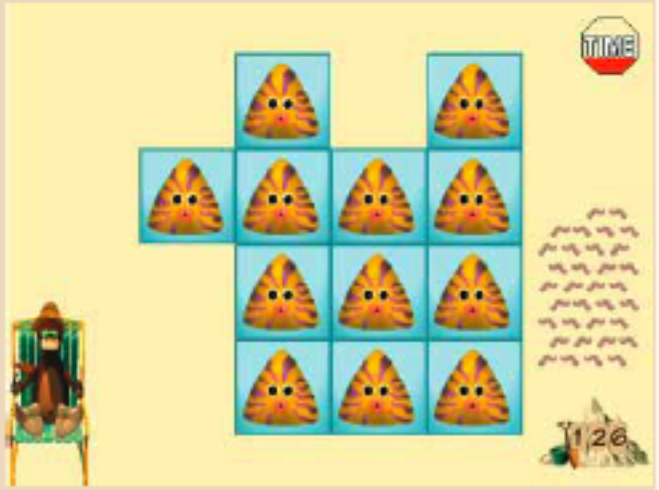
−1
−2
0
1000
2000
3000
4000
Time (msec)


ForWord Two CD
Version 1.0
Copyright © 1998 Scientific Learning Corporation. All rights reserved.
fast forword two

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

Circus Sequence

Phonic Match



Phonic Word

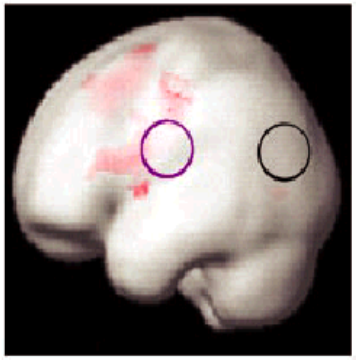
Language Comprehension Builder

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

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

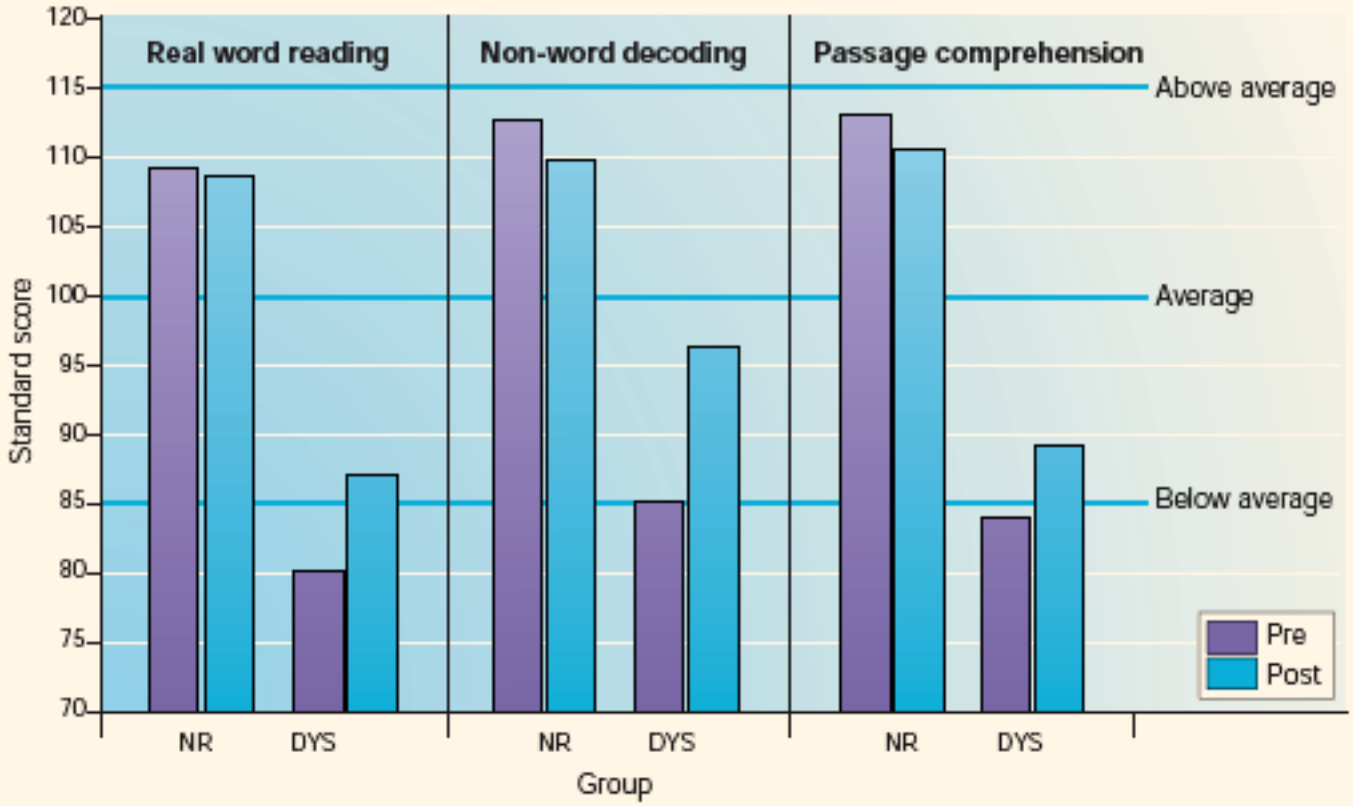


Figure 4 | **Improvements in language and reading scores after neuroplasticity-based training.** Standard scores on the three subtests of the Woodcock–Johnson Reading Mastery Test – Revised (AGS Publishing, Circle Pines, Minnesota) for normal readers (NR) compared with readers with dyslexia (DYS) before (purple pars) and after (blue bars) Fast ForWord® Language training. Mean = 100; standard deviation = 15; below average = 85. Adapted from data in REF. 104.

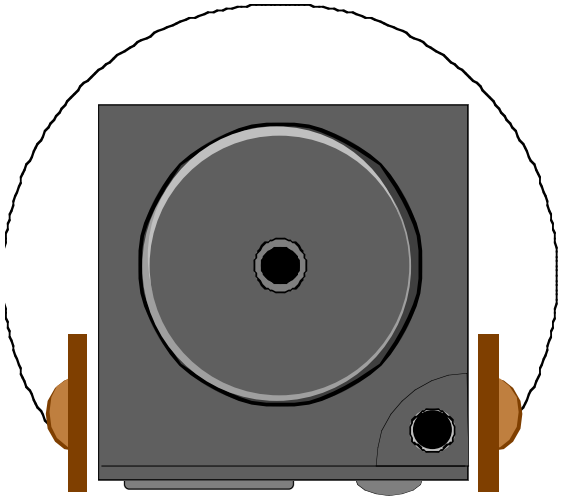
Entraînement temporo-phonologique : le programme "Lavande"

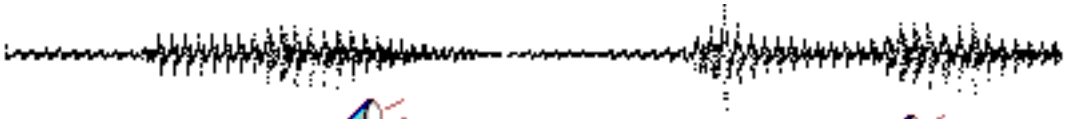
déficit temporel chez les 'Language Learning Impaired'

trouble de la conscience phono. chez dyslexiques

Combinaison d'un entraînement phonologique et temporel:

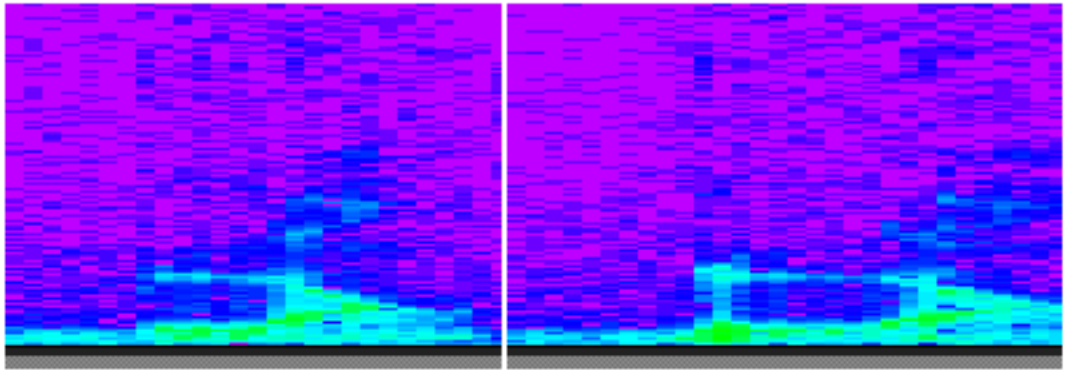
Modification acoustique de la parole dans exercices de conscience phonologique

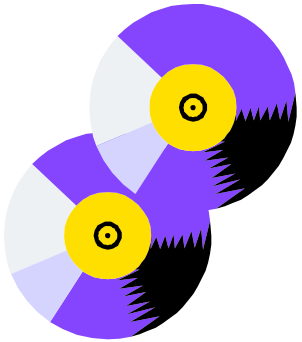


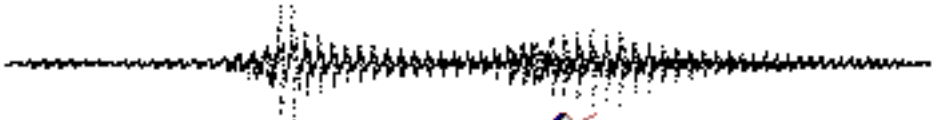


100%

133%







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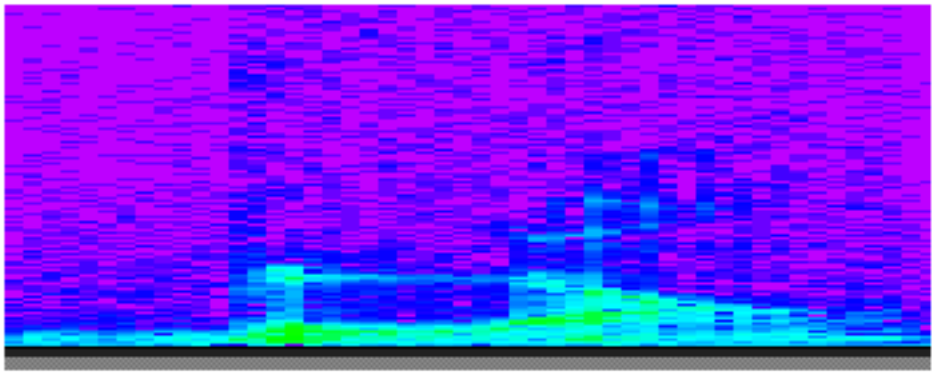
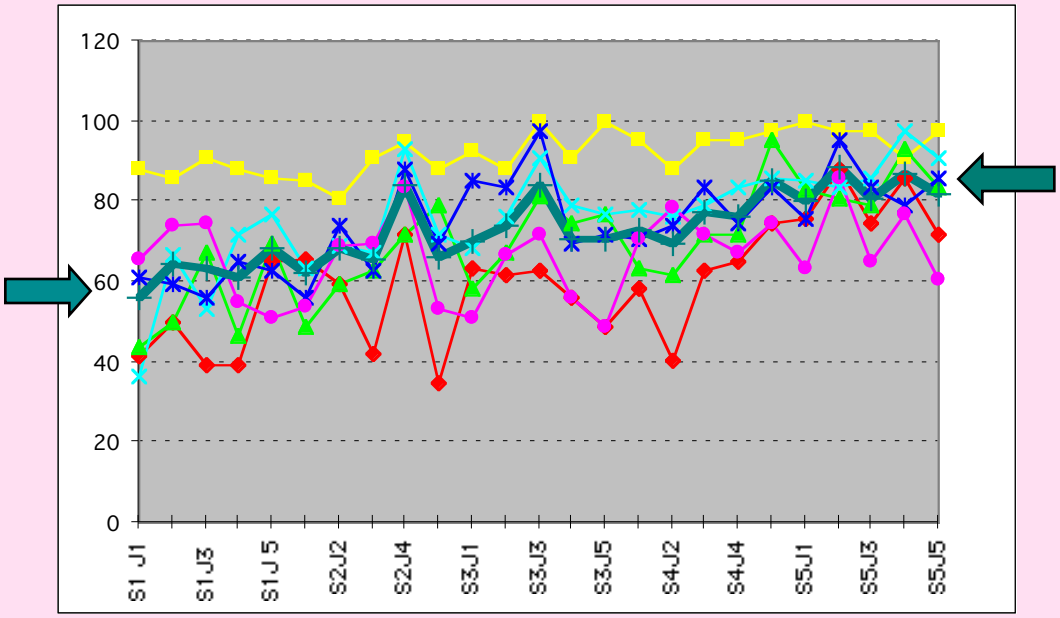
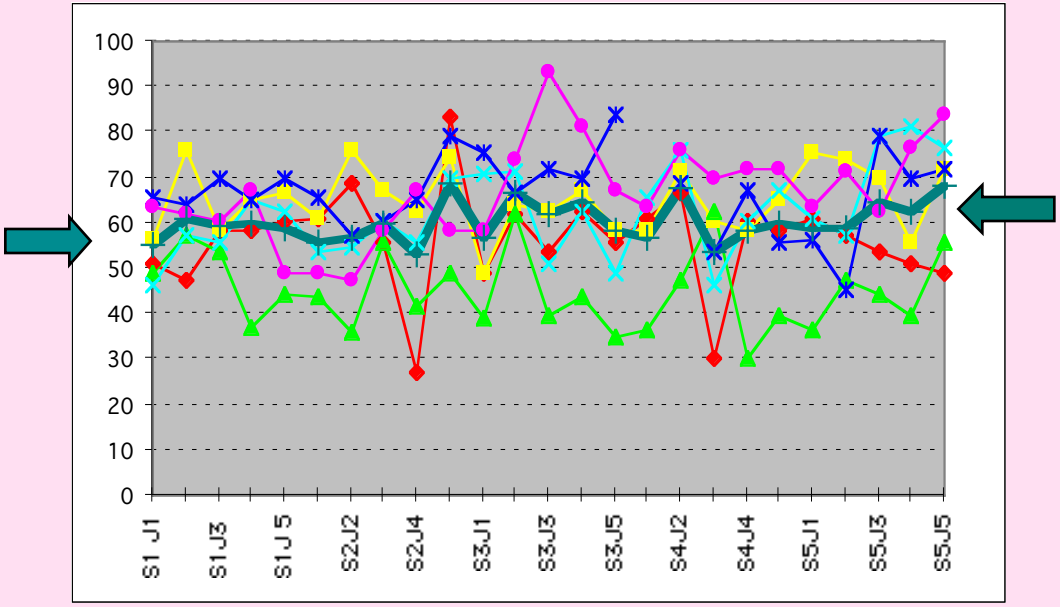


Programme “Lavande” : Caractéristiques des exercices d’entraînement

	structure syllabique simple	**structure syllabique complexe**
trouver l'intrus qui ne commence pas pareil	*ex:* dauphin-tonneau-démon	*ex:* palto-plati-paltu
trouver l'intrus qui contient un son cible	*ex:* /d/ : pitou-bodu-mité-nintan	*ex:* /sp/: aspofil-apsofal-aspoful
dictée de non-mots	*ex:* sujachi	*ex:* aclipsu

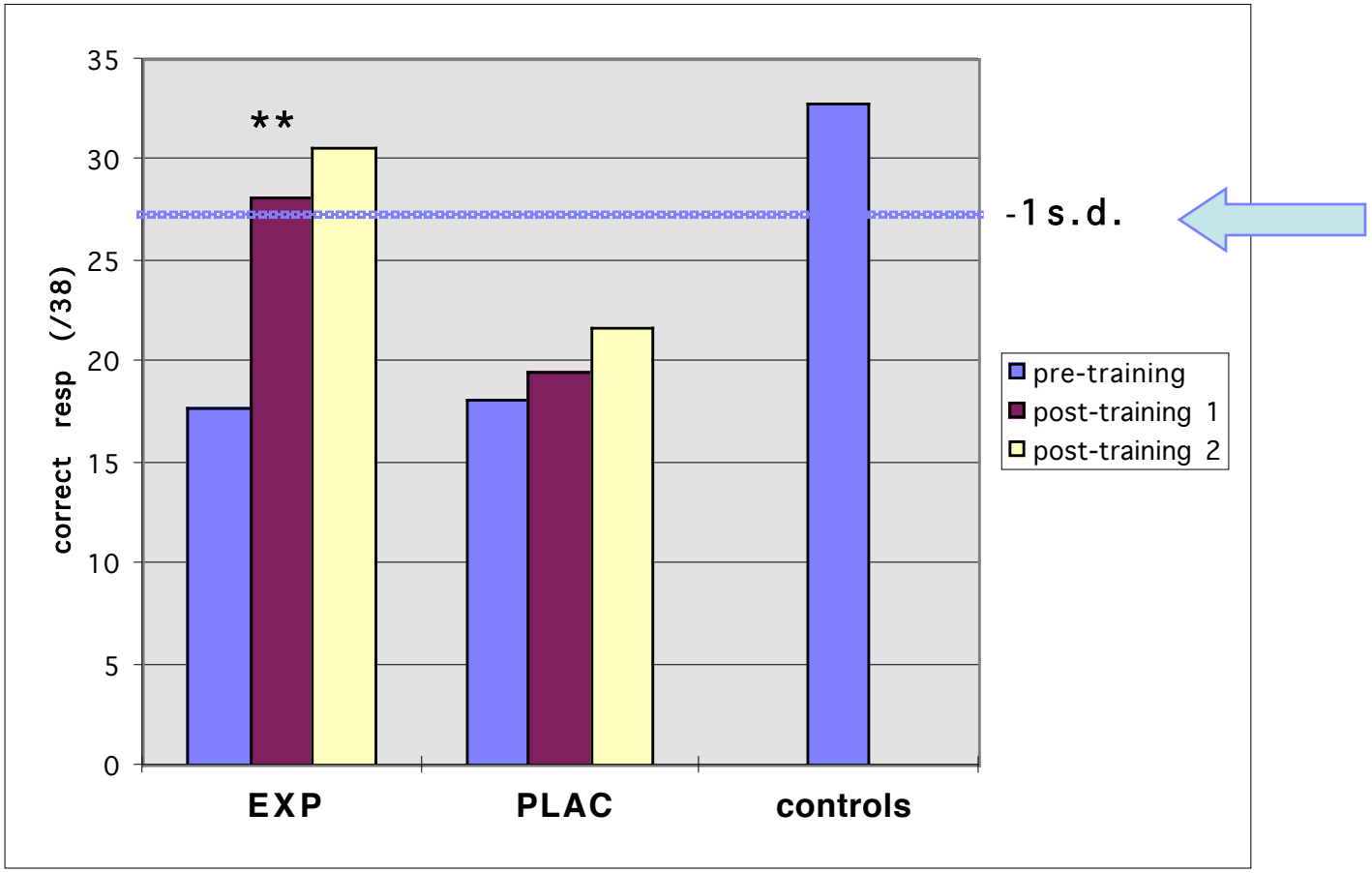


Groupe expérimental
(6 enfants avec parole modifiée)



Groupe placebo
(6 enfants avec parole normale)

Amélioration des tâches phonologiques après entraînement



Habib, Espesser, Rey, Giraud, Bruas, Grès (Brain & Cogn, 1999)

tâche	Amélioration (valeur de p)	Effet groupe (valeur de p)
Rapid automated naming	ns	ns
Stroop effect	0.049	ns
Test de l'Alouette	0.001	ns
Age de lecture (mois)	0.006	ns
Comptage syllabique (/5)	ns	ns
Comptage phonémique (/10)	0.0029	ns
Jugement de rimes (%)	0.031	ns
Segmentation phoném. (%)	0.0007	ns
Suppression 1er phonème (%)	0.008	ns
Compréhension orale	0.024	ns
Transcript. ps-mots simpl (%)	0.035	ns
Transcript. Ps-mots comp (%)	ns	0.043
Recherche d'intrus struct syll. simple (/32)	0.023	0.054
Recherche d'intrus struct syll. complexe (/37)	0.014	0.010

Résumé résultats étude 1 (ANOVA mes. répét.):

- Amélioration nette sur la majorité des tâches
- mais supériorité de la parole modifiée seulement sur les tâches entraînées
- pas de généralisation de l'avantage sur parole non-modifiée (sauf pour la transcription de pseudo-mots)

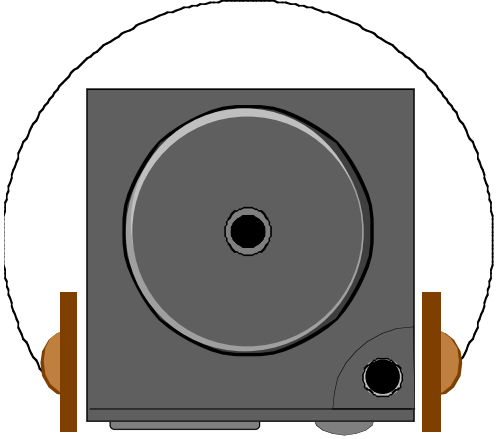
⇨ Confirmation partielle des résultats de Tallal

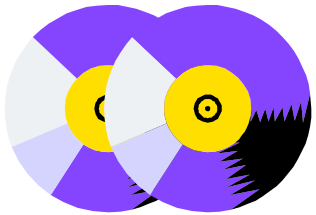
Entraînement temporo-phonologique dans la dyslexie : le programme Lavande 2

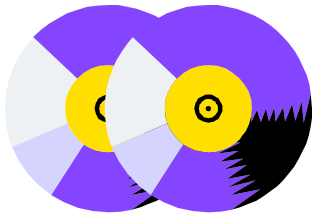
- Environ 30 enfants
- Sélectionnés comme dyslexie à prédominance phonologique par leur orthophoniste
- 10 à 15 mn d'exercices phonologiques similaires à 'Lavande 1', plusieurs sessions de 3 semaines
- 2 jours par semaine au cabinet de l'orthophoniste, le reste du temps à domicile.
- Bilan pré- et post entraînement

niveau 1

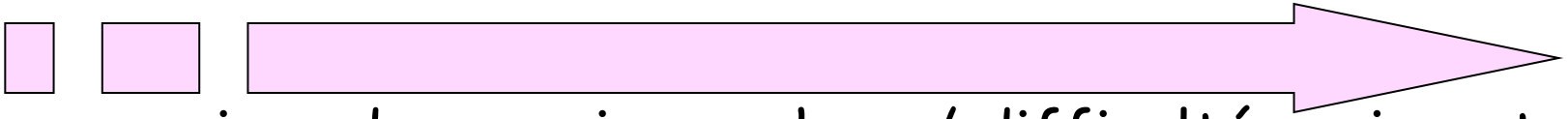
niveau 2



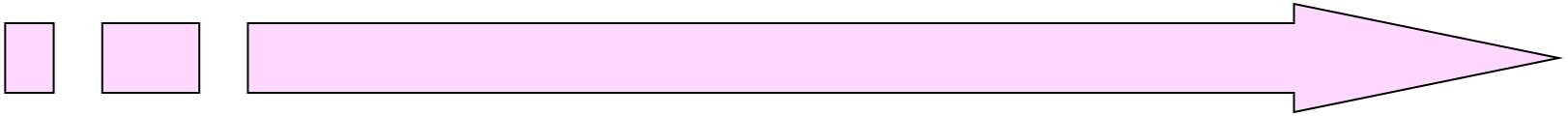




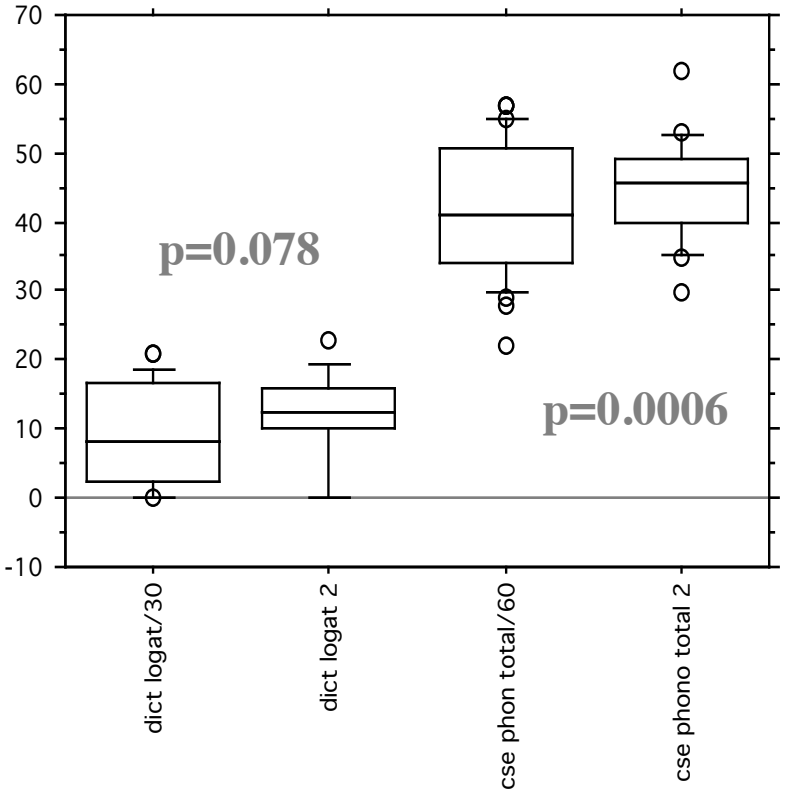
sem. 1-2-3 sem. 4-5-6 sem. 1-2-3 sem. 4-5-6

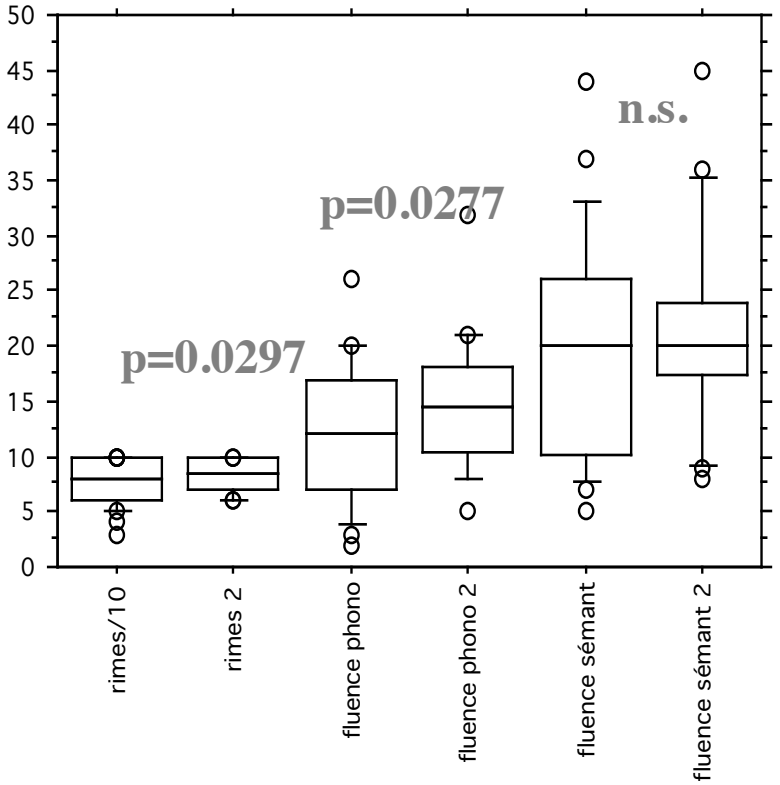


•exercices de conscience phono/ difficulté croissante

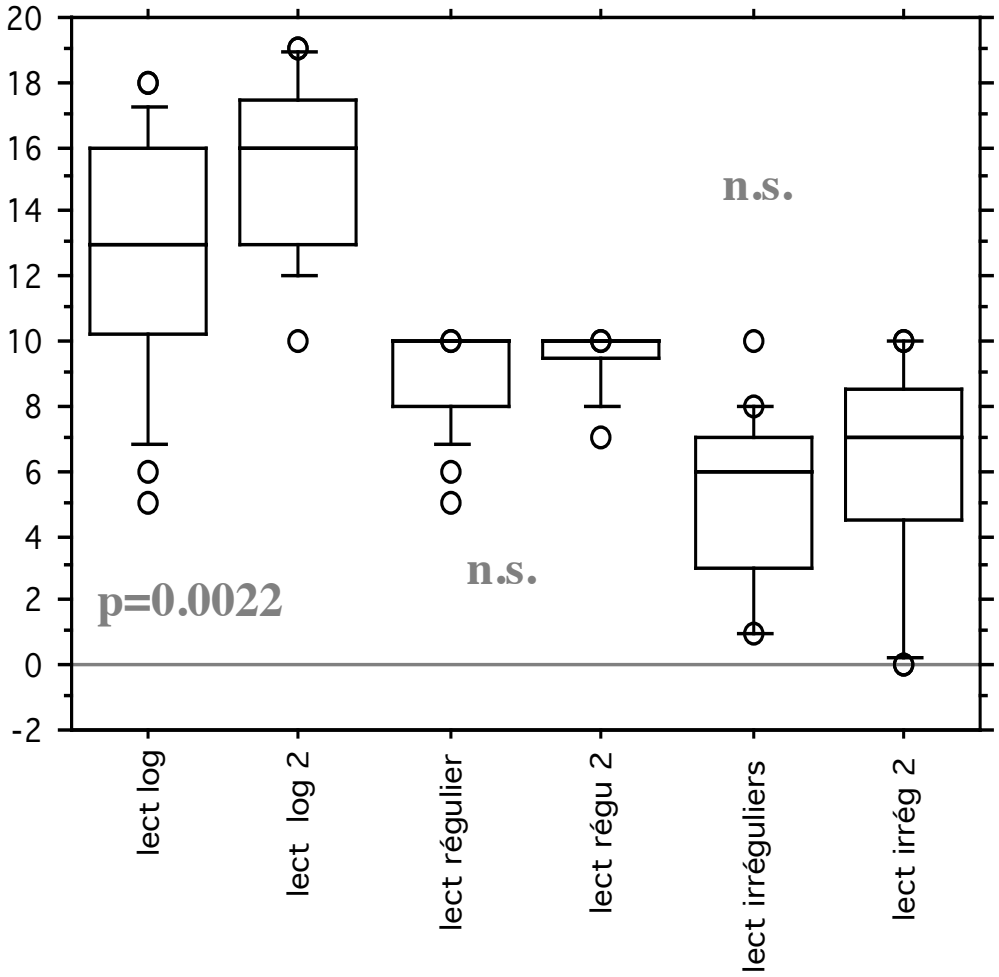


• modification temporelle décroissante





effet de l'entraînement : amélioration dans toutes les tâches phonologiques

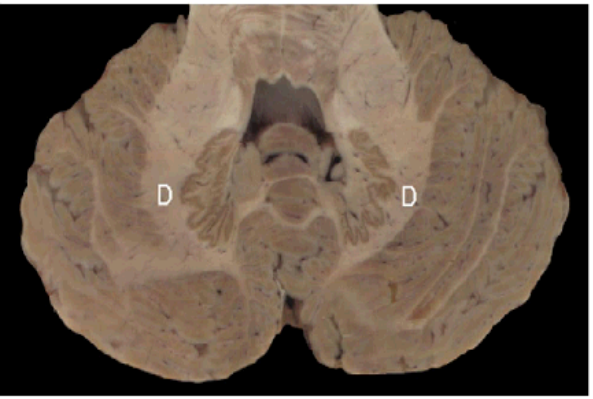


effet de l'entraînement : amélioration en lecture de non-mots

The “Lavande” programme : Study 3

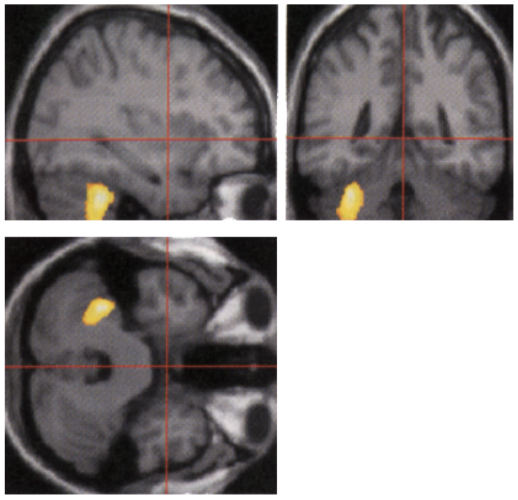
Adding the intermodal dimension

- The cerebellar theory and evidence of articulatory deficit in dyslexia
- Testing the theory
- Application to phonological training : audio-articulatory phonological approach



Developmental dyslexia: the cerebellar deficit hypothesis

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



Evidence for an Articulatory Awareness Deficit in Adult Dyslexics

Sarah Griffiths, and Uta Frith*

UCL, Institute of Cognitive Neuroscience, 17 Queen Square, London WC1N 3AR, UK

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

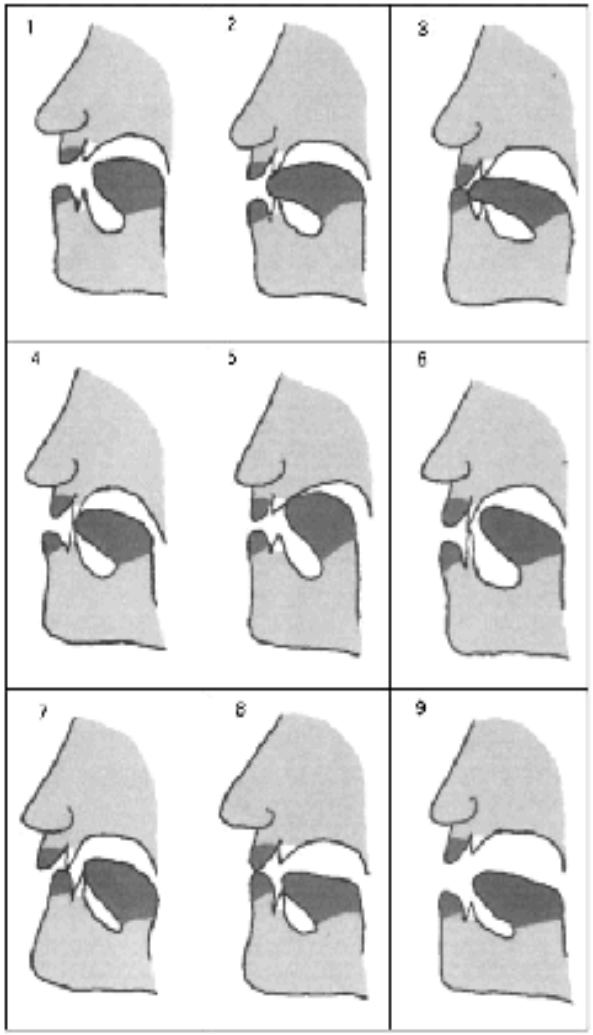
	Dyslexics ($N = 17$)		Controls ($N = 17$)		F
	Mean	S.D.	Mean	S.D.	
Age (years)	21.67	3.18	21.36	5.70	0.04
VESPAR spatial reasoning test†	11.06	1.25	11.65	0.86	2.56
VESPAR verbal reasoning test†	10.82	1.47	12.00	0.87	8.10**
WRAT reading†	97.94	6.46	113.53	6.53	48.99***
WRAT spelling†	93.00	13.92	113.24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

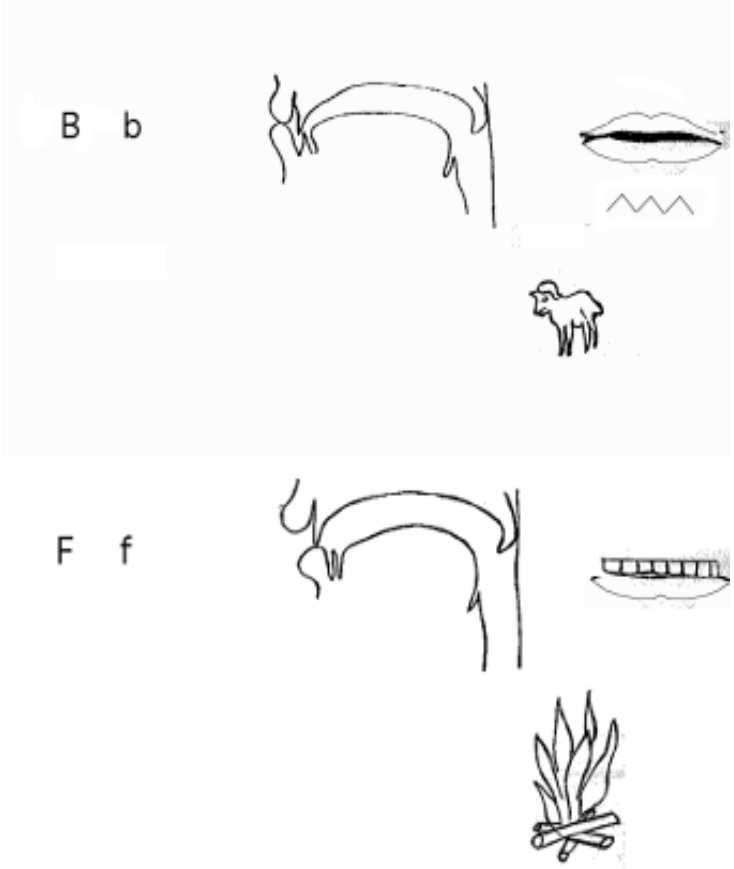
Group differences significant $^{*}p < 0.05$.
$^{**}p < 0.01$.
$^{***}p < 0.001$.



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

Traitement du déficit phonologique par entraînement de la boucle audio-articulatoire

19 enfants : 7 à 11 ans. Dyslexie phonologique sévère classique



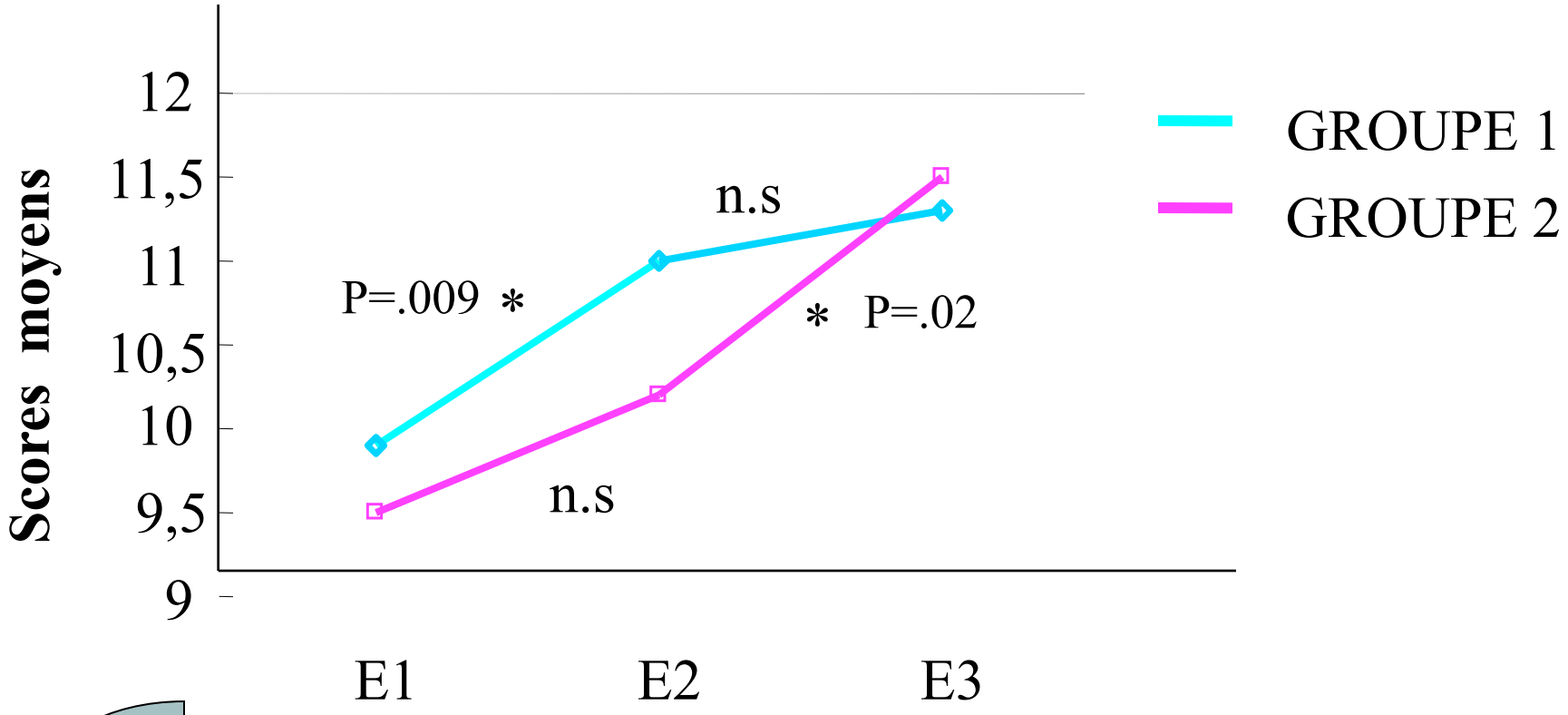
- Exemple de planche utilisée dans l'entraînement articulatoire (15mn/j, 2 fois/sem)
- associé au logiciel « Speech-viewer™ » d'IBM

Déroulement de l'entraînement

	GROUPE 1 10 Sujets	GROUPE 2 9 Sujets	
SESSION 1	Phonologie + Articulation	Phonologie	**BILAN 1**
SESSION 2	Phonologie	Phonologie + Articulation	**BILAN 2**
			BILAN 3

G2 * C2 * E3

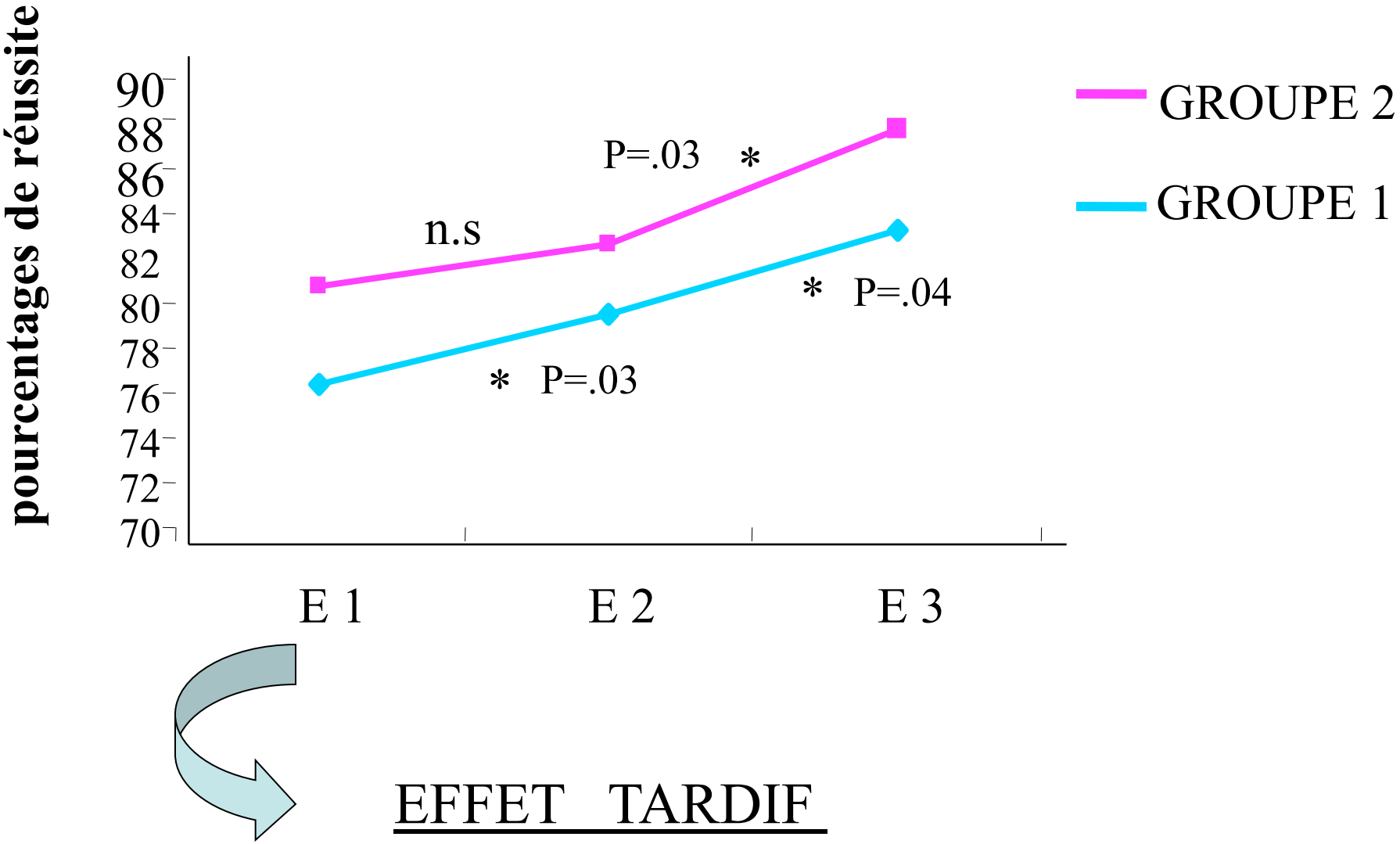
CONSCIENCE PHONOLOGIQUE



EFFET CUMULATIF (PHONO +ARTIC.)

B. Joly-Pottuz, M. Mercier, A. Leynaud, M. Habib (en préparat

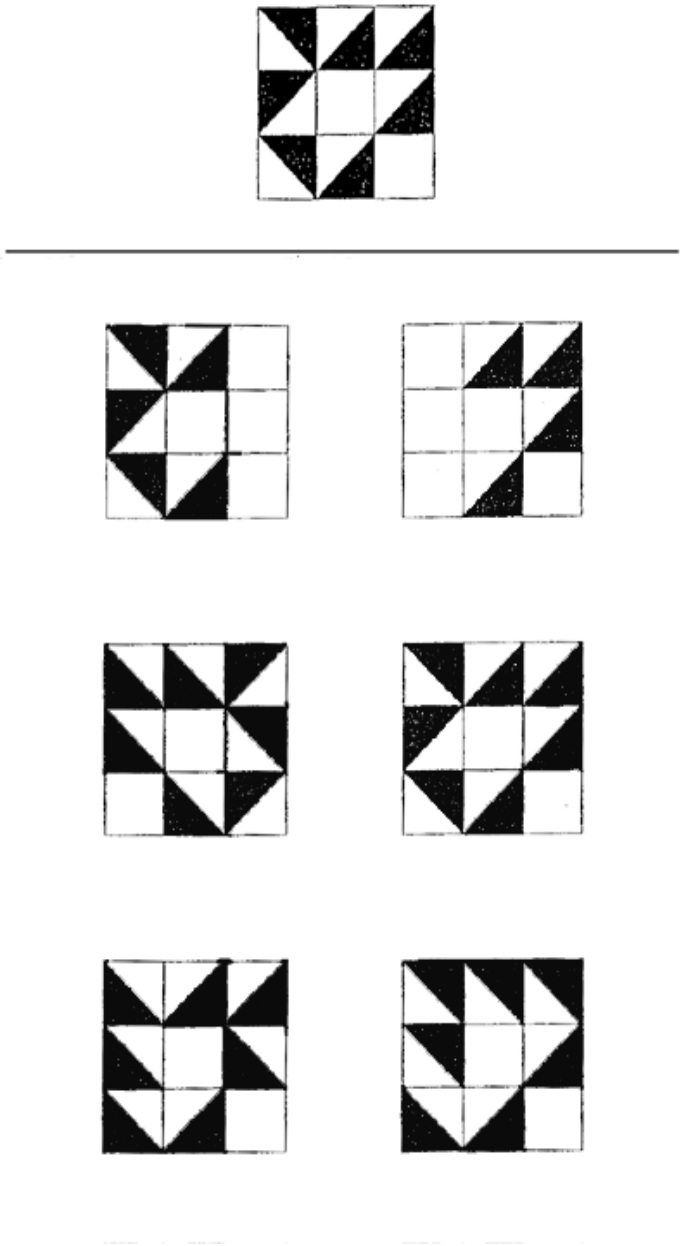
LECTURE

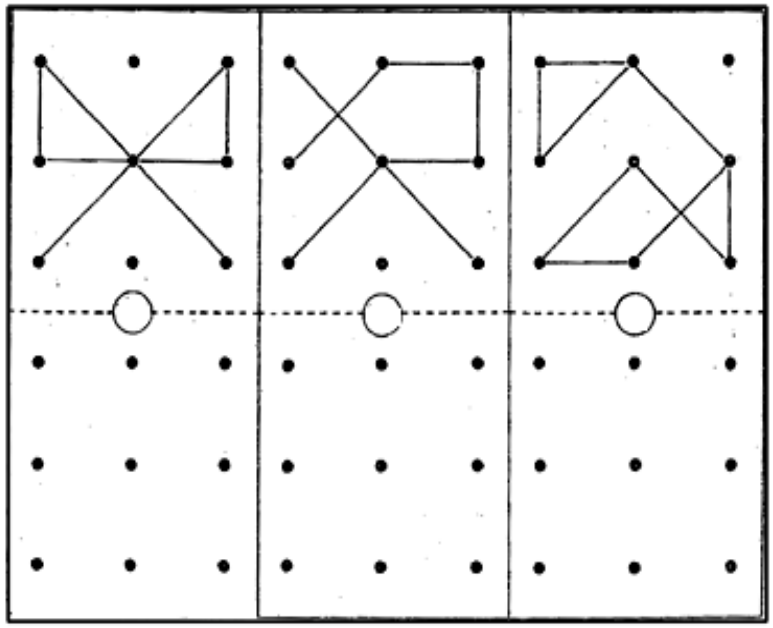


EFFET TARDIF

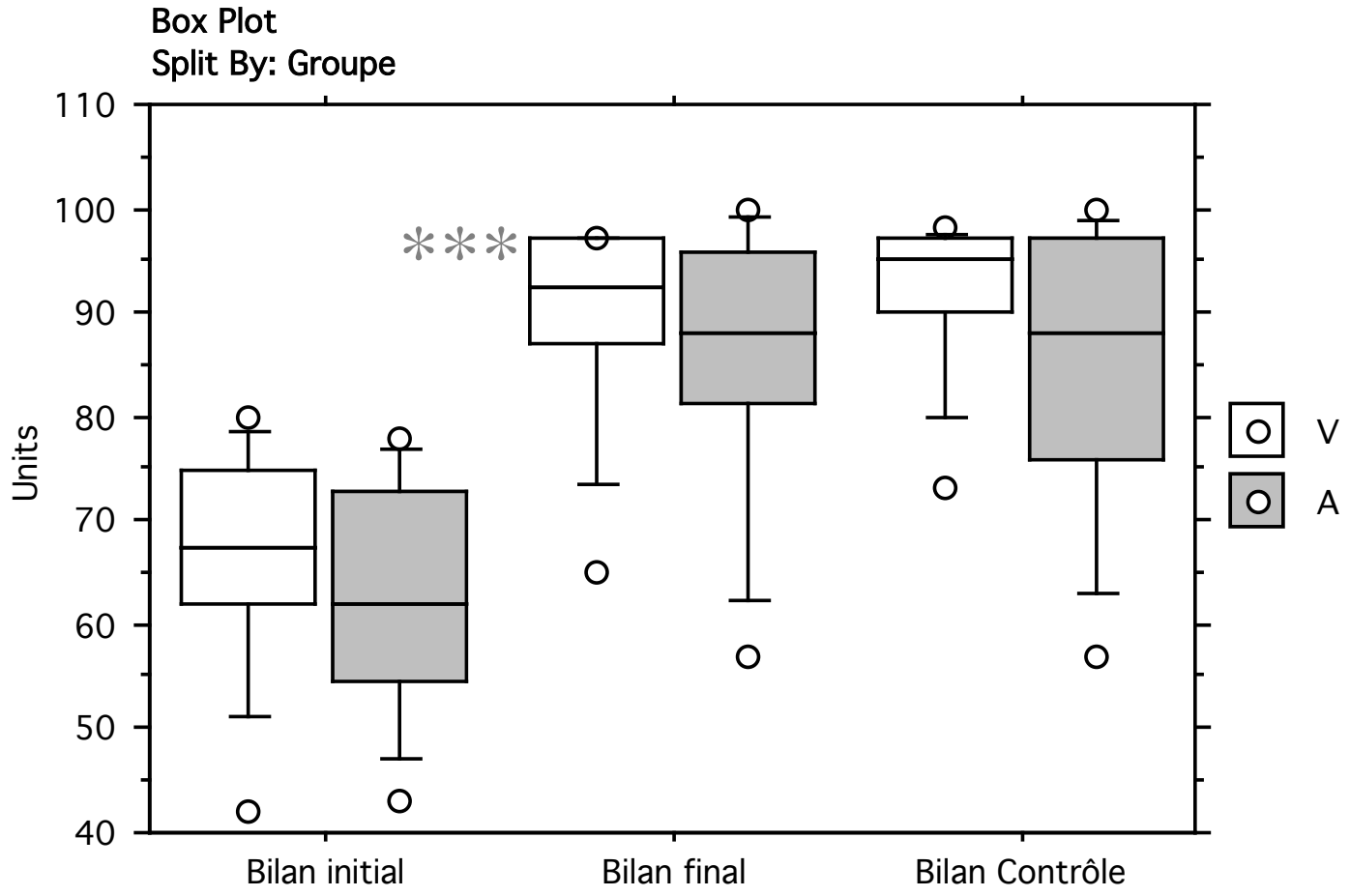
Evaluation de l'entraînement articulatoire par comparaison avec un groupe « contrôle » visuel

- Groupe 1 ; n = 12 : entraînement phonologique quotidien + exercices visuo-attentionnels et spatiaux (V)
  - F = 6, M = 6.
  - âges 7;7 a/m à 11;3 a/m
- Groupe 2 ; n=10 : entraînement phonologique quotidien + entraînement articulatoire (A)
  - F = 4, M = 6.
  - âges 7;9 à 10;11
- 6 semaines d'entraînement. Evaluations avant traitement, après traitement et 7 mois plus tard .

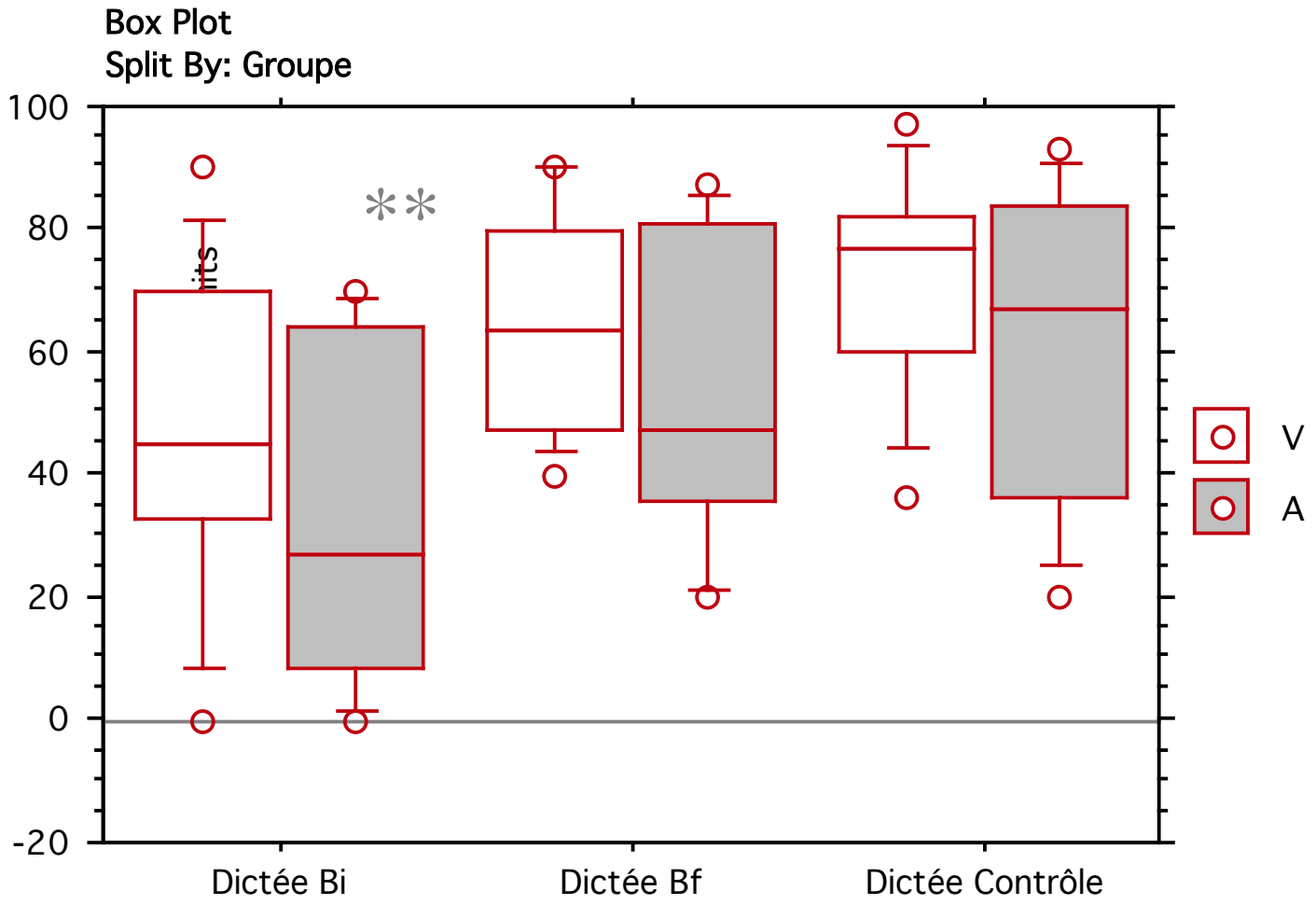




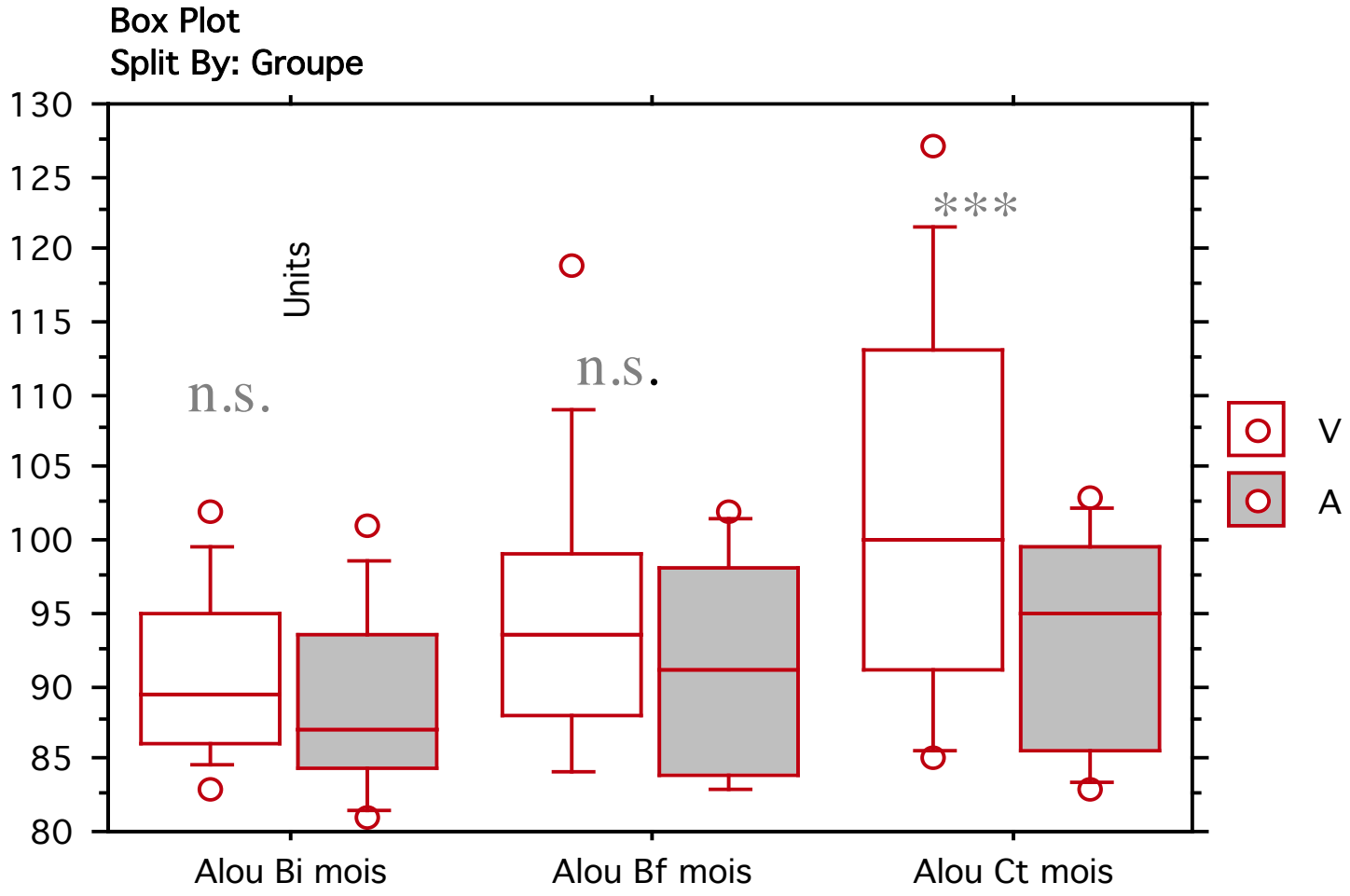
Exemples d'exercices dans le groupe « entraînement visuel »



Score phonologique : amélioration significative des deux groupes



Dictée de mots : amélioration significative des deux groupes



Lecture : amélioration très significative du groupe visuel seul à 7 mois

Entraînement phonologique intensif: conclusions (1)

- L'utilisation de parole temporellement modifiée dans l'entraînement phonologique procure un avantage modéré sur les tâches phonologiques et aucun avantage sur les tâches de lecture.
- Cependant, cela n'élimine pas un mécanismes de déficit temporel à l'origine du trouble phonologique dans la dyslexie, des preuves expérimentales solides allant dans ce sens
- Un entraînement phonologique intensif, modifié acoustiquement ou pas, surtout s'il contient des exercices portant sur les étapes épiphonologiques, est sans doute le moyen le plus efficace d'entraîner la phonologie chez le dyslexique

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

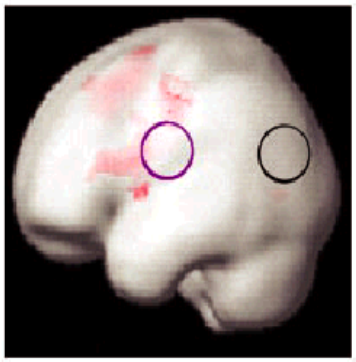
	Dyslexic-reading children				Normal-reading children			
	Pretraining	Posttraining	T-stat	*P*	1st scan	2nd scan	T-stat	*P*
Reading: WJ-RMT								
Word ID	78.2 (56–95)	86.0 (72–99)	3.9	0.0005	109.0 (95–120)	108.3 (97–126)	0.6	0.6
Word Attack	85.5 (72–102)	93.7 (82–109)	6.8	0.0001	112.3 (99–132)	109.4 (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.

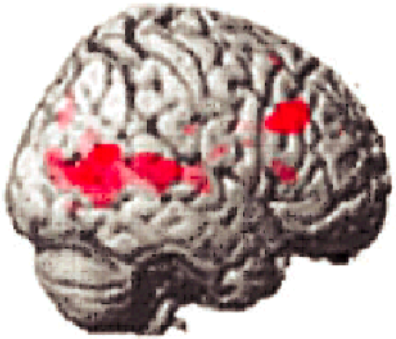
A Children with no remediation

Normal reading children while rhyming

Dyslexic reading children while rhyming before remediation



B Dyslexic children increases after remediation



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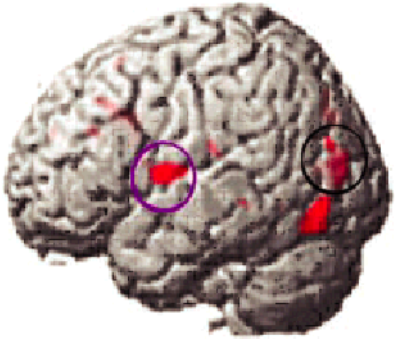
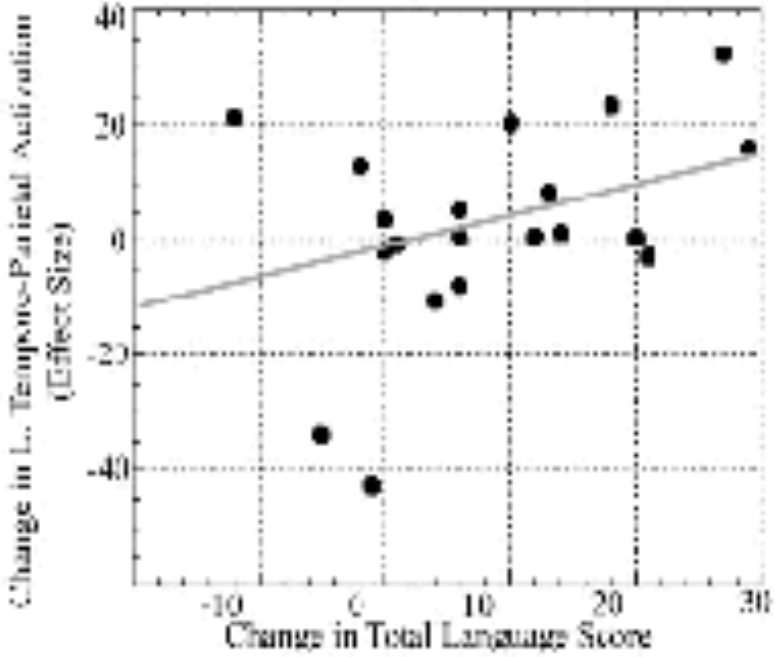


Left



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

Entraînement phonologique intensif: conclusions (2)

- L'adjonction d'exercices entraînant la boucle audio-articulatoire facilite et accélère la réduction du déficit phonologique
- Mais, ici encore, les preuves d'un effet sur la lecture restent minces
- L'adjonction d'un entraînement des processus visuo-perceptifs n'affecte pas l'amélioration immédiate des processus phonologiques mais procure une amélioration significative de la lecture à distance

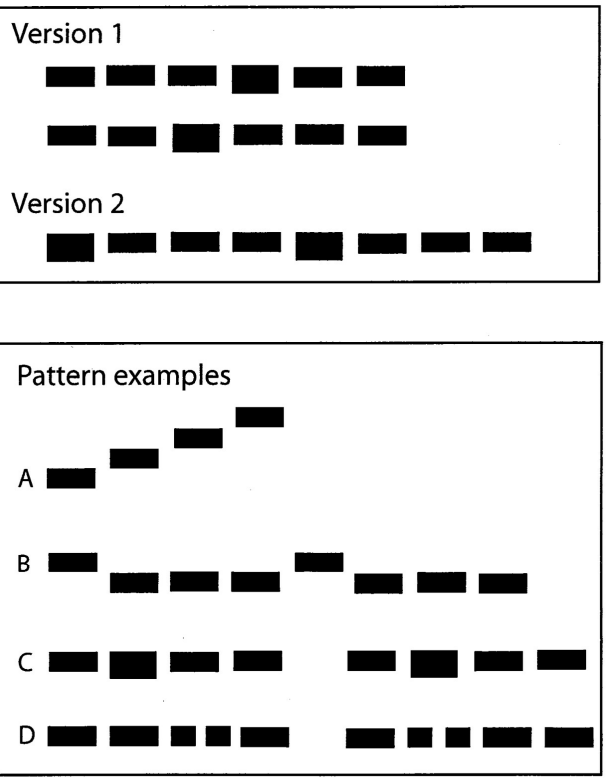
Plastic neural changes and reading improvement caused by audiovisual training in reading-impaired children

T. Kujala*†, K. Karma‡, R. Ceponiene*, S. Belitz*, P. Turkkila‡, M. Tervaniemi*, and R. Näätänen*§

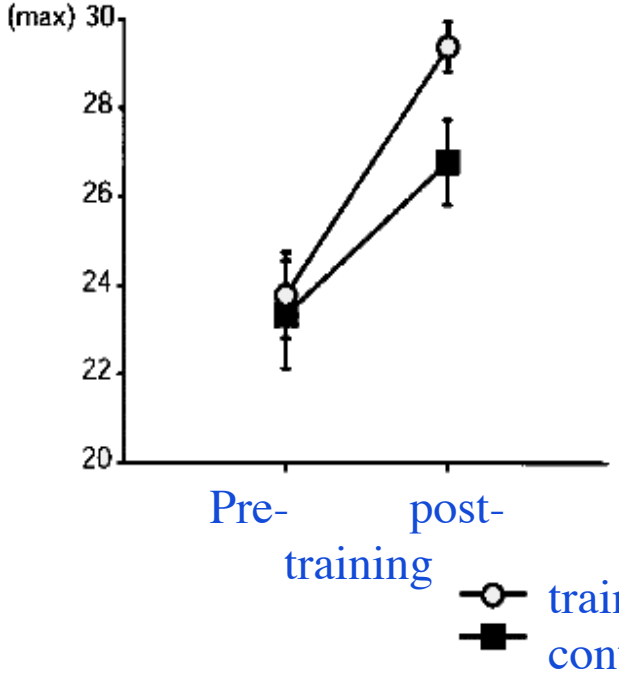
*Cognitive Brain Research Unit, Department of Psychology, P.O. Box 13, University of Helsinki, FIN-00014 Helsinki, Finland; ‡Sibelius Academy, Department of Music Education, FIN-00251 Helsinki, Finland; and §BioMag Laboratory, Meilahti, P.O. Box 340, 00029 HUS, Finland

PNAS | August 28, 2001 | vol. 98 | no. 18 | 10509–10514

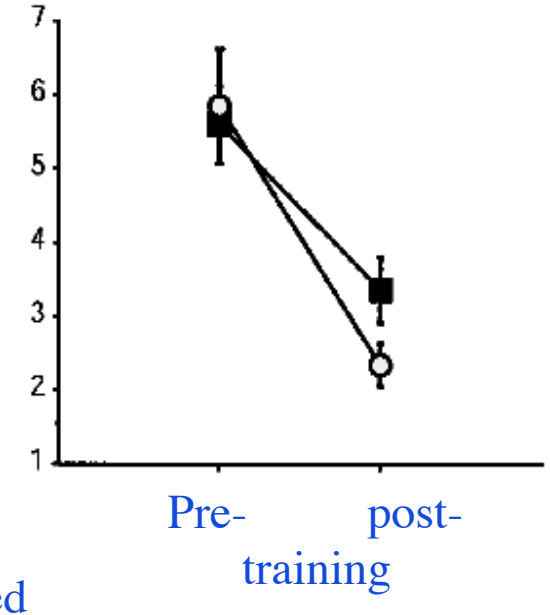
Game patterns

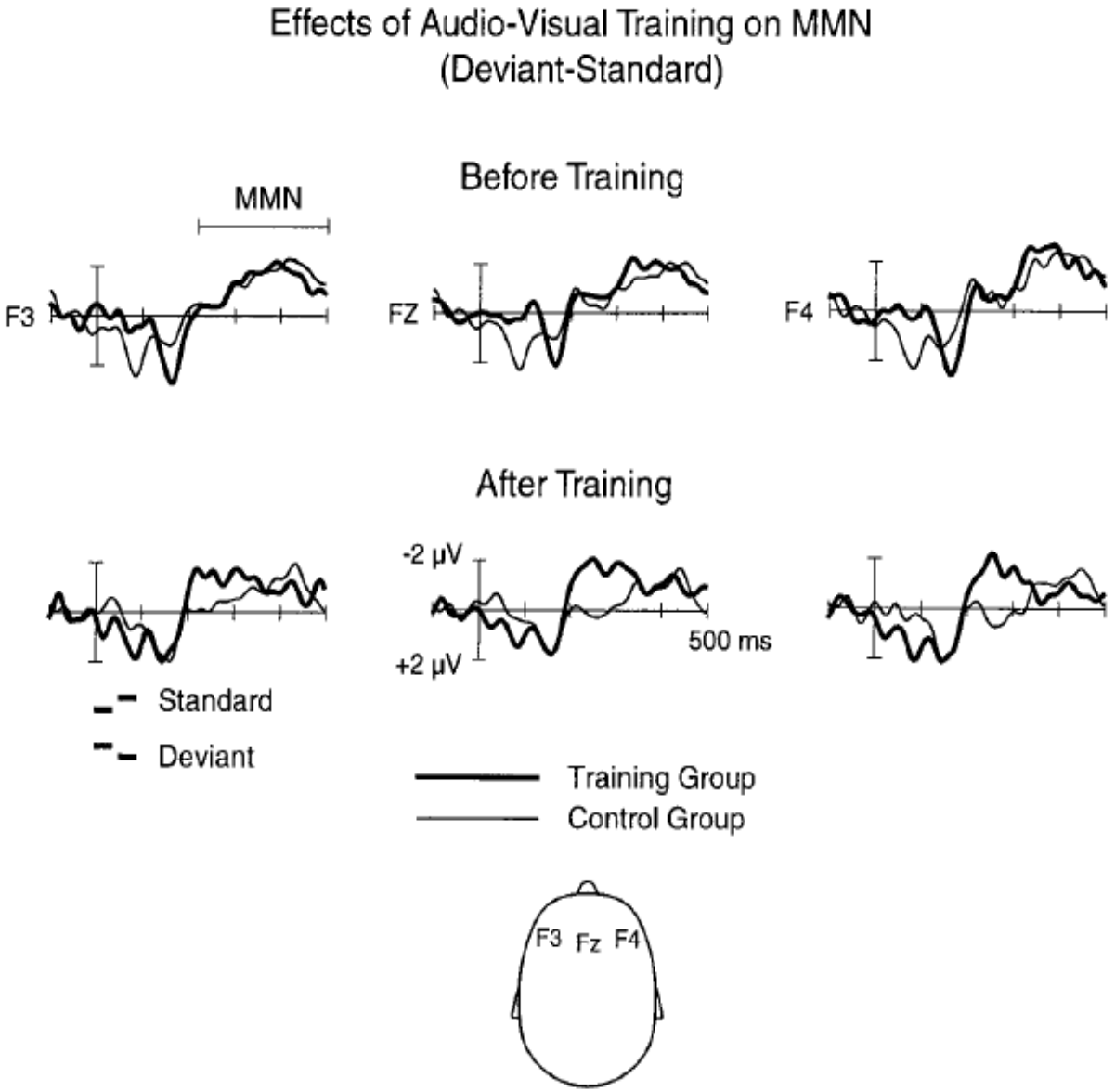


Words correctly read



Reading speed (sec/word





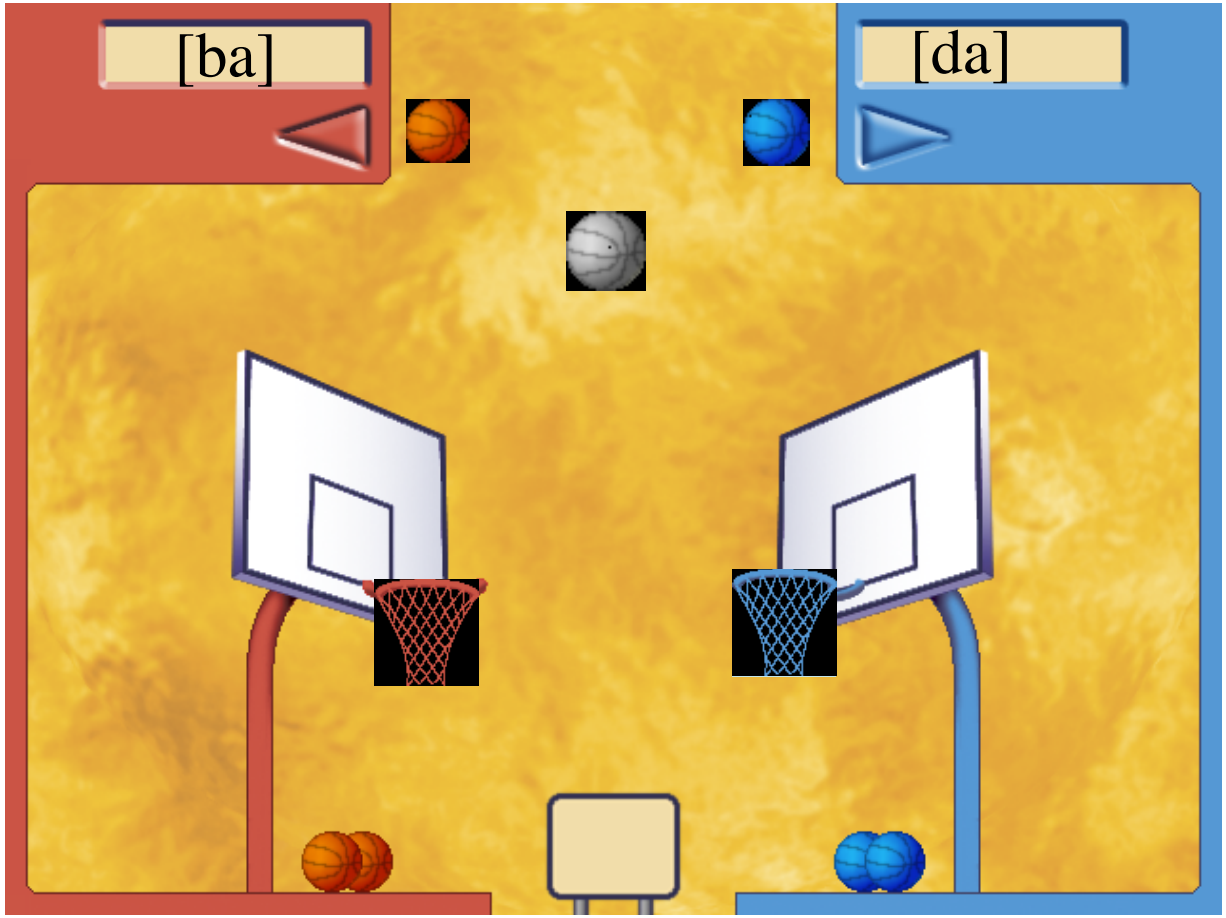
Kujala et al., 2001

Evaluation d'un logiciel d'aide à la lecture auprès d'enfants dyslexiques

A. Magnan, J. Ecalle, E. Veuillet, L. Danon-Boilleau et D. Barbier

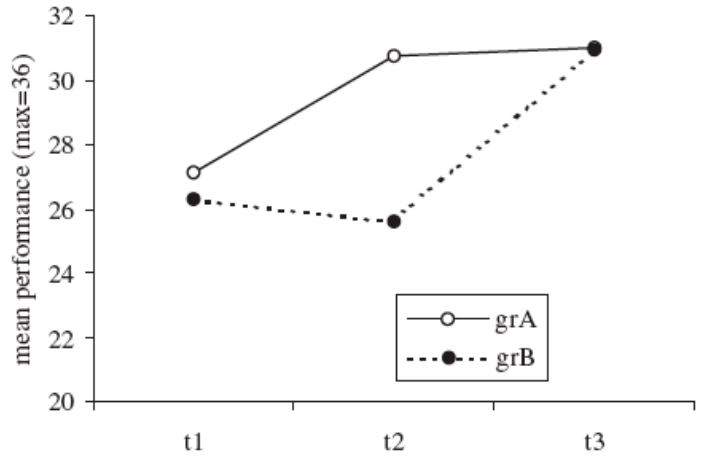
- 14 enfants dyslexiques divisés en 2 groupes
- âge moyen : 10 ans 1 mois
- bilans pré et post entraînement : épreuves phonologiques et épreuves de reconnaissance de mots (3 conditions : prononcé, image, amorce sémantique)
- entraînement : 2 séances de 15 mn/jour, 4 jours/ semaine et pendant 5 semaines
- « jeu de Basket »

Ecalle J. Développement des processus d'identification de mots écrits : une étude transversale entre 6 et 8 ans, sous presse in rééducation orthophonique.



Intermodal training with « Play-on® » (Danon-Boileau & Barbier, 2000)

Danon-Boileau, L., & Barbier, D. (2000). Play-On: Un logiciel d'entraînement à la lect
Paris: Audivi-Media.



. Mean performance in two groups of dyslexic children in three testing sessions (t1, t2, t3).

Performance moyenne en lecture (TIME2)

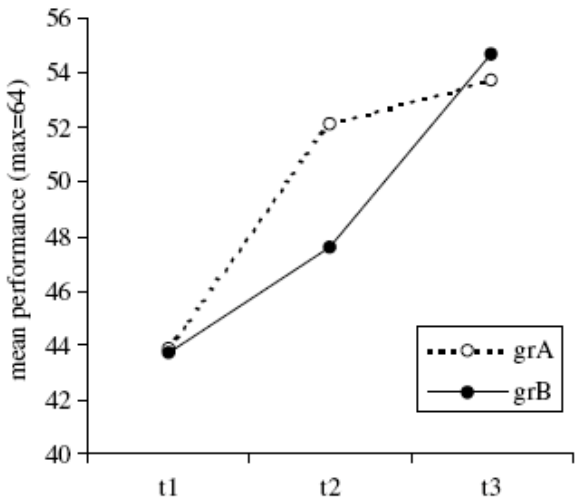


Fig. 2. Mean performance in two groups of dyslexic children in three testing sessions (t1, t2, t3).

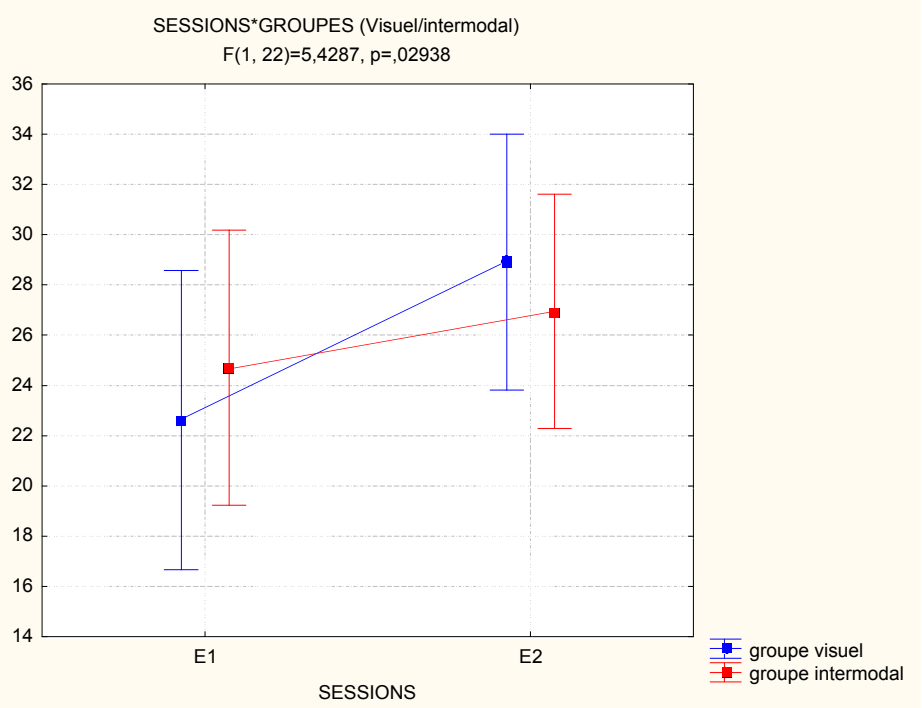
Performance moyenne en conscience phonologique

Entraînement phonologique intensif : derniers développements

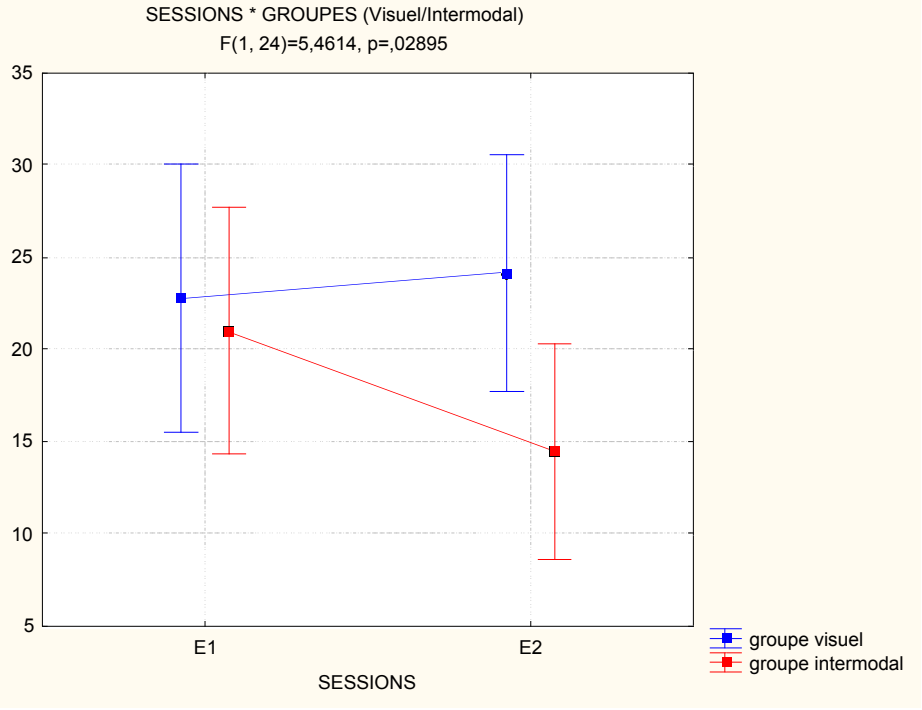
- Ajout d'une composante "intermodalitaire"
- À l'instar de Kujala et al.
- Utilisation des potentiels évoqués pour confirmer l'impact sur les mécanismes neuraux sous-jacents
- Hypothèse : le groupe intramodalitaire devrait s'améliorer plus significativement en conversion grapho-phonémique (et phono-graphémique)

Protocole expérimental

	Groupe 1 (PA/PV) n=6	**Groupe 2 (PV/PA) n=6**	**Groupe 3 (PA/PI) n=7**	**Groupe 4 (PI/PA) n=7**
Bilan 1 + potentiels évoqués				
Sem. 1-3	Phono-articulat.	Phono - visuel	Phono-articulat.	Phono-intermod
Sem. 4-5 pause	**Bilan 2**			
Sem 6-9	Phono - visuel	Phono-articulat.	Phono-intermod	Phono-articulat.
Bilan 3 + potentiels évoqués				

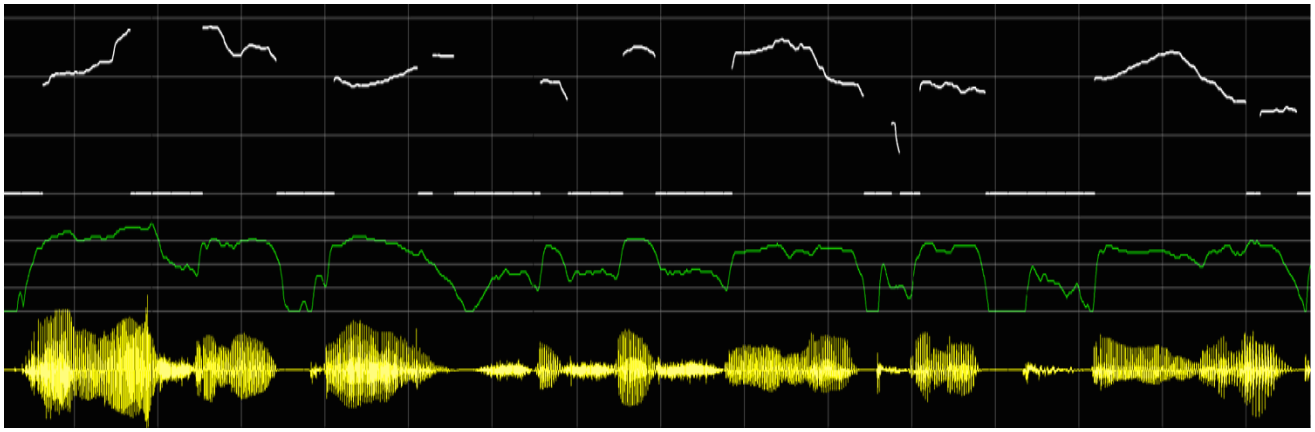


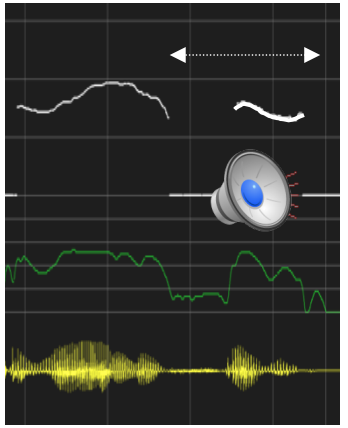
Amélioration du groupe visuel seul pour les tâches de lecture



Amélioration du groupe intermodal seul pour le transcodage (dictée de mots et de textes)

Un loup solitaire se faufile entre les troncs de la grande **forêt**





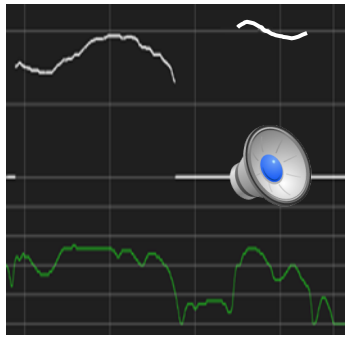
120 sentences from a children's book :

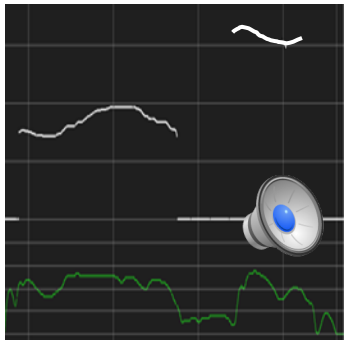
40 with F0 unchanged

+ 35%

40 with F0 increased by 135 %

40 with F0 increased by 220 %





Un loup solitaire se faufile entre
les troncs de la grande forêt

+ 120%

Je voudrais un animal à moi
pour lui dire tous mes secrets
Dans la mare, il y a des canards
qui jouent à cache-cache

ELSEVIER

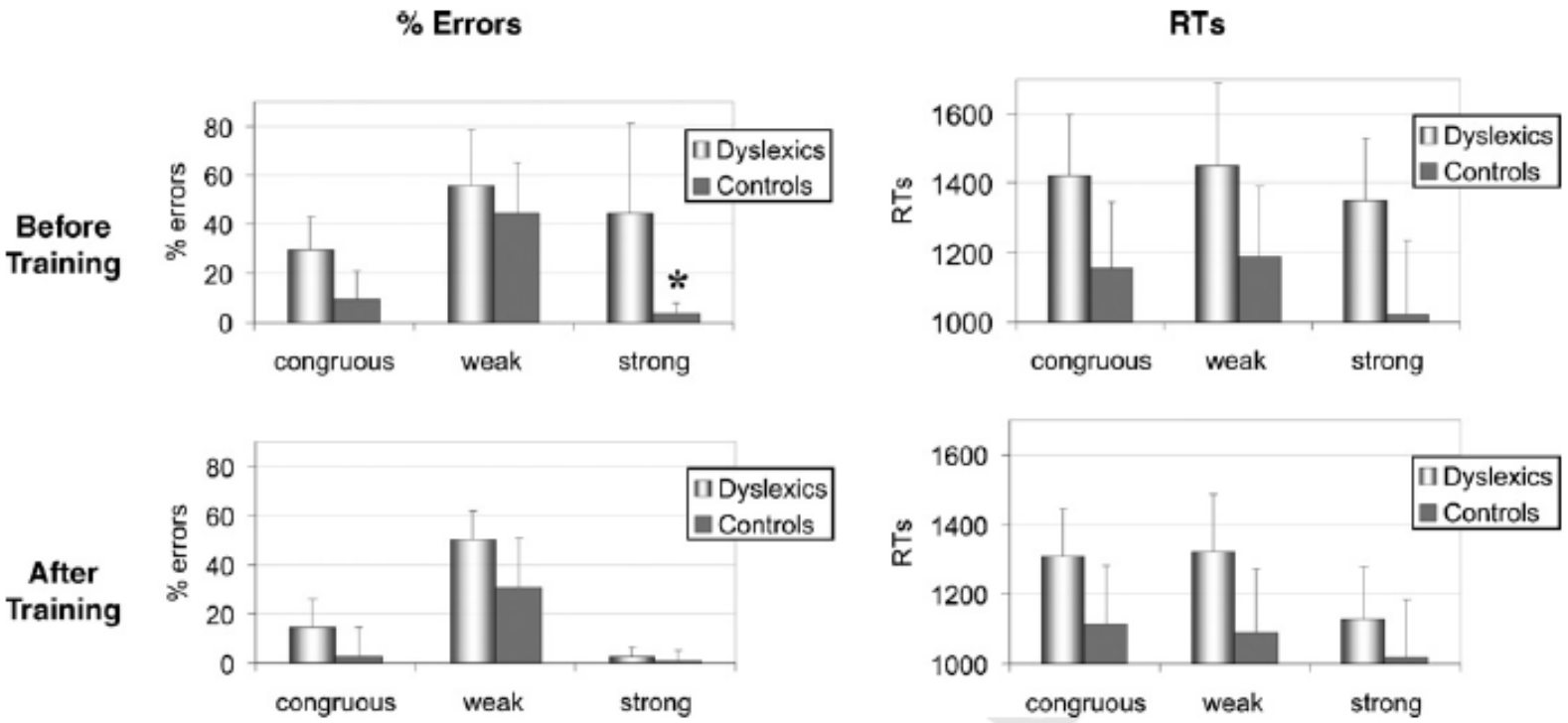
Neuropsychologia xxx (2006) xxx–xxx

www.elsevier.com/locate/neuropsychologia

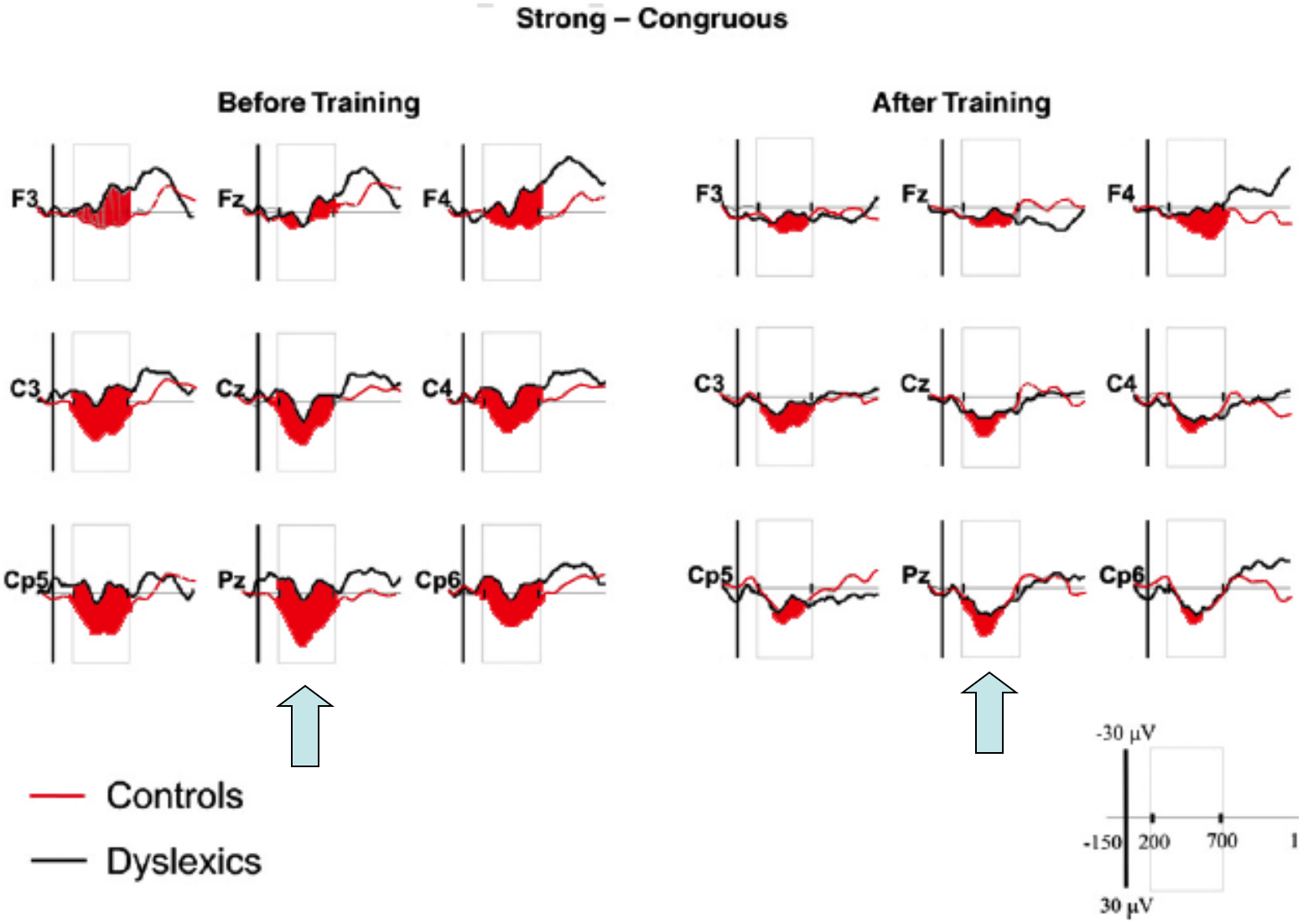
Behavioural and event-related potentials evidence for pitch discrimination deficits in dyslexic children: Improvement after intensive phonic intervention

Andreia Santos [a,*], Barbara Joly-Pottuz [a,b], Sylvain Moreno [a], Michel Habib [a,b], Mireille Besson [a]

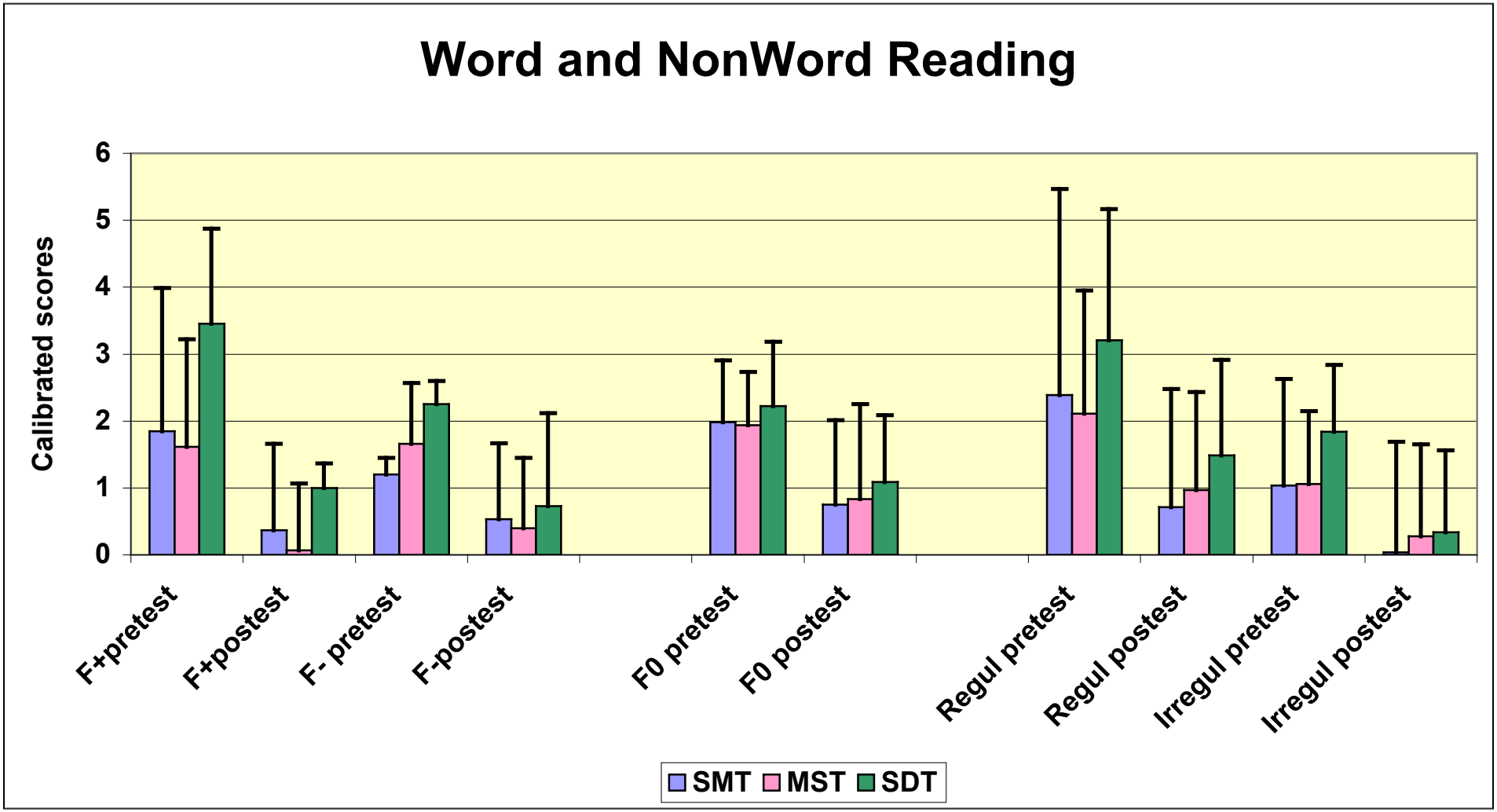
[a] *Institut de Neurosciences Cognitives de la Méditerranée, Marseille, France*
[b] *Department of Pediatric Neurology, CHU Timone, Marseille, France*



2. Percentage of errors and reaction times (RTs) before and after training in the three experimental conditions (congruous words, weak and strong incongruities)



Ondes de différences d'« effet de forte incongruité » (forte incongruité – condition congruente) chez les sujets contrôles et dyslexiques avant et après entraînement



LeNormand et al. (2007) : **comparing 3 training methods in dyslexic children: semiophony (speech envelope-based therapy); modified (temporal) speech training; standard speech therapy. F+ =familiar words, F- =unfamiliar, F0=non-words**

Significant improvement for all 3 methods :"Modified Speech Training

cannot be considered so far as the most efficient program for improving metaphonology"

Conclusion N°3

- L'entraînement quotidien intensif sur de courtes périodes est aussi efficace qu'une rééducation "phonique" habituelle sur plusieurs années
- L'effet est de l'ordre de ~15% de gain pour la lecture
- Supériorité de l'entraînement intermodal pour les tâches de transcription phono-graphémique
- Confirmation générale de l'impact sur les mécanismes neuraux sous-jacents

+ transfert d'apprentissage d'un domaine de la perception du langage (auditivo-phonologique) à un autre (prosodique)?

Entraînement phono+intermodalitaire : conclusions

- Confirmation de l'effet favorable de l'entraînement phonologique dans les proportions habituelles (~15% de gain pour la lecture)
- Supériorité de l'entraînement intermodal pour les tâches de transcription phono-graphémique
- Confirmation générale de l'impact sur les mécanismes neuraux sous-jacents

Projet ANR : "Influence de l'apprentissage de la musique sur le traitement des aspects temporels du langage et sur la remédiation de la dyslexie" (Besson, Habib et al.)

- Basé sur la constatation de meilleures performances en lecture d'enfants ayant eu un enseignement de la musique et sur des résultats préliminaires montrant de meilleures performances phonologiques chez des enfants après un entraînement musical
- Entraînement d'enfants non musiciens à l'aide d'un protocole d'entraînement musical comparé à une pratique régulière d'activité artistique d'autre nature
- Réalisation de potentiels évoqués avant et après entraînements

Musique et apprentissage de la lecture

- Rauscher, Neurol Res., 1997
- Chan et al., Nature, 1998
- Vaughn, J. Esthet Educ, 2000
- Overy, Psychol Music, 2000
- Anvari et al., J Exp Child Psychol, 2002

- Schellenberg Psychol Sci, 2002
- Ho et al., Neuropsychology, 2003
- Brandler & Pammsayer Psychol Music 2003
- Jakobsen et al., Music Percept 2003
- Magne et al., Ann NY Acad Scie 2003

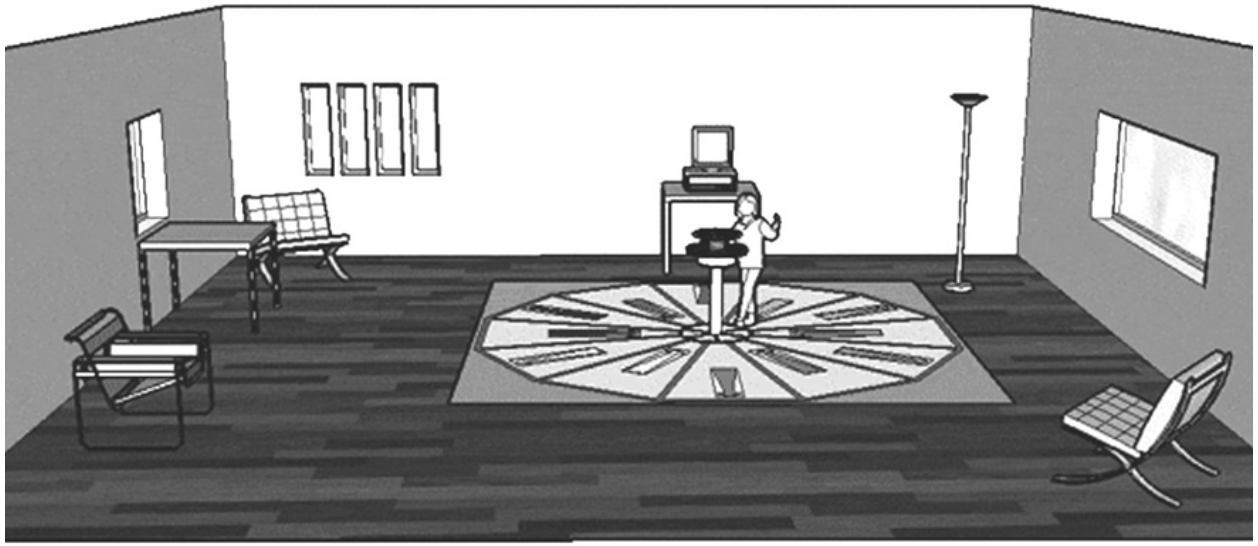
- Rouscher Neurol Res 2003
- Schan et al., Psychophysiologuye 2004
- Gaab et al., Ann NY Acad Sci 2005
- Magne et al., J Cogn Neurosci 2006
- Schellenberg J. Educ Psychol 2006
- Tallal & Gaab, TINS 2006

- Moreno & Besson, Ann NY Acad Sci, 2005
- Moreno et al., Cer Cortex 2009
- Forgeard et al., PlosONE, 2008

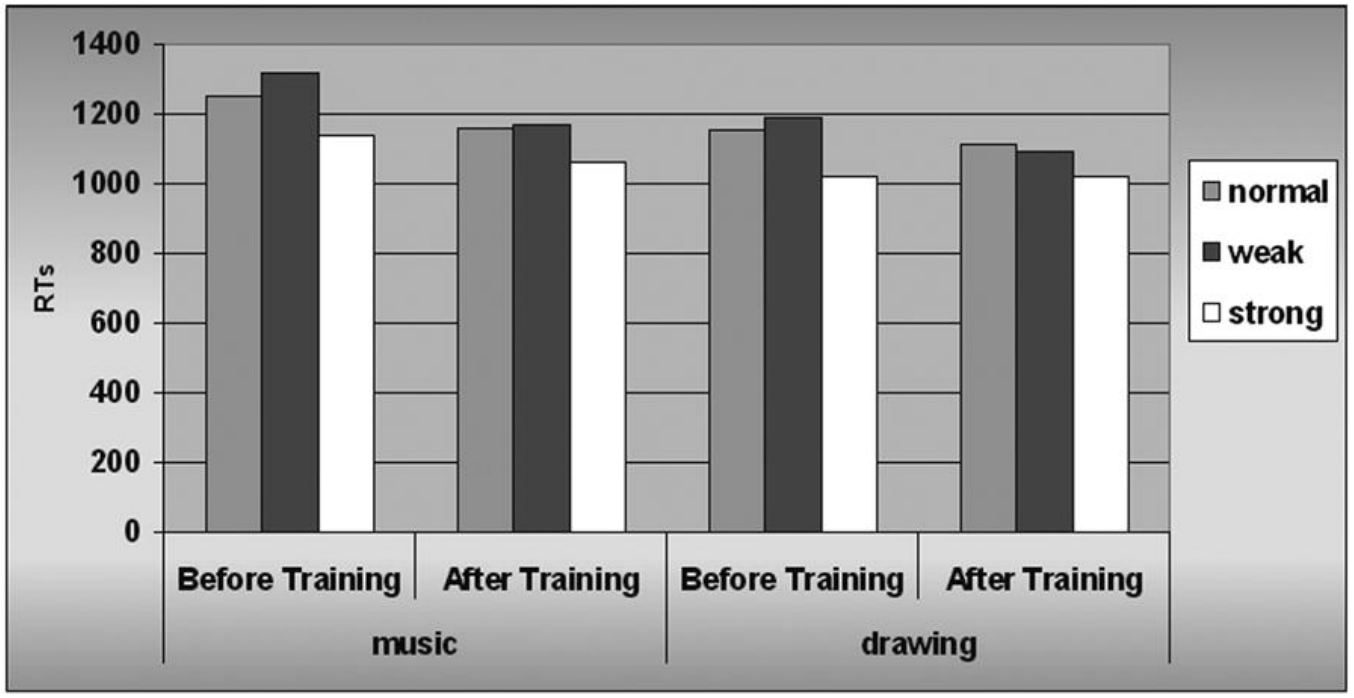
Influence of Musical Training on Pitch Processing: Event-Related Brain Potential Studies of Adults and Children
[The Neurosciences and Music II: From Perception to Performance: Part II. Music and Language: Poster Papers]

MORENO, SYLVAIN; BESSON, MIREILLE

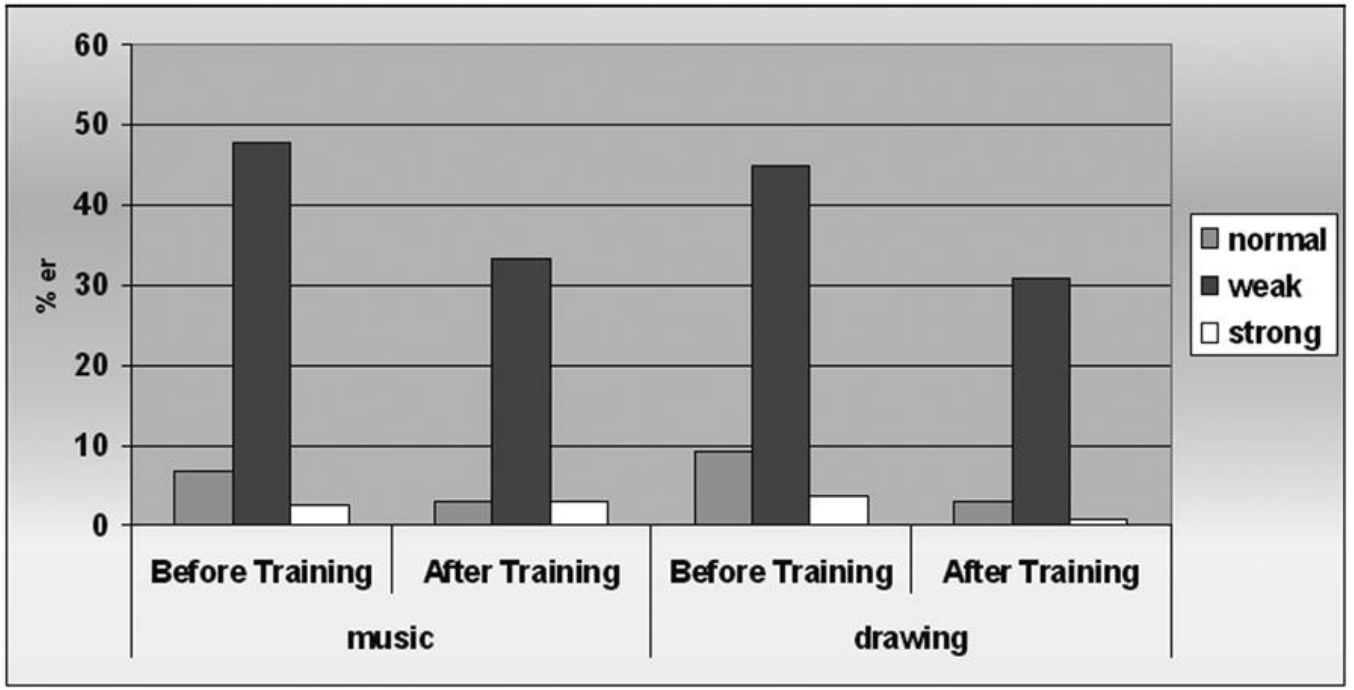
20 nonmusician eight-year-old children (i.e., without any specific musical training) from the same elementary school, matched by age, years of education, and socioeconomic background, and who were all involved in extra-scholarly activities other than music. All children performed the same task (see below). Then, one group of 10 children took eight weeks of music training and the other group of 10 children eight weeks of painting training



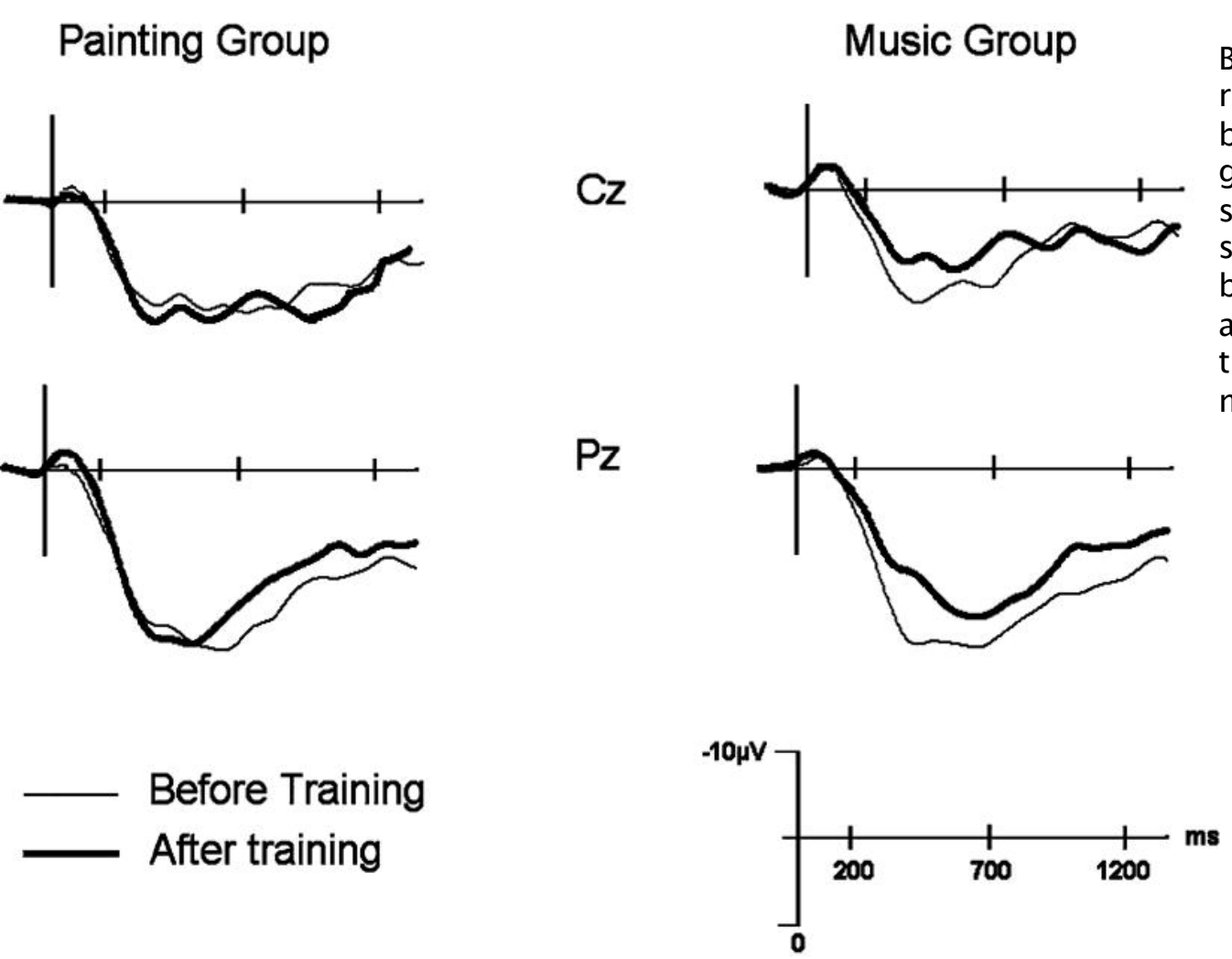
The "musical garden"



Although main effects of pitch violation and training were found on both reaction times (RTs) and error rate measures, these effects were not significantly different between the music and painting training groups



Moreno et al., 2005



By contrast, analysis of the ERPs revealed significant differences between music and painting groups. Clearly, whereas the strong incongruities elicited very similar effects in both groups before training, a decrease in the amplitude of a late positivity after training was found only in the music group

Comparison of the ERPs to the strong incongruities in the painting and music groups before (gray curve) and after (black curve) training. Data are presented for central (Cz) and parietal (Pz) electrodes.

Deficit in the preattentive processing of syllabic duration and VOT in children with dyslexia.

(in press, *Neuropsychologia*)

Julie Chobert[1], Clément François[1], Michel Habib[1,2] & Mireille Besson[1]

- 24 enfants normolecteurs
- 24 enfants dyslexiques

AC = 8.2 / AL = 7.8

AC = 10.2 / AL = 6.9

-12 normolecteurs (AC = 8.1)

-12 dyslexiques (AC = 10.8)

de même AL = 7

-7 normolecteurs (AL = 9.3)

-7 dyslexiques (AL = 6.8)

de même AC = 8.5

Standard = Ba

Multi-feature MMN Paradigm (Näätänen et al, 2004)

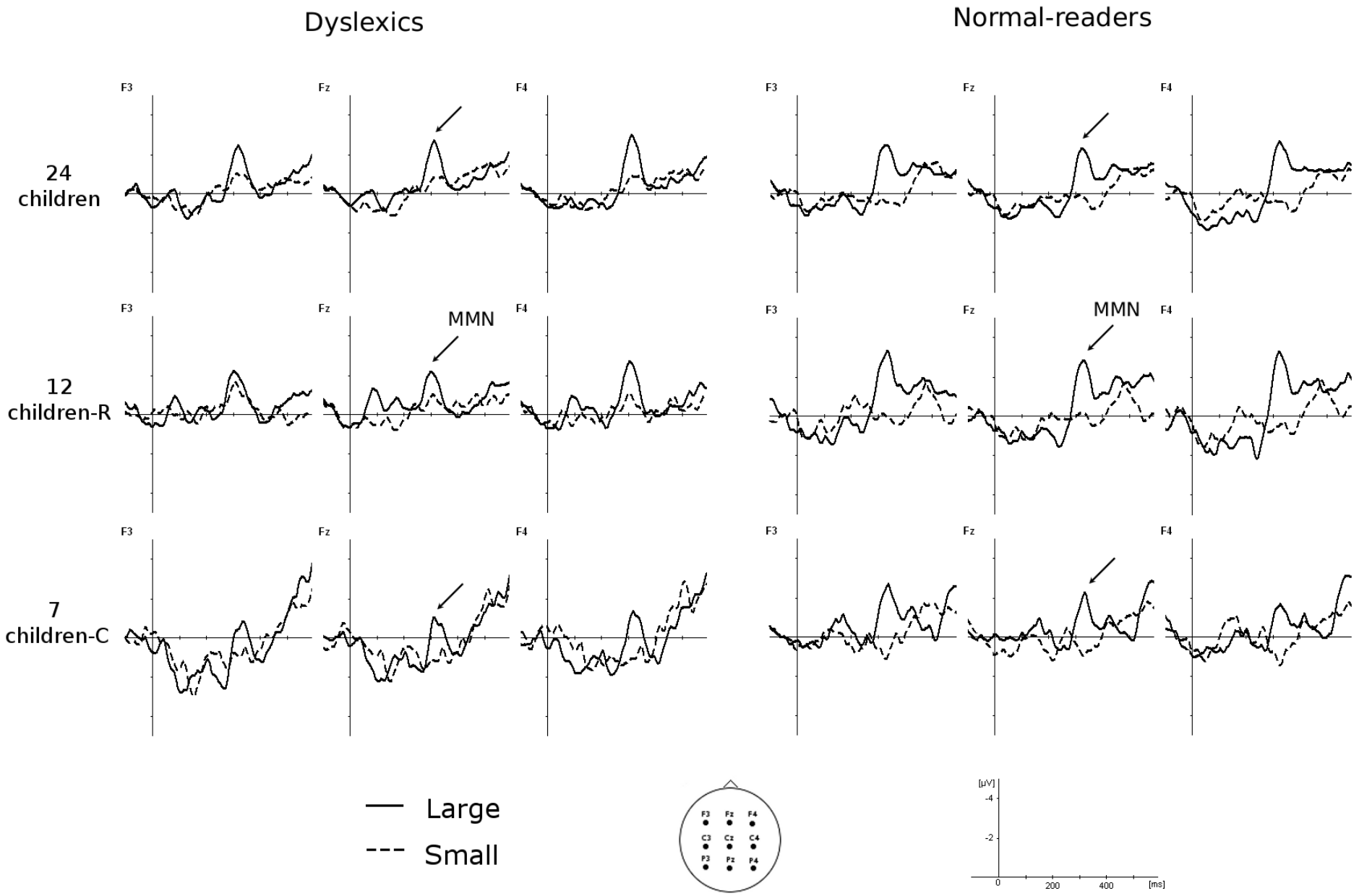
Déviants en:

- Fréquence
- Durée
- Consonne (VOT)

Petits et Grands déviants

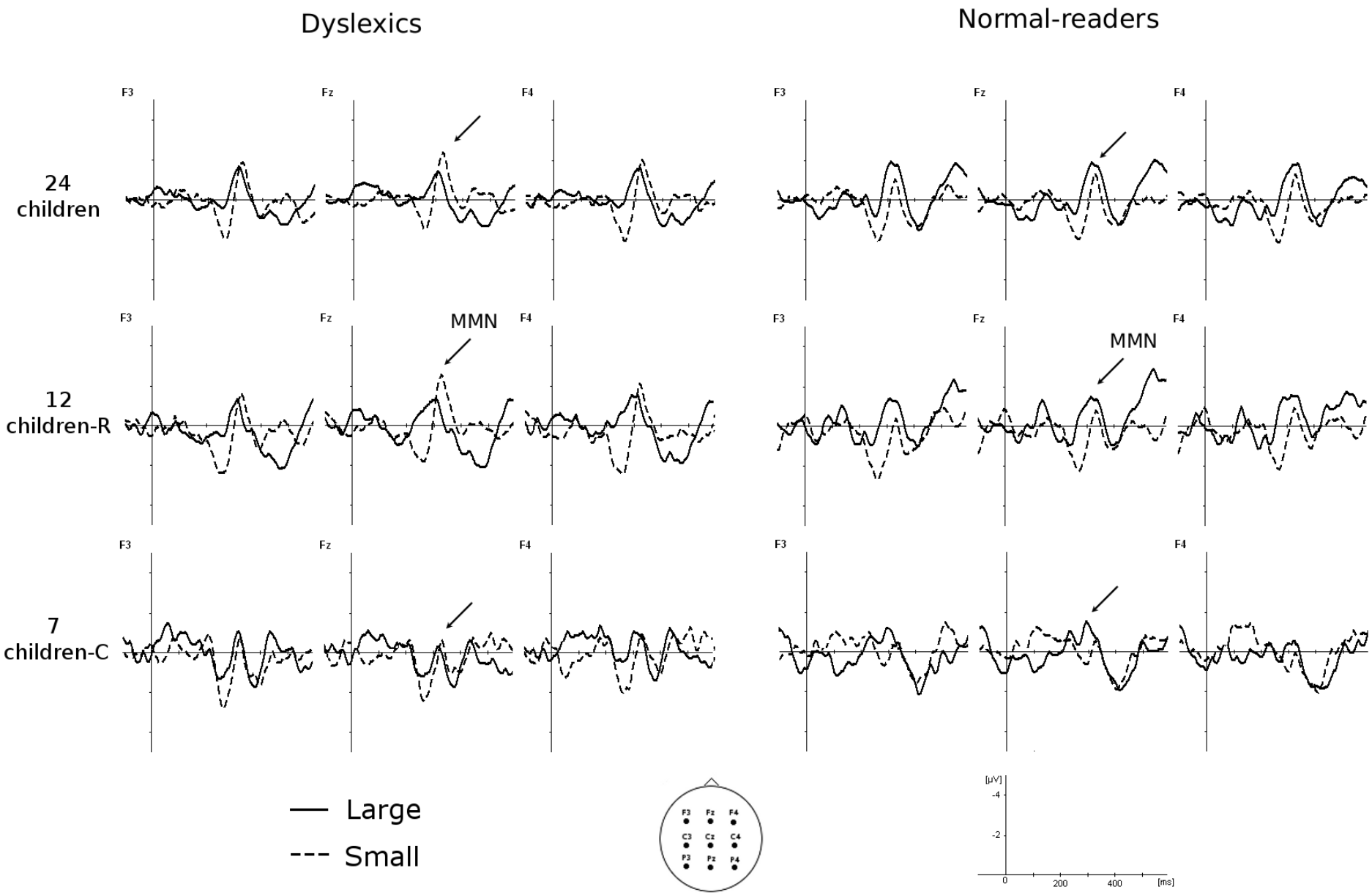
Expérience II

Fréquence



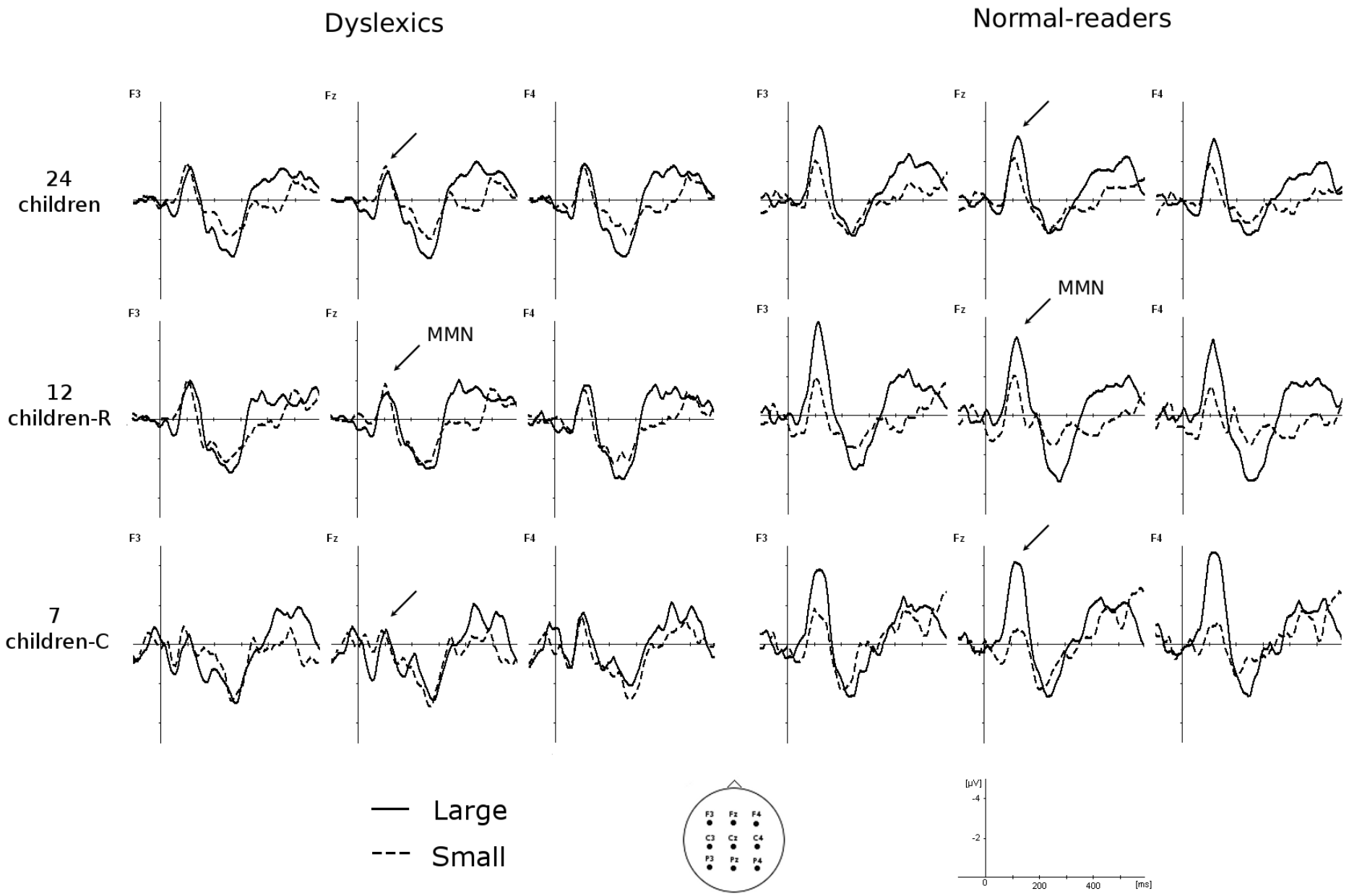
Expérience II

Durée



Expérience II

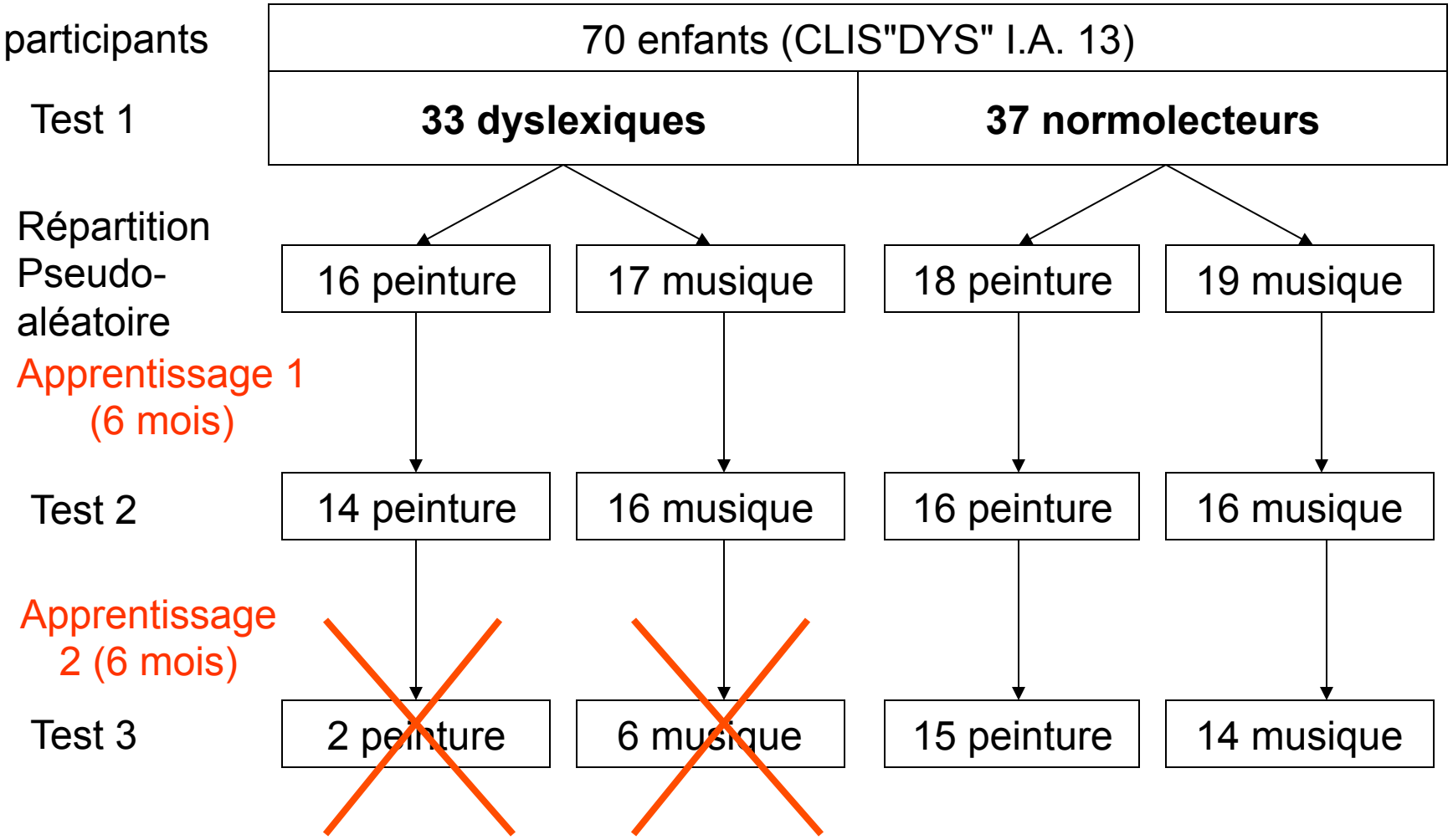
VOT



En résumé (Chobert et al., sous presse)

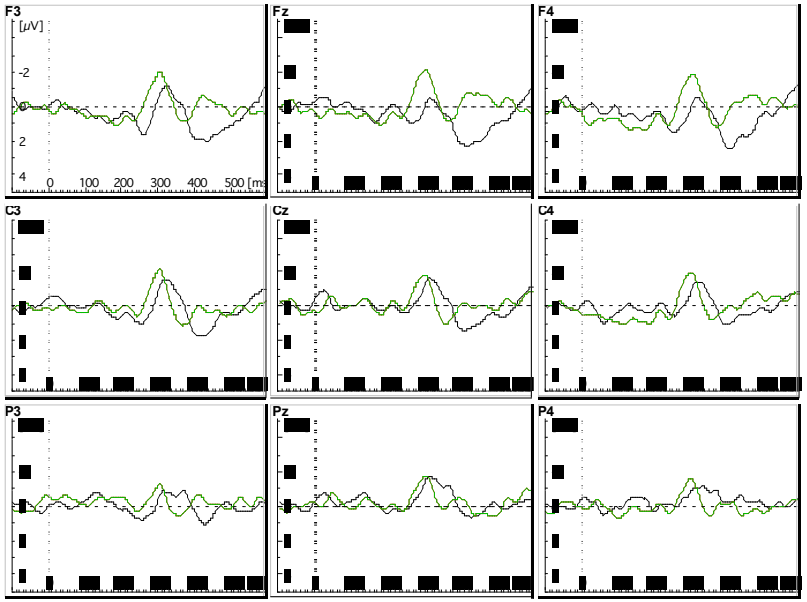
- Les enfants dyslexiques présentent un déficit de discrimination pré-attentive du VOT, une variable typiquement temporelle cruciale dans la différenciation de certaines consonnes, que ce soit par rapport à des témoins d'âge chronologique ou d'âge de lecture
- Les enfants dyslexiques sont également significativement déficitaires pour le traitement pré-attentif de différences de durée, mais seulement par rapport à des témoins de même âge chronologique
- Ils ne diffèrent pas des témoins dans le traitement de différences de hauteur

Entraînement musical (Chobert et al., en préparation)

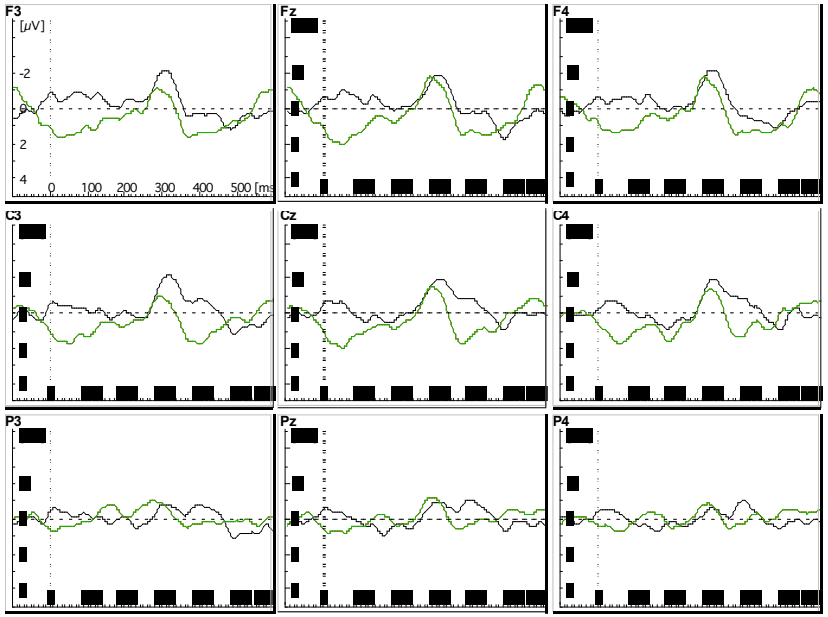


DUREE: Pré / Post1

Musique

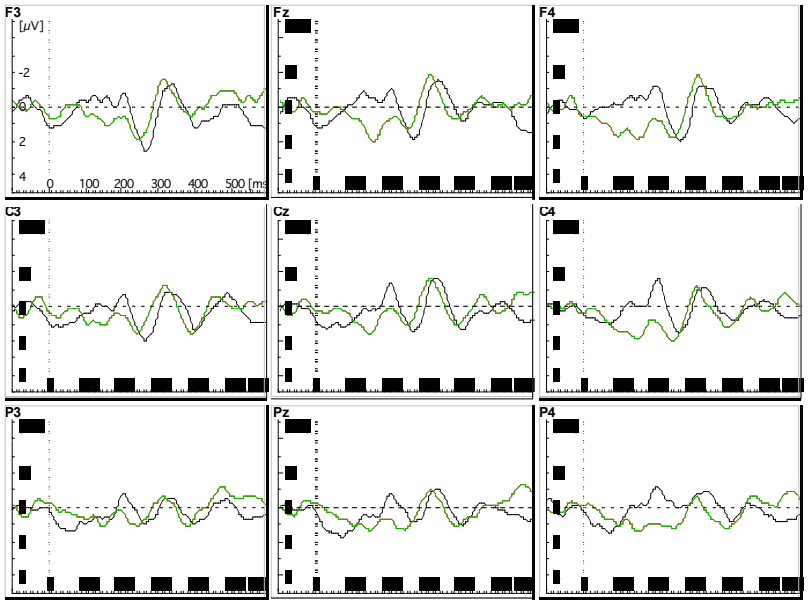


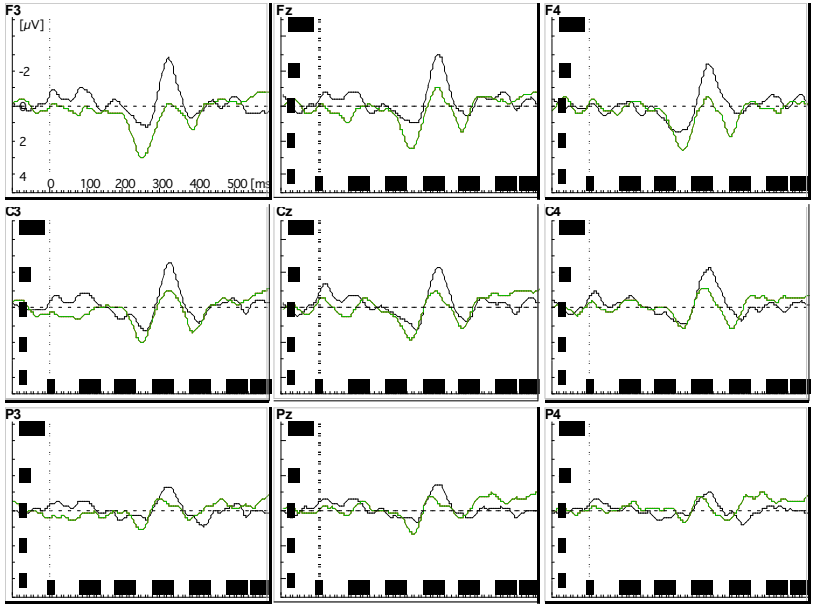
Peinture



Large

Small



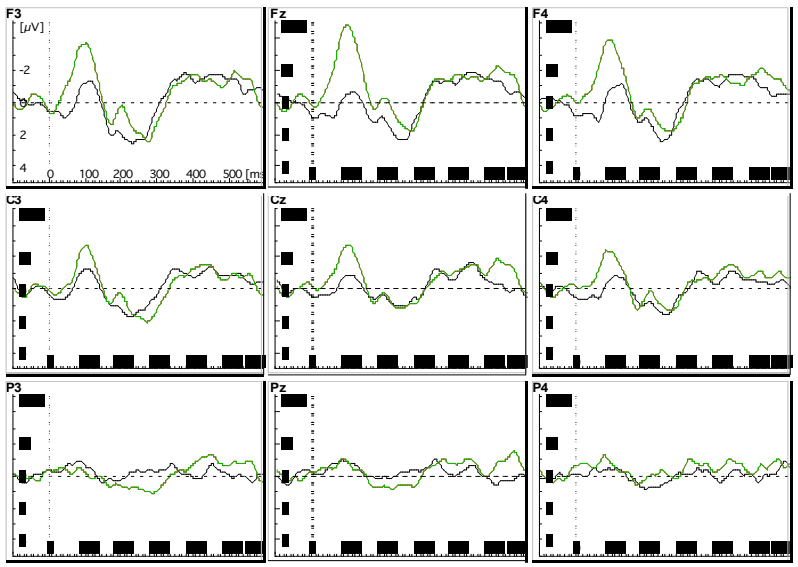


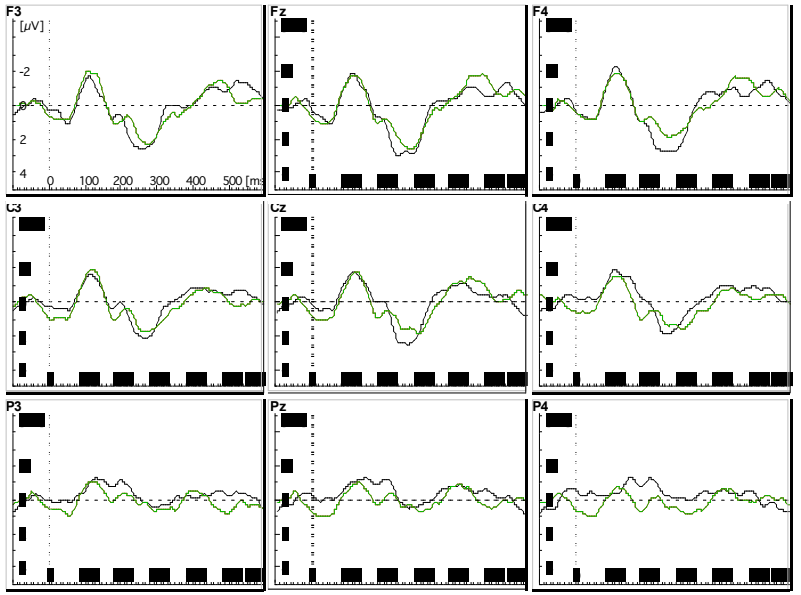
Expérience IV

VOT: Pré / Post1

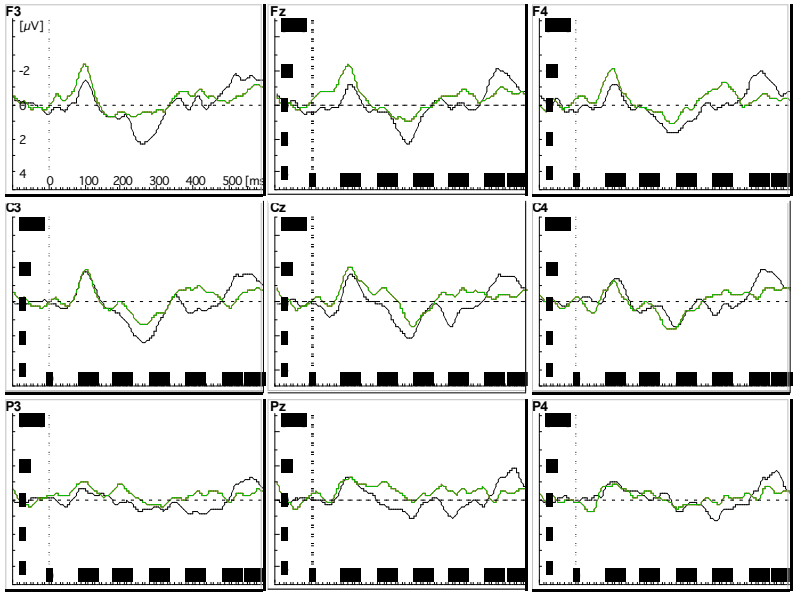
Musique **Peinture**

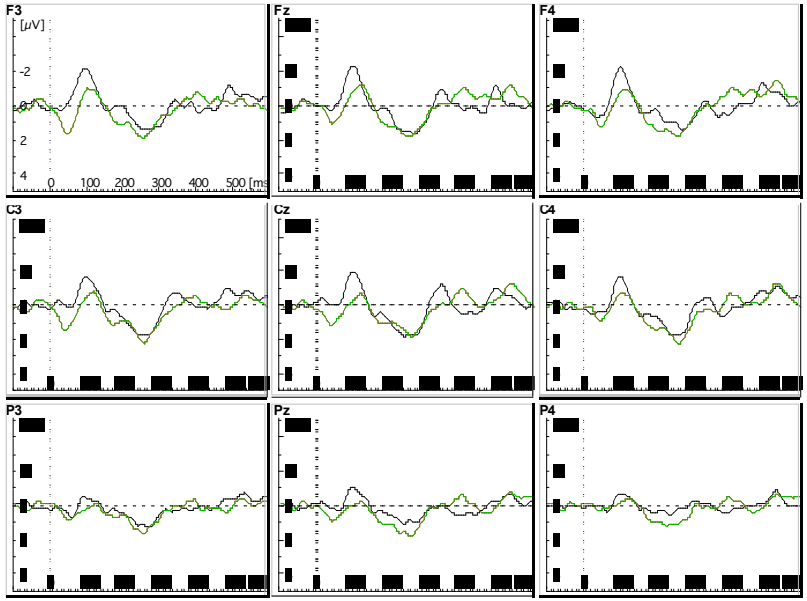
Large





Small





Discu Expé IV

- Fréquence: Test * Antpost ($p < .03$)

En Frontal = MMN Test 2 > Test 1 ($p = .08$)

: effet maturation, répétition

- Durée: Test * Group * Antpost:

En Frontal: Groupe Peinture: MMN Test2 < Test1 ($p < .01$) **!!!!!!**

Groupe musique: MMN Test 2 = Test 1 ($p = .25$)

- VOT: Test * Group * Antpost:

Frontal: Groupe Musique: MMN Test 2 > Test 1 ($p < .01$)

Groupe Peinture: MMN Test 2 = Test 1 ($p = .98$)

: effet apprentissage musique sur sensibilité aux déviants en VOT

Conclusion (Chobert et al., en prep.)

- Le traitement pré-attentif des variables temporelles à l'intérieur de la syllabe (durée, VOT) est plus significativement amélioré par un entraînement musical que par un entraînement par le dessin
- L'amélioration est surtout nette pour le VOT, ce qui confirme le transfert d'apprentissage de variables musicales sur des variables phonémiques
- Il est possible que cette amélioration soit due au caractère multimodal de la musique et serait encore plus net si on l'entraînait de façon exclusive (instrument)

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

Jennifer M. Thomson [1], Usha Goswami *

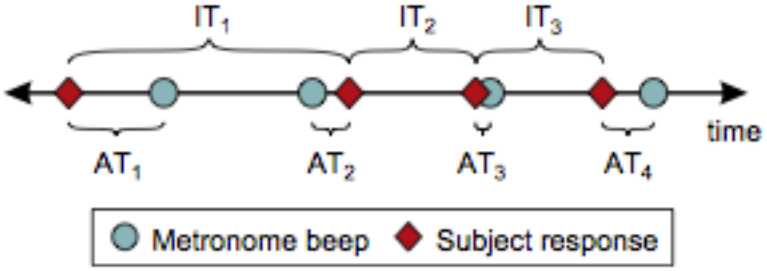

Fig. 1 – Schematic depiction of ITI and AT calculation.

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

CORTEX 45 (2009) 119–130

Special issue: Research report

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

Kathleen H. Corriveau[a,b] *and Usha Goswami*[a,*]

[a]Centre for Neuroscience in Education, University of Cambridge, Cambridge CB2 8PQ, UK
[b]Harvard University Graduate School of Education, Cambridge, MA, USA

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

CORTEX XXX (2010) 1–16

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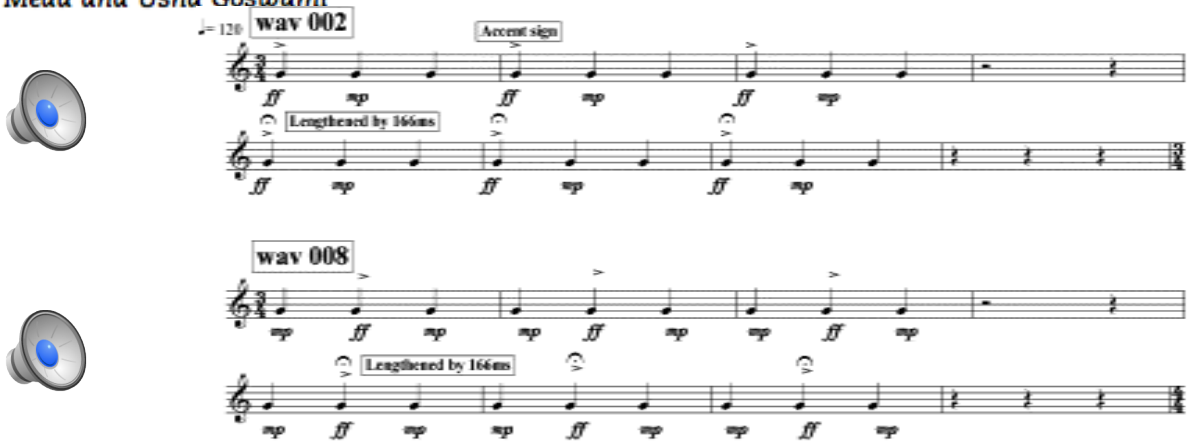
Research report

Music, rhythm, rise time perception and developmental dyslexia: Perception of musical meter predicts reading and phonology

*Martina Huss, John P Verney, Tim Fosker, Natasha Mead and Usha Goswami**



- Performances aux épreuves métriques corrélées aux tests phonologiques et de lecture
- Dyslexiques<contrôles sur toutes les épreuves métriques

308 • The Journal of Neuroscience, January 10, 2007 • 27(2):308–314

Behavioral/Systems/Cognitive

Action Representation of Sound: Audiomotor Recognition Network While Listening to Newly Acquired Actions

Amir Lahav,[1,2] Elliot Saltzman,[2,3] and Gottfried Schlaug[1]
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Non-musicians trained to play simple melodies : activation of (mainly left) IFG when listening to learned melodies (compared to same notes unlearned)

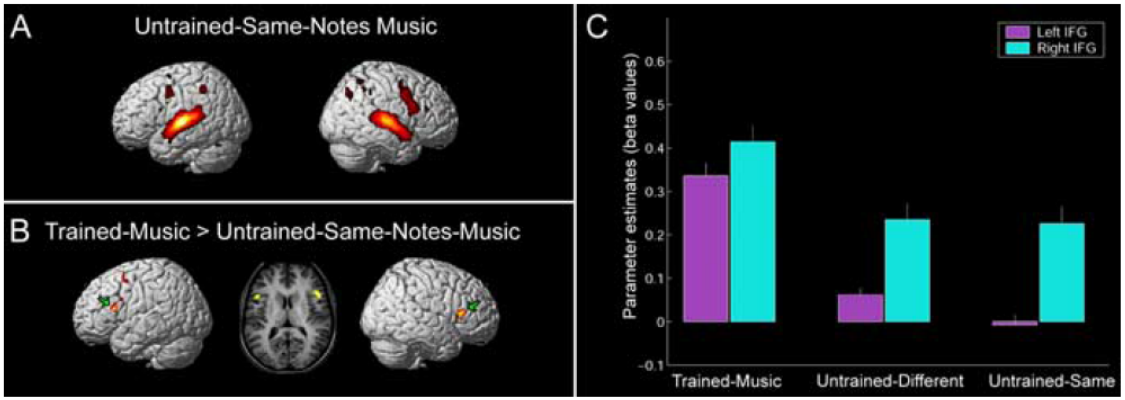


Figure 4. ***A***, Areas activated during listening to the untrained-same-notes-music contrasted against rest ($p < 0.05$, FDR corrected). ***B***, Contrasted image of group mean activation is presented in areas that were significantly more active during listening to trained-music compared with untrained-same-notes-music. This included the left premotor region as well as Broca's area and its right hemispheric homolog (green arrows), shown also in the corresponding coronal view (middle) ($p < 0.05$, FDR corrected). ***C***, Parameter estimates (β values) of the left ($-50, 18, 16$; magenta) and right ($52, 18, 16$; cyan) IFG across listening conditions. Results indicate significant pick activations on the left IFG only when subjects listen to the trained-music they knew how to play ($p = 0.001$), whereas the right IFG remained fairly active across listening conditions ($p = 0.973$).

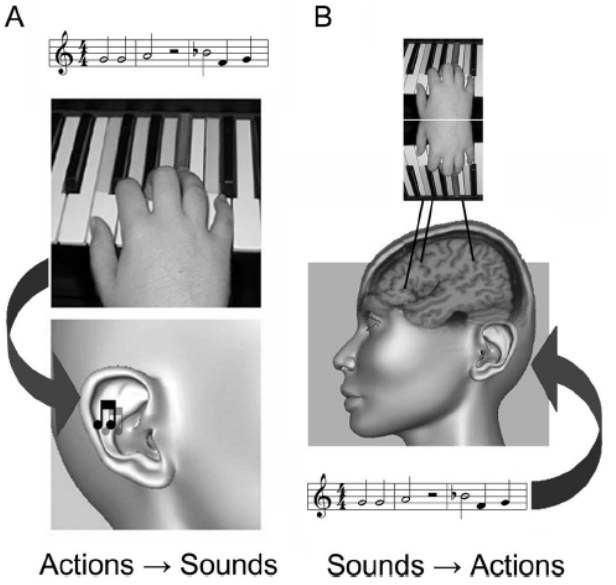


Figure 1. Action–listening illustration. ***A***, Music performance can be viewed as a complex sequence of both actions and sounds, in which sounds are made by actions. ***B***, The sound of music one knows how to play can be reflected, as if in a mirror, in the corresponding motor representations.

Our findings thus support the view that Broca's area is presumably a central region ("hub") of the mirror neuron network (Iacoboni et al., 1999; Nishitani and Hari, 2000; Hamzei et al., 2003; Rizzolatti and Craighero, 2004; Nelissen et al., 2005), demonstrating here its multifunctional role in **action listening**.

Behavioral/Systems/Cognitive

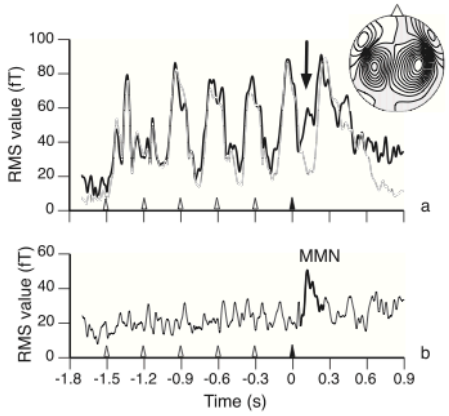
Cortical Plasticity Induced by Short-Term Unimodal and Multimodal Musical Training

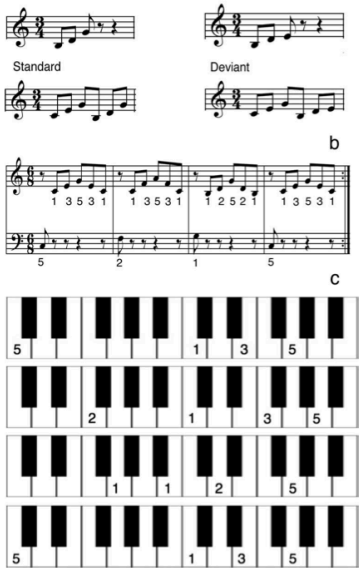
Claudia Lappe,[1]* Sibylle C. Herholz,[1]* Laurel J. Trainor,[2,3] and Christo Pantev[1]
[1]Institute for Biomagnetism and Biosignalanalysis, University of Münster, 48149 Münster, Germany, and [2]Department of Psychology, Neuroscience, and Behaviour and the [3]McMaster Institute for Music and the Mind, McMaster University, Hamilton, Ontario, Canada L8S 4K1

Cortical Plasticity Induced by Short-Term Multimodal Musical Rhythm Training

Claudia Lappe[1], Laurel J. Trainor[2], Sibylle C. Herholz[1,3], Christo Pantev[1]*
1 Institute for Biomagnetism and Biosignalanalysis, University of Muenster, Münster, Germany, **2** Department of Psychology, Neuroscience & Behaviour and the McMaster Institute for Music and the Mind, McMaster University, Hamilton, Canada, **3** Montreal Neurological Institute, McGill University, Montreal, Canada

Études en MEG de sujets non musiciens entraînés durant 8 sessions de 25 mn sur 2 semaines à jouer une mélodie des deux mains, guidés par un schéma du clavier marqué des doigtés, comparés à un groupe témoin ne jouant rien mais écoutant l'autre groupe apprendre à jouer!





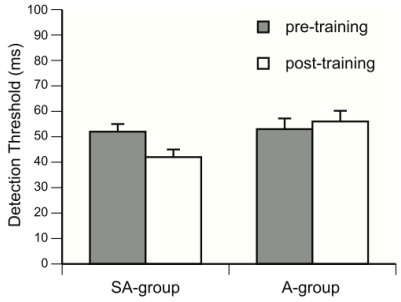
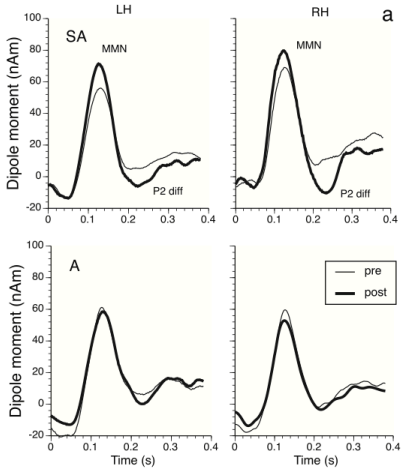
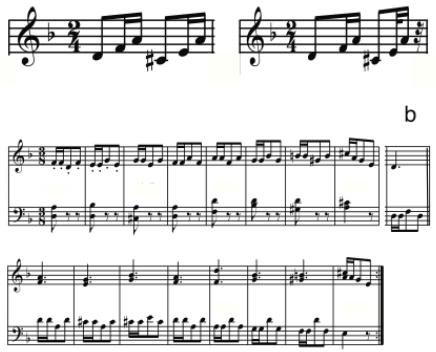
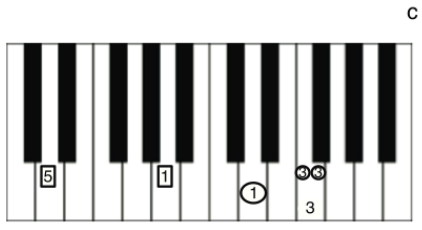


Figure 2. Group means of behavioral performance in the auditory discrimination test before and after training: pre, pretraining; post, postraining. Error bars indicate SEM.







L'entraînement sensori-moteur et auditif (SA) améliore la discrimination de manière plus nette et provoque une MMN plus ample que l'entraînement auditif seul (A), tant pour la discrimination de mélodies que de rythmes

cerveau, musique, dyslexie :

des ateliers pour rééduquer en apprenant un instrument

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