

Imagerie cérébrale et évaluation en éducation

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Journée nationale de l'ADMEE-Europe intitulée
Évaluation des apprentissages scolaires :
apports des neurosciences et de la psychologie cognitive
Université de Mons, Belgique - 21 septembre 2016

labneuroeducation.org
associationneuroeducation.org

EEG



MEG



TEP



IRMf



IO



Évaluation = mesure + norme



Activité
cérébrale

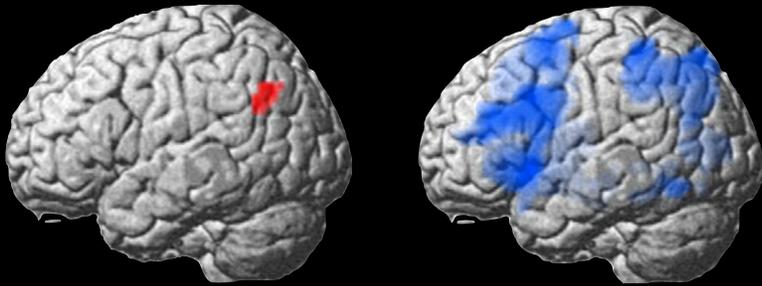
L'activité cérébrale ne peut pas remplacer
les autres types de mesure.

4 exemples

|
Évaluer les processus
cognitifs ou les stratégies
utilisés par les élèves

4 x 8

Grabner et al. (2009)



Récupération de faits arithmétiques

Autres stratégies

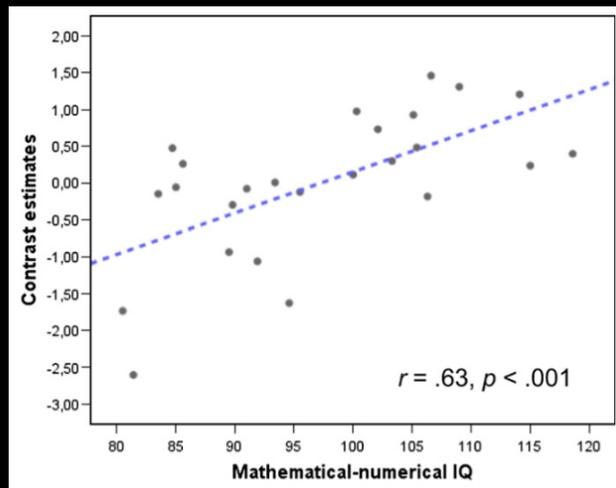
Grabner et al. (2007)



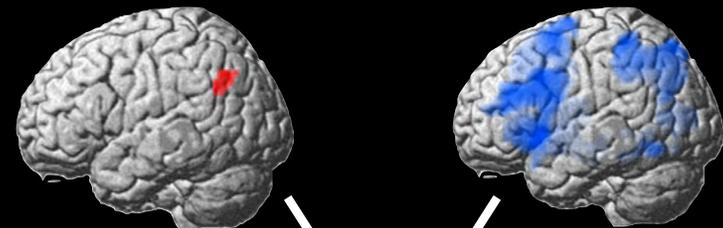
Gyrus angulaire gauche

Plus compétent > moins compétent

Grabner et al. (2007)



Si maths \uparrow \rightarrow Gyrus angulaire \uparrow



Récupération de faits arithmétiques

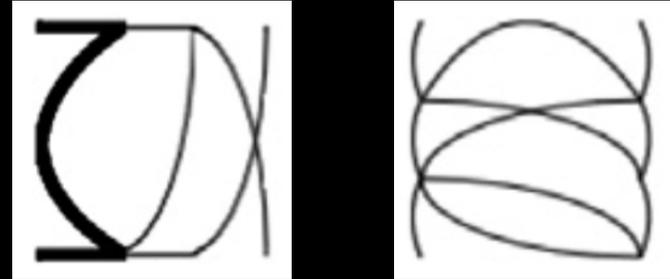
Autres stratégies



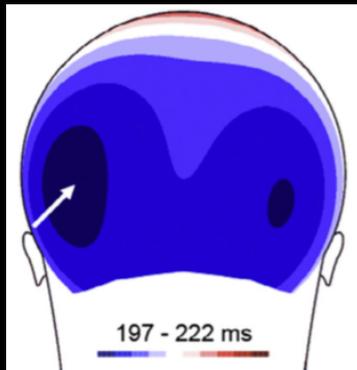
Expert

Lecture

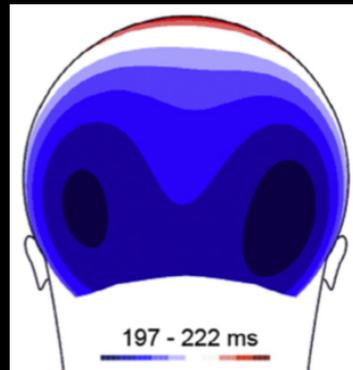
Yoncheva et al. (2015)



Yoncheva et al. (2015)

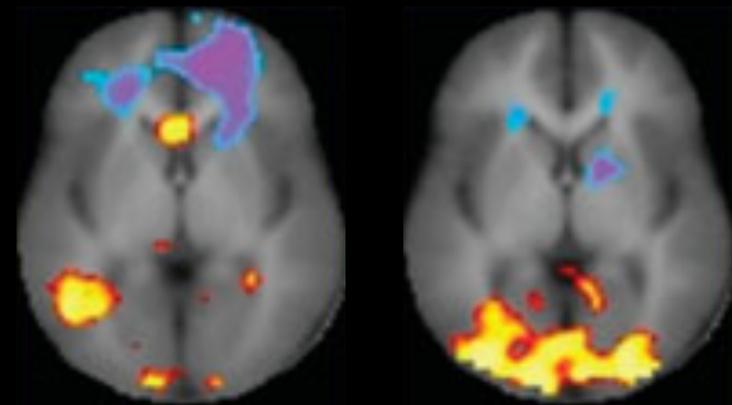


Lecture graphophonémique



Lecture globale

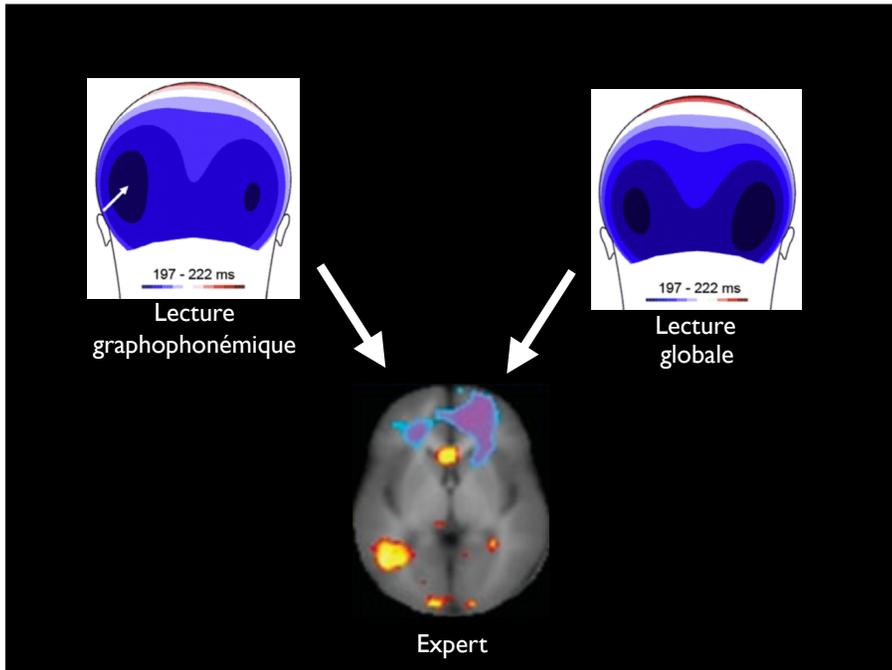
Shaywitz et al. (2007)



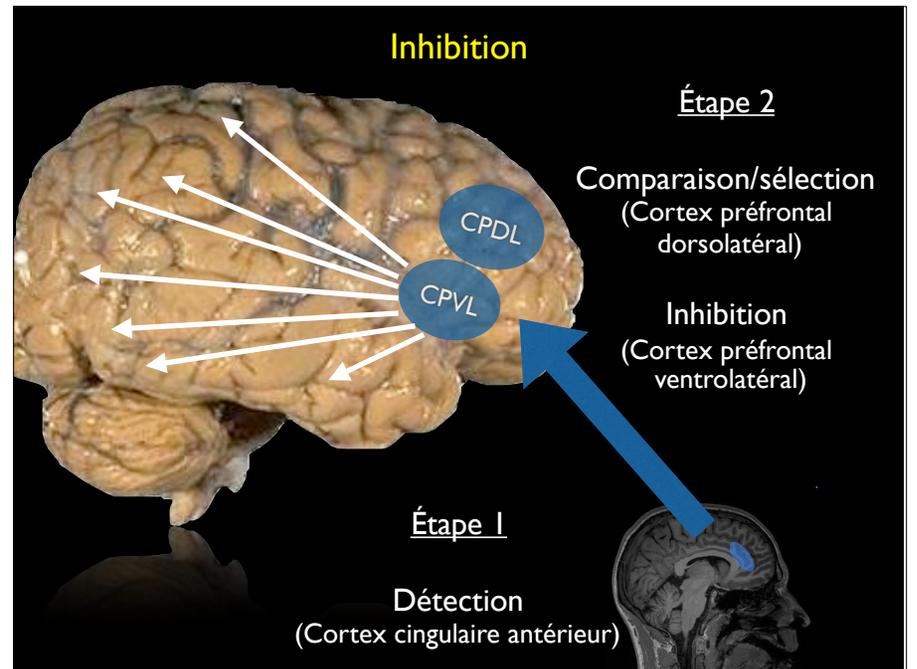
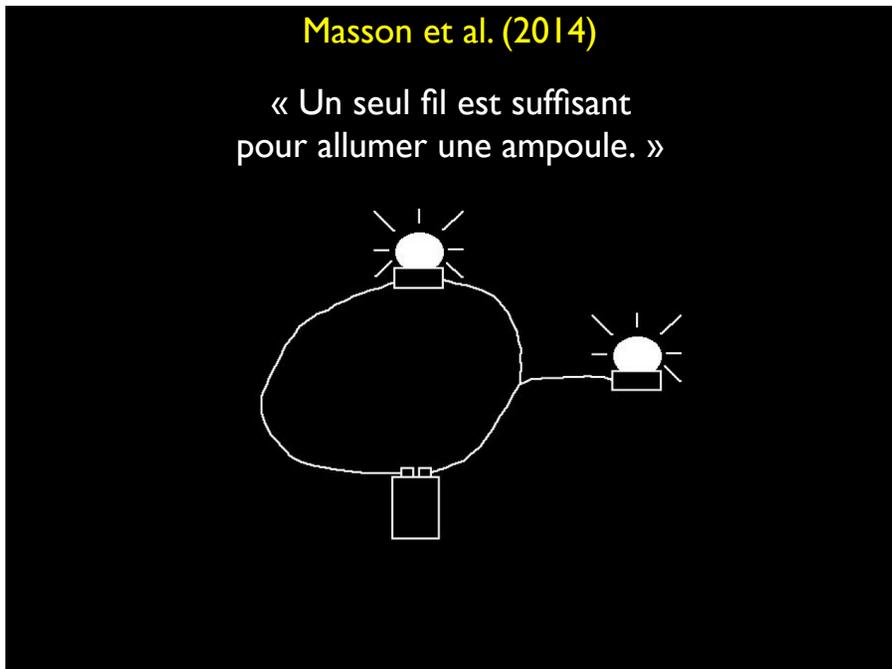
Plus compétent

Moins compétent

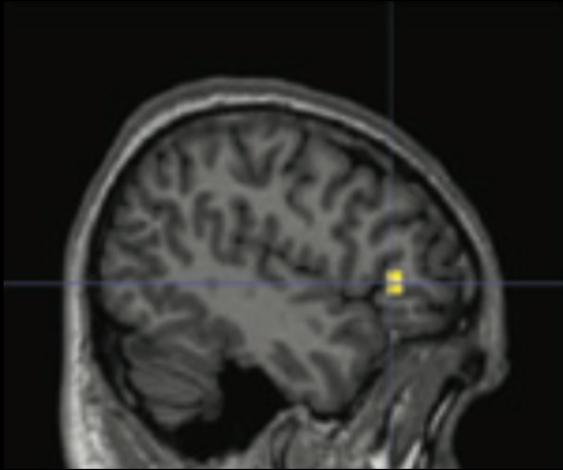
7 à 18 ans



Sciences



Masson et al. (2014)

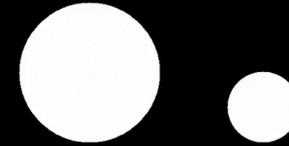


Cortex préfrontal ventrolatéral

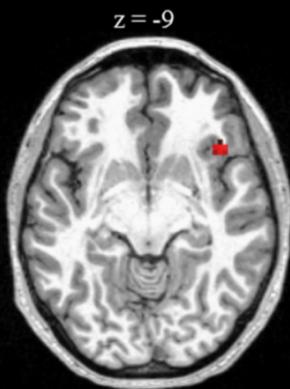
Experts > novices

Brault Foisy, Potvin, Riopel et Masson (2015)

« Les objets plus lourds tombent plus rapidement. »



Brault Foisy, Potvin, Riopel et Masson (2015)

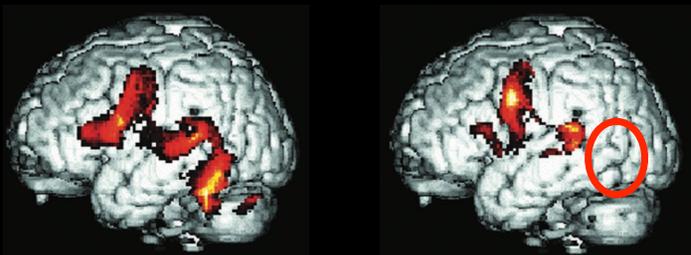


Cortex préfrontal ventrolatéral

Experts > Novices

2
Évaluer l'existence et la
persistance d'un trouble
d'apprentissage

Paulesu et al. (2001)



Élèves typiques

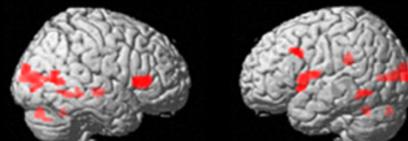
Élèves dyslexiques

Raschle et al. (2012)

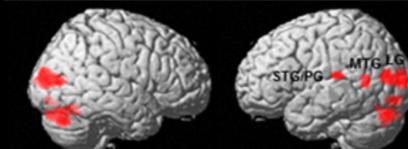
Avec facteur de risque (FHD+)



Sans facteur de risque (FHD-)

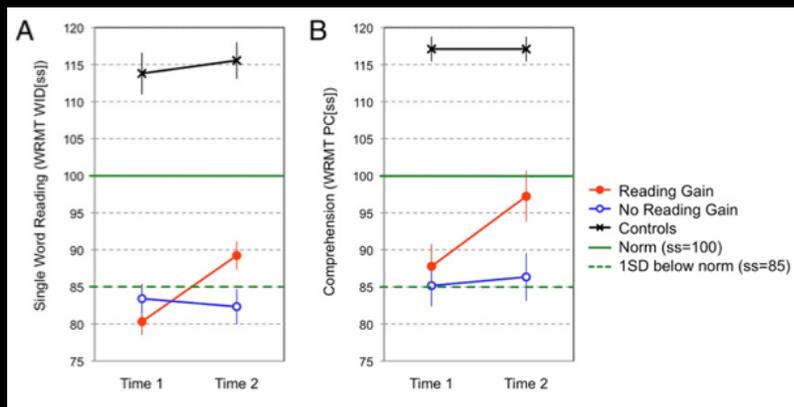


Différence



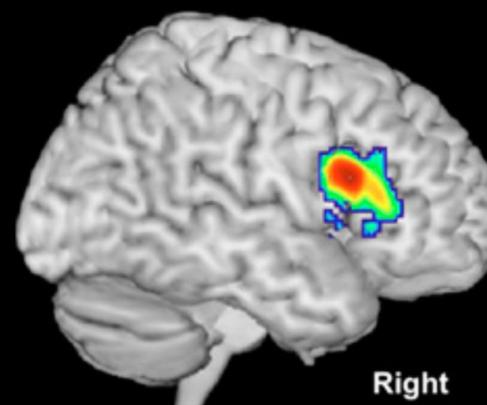
Avant l'apprentissage de la lecture 5-6 ans (tâche phonologique)

Hoefl et al. (2011)



Aucune donnée comportementale dans cette étude ne peut prédire avec fiabilité si un élève dyslexique s'améliorera ou non

Hoefl et al. (2011)



Right

2,5 années plus tard

Amélioration ou non est prédite avec une précision > 90 %

3

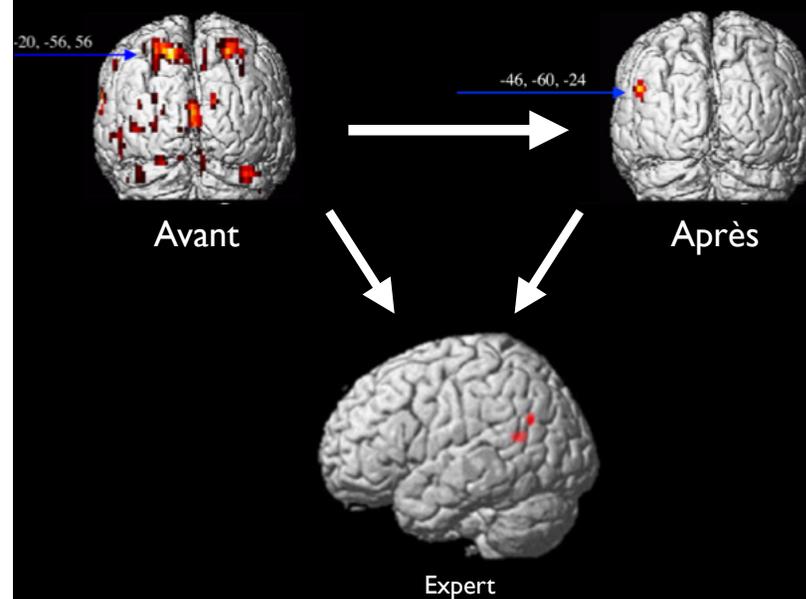
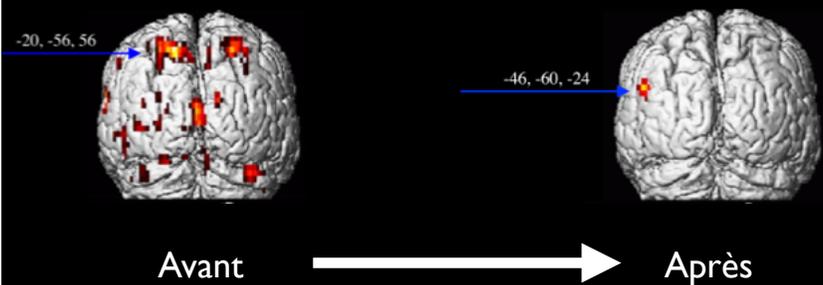
Évaluer les effets de
l'apprentissage sur le
cerveau

4 x 8

Delazer et al. (2003)

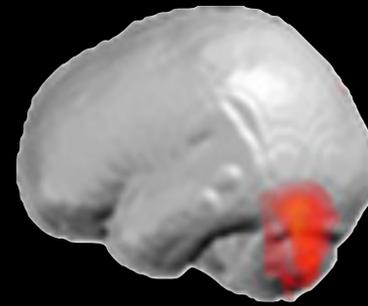
Sillons intrapariétaux

Gyrus angulaire

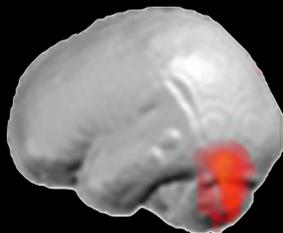


Lecture

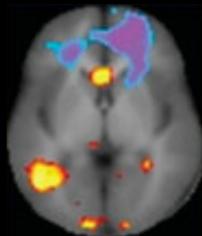
Brem et al. (2010)



Après > avant



Après > avant

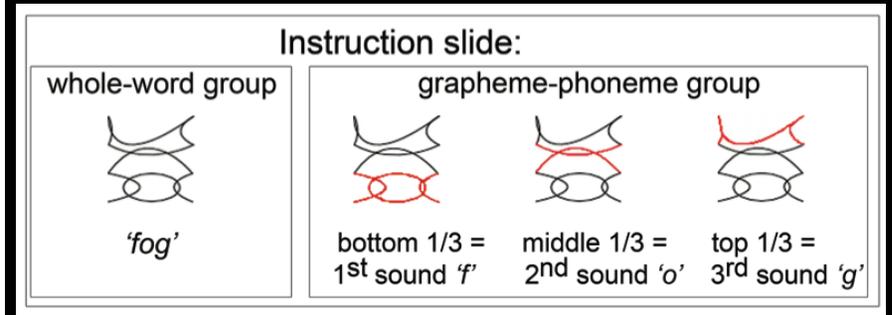


Expert

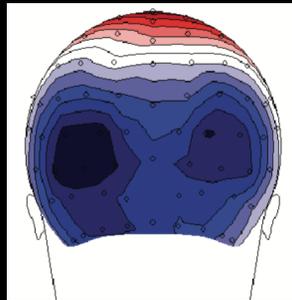
4
Évaluer les effets de
l'enseignement sur le
cerveau

Lecture

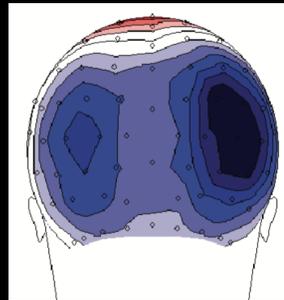
Yoncheva et al. (2010)



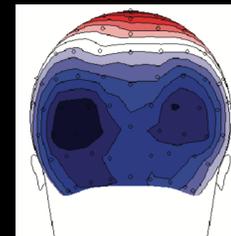
Yoncheva et al. (2010)



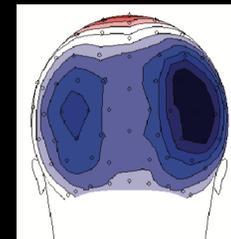
Enseignement
graphophonémique



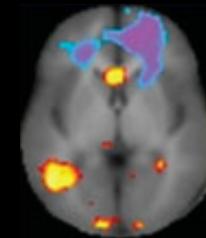
Enseignement
global



Enseignement
graphophonémique

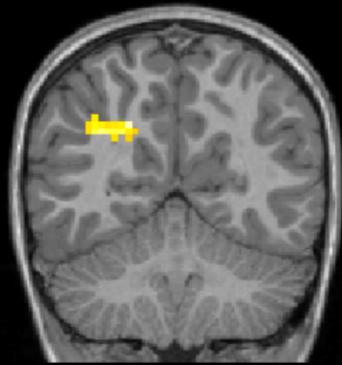


Enseignement
global

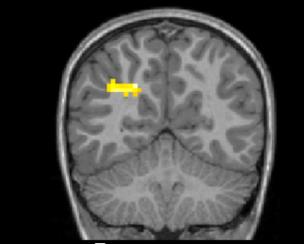


Expert

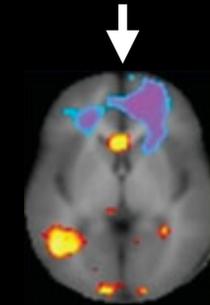
Brault, Riopel, Myre-Bisaillon, Dehaene et Masson
(en préparation, résultats préliminaires)



Enseignement
graphophonémique > global



Enseignement
graphophonémique > global



Expert

Dyslexie

Temple et al. (2003)

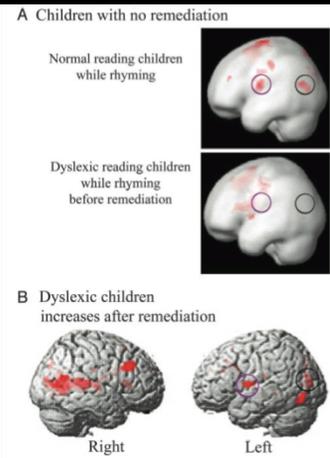


Fig. 1. Neural effects of remediation in children with developmental dyslexia. (A) Left hemisphere activations of control children and children with dyslexia are shown during rhyming (as compared with matching) letters ($P < 0.025$, 20-voxel threshold, ref. 12). (B) Brain areas that showed increased activity during phonological processing in the dyslexic group after remediation. Shown at $P < 0.01$, 20-voxel threshold. Black circles highlight left temporo-parietal region, which is disrupted in children with dyslexia and affected by remediation. Purple circles highlight the left frontal region that is active in control children and is affected by remediation in children with dyslexia.

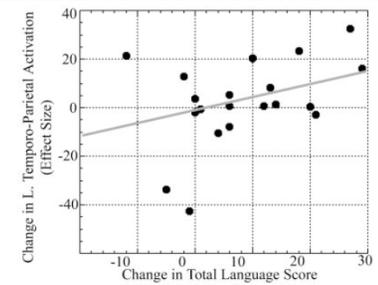
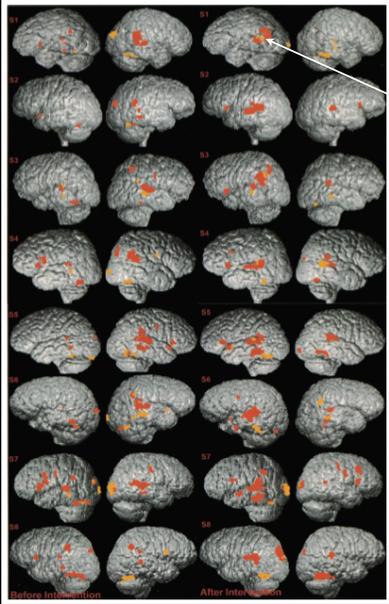


Fig. 2. Language improvement and increased brain function. Correlation between magnitude of change in left temporo-parietal ROI (BA 39) and improvement in oral language ($r = 0.41$, $P = 0.03$). Left temporo-parietal ROI encompassed brain areas that showed underactivation and increases after training in children with dyslexia. Change in effect size is on the vertical axis; change in total language score (CELF-3) is on the horizontal axis. Effect size is the weighted sum of parameter estimates from the multiple regression for rhyme vs. match contrast pre- and posttraining.

Intervention : Fast
ForWord Language

Cortex temporo-pariétal

Simos et al. (2002)

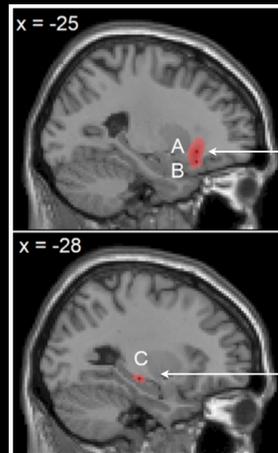


Intervention :
Phono-Graphix program et
Lindamood Phonemic
Sequencing program

Région temporo-
pariétale

Mémorisation

Vestergren et al. (2014)



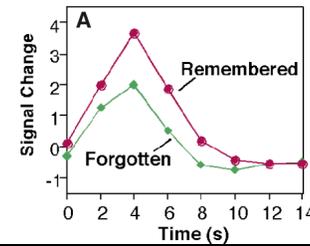
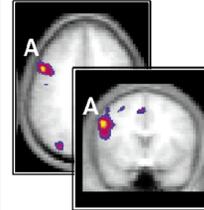
Cortex préfrontal
ventrolatéral

Hippocampe

Test > Étude

Wagner et al. (1998)

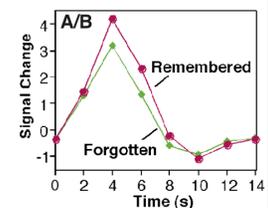
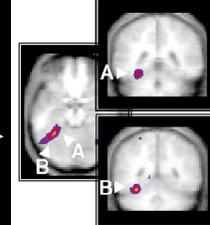
Posterior LIFG



Cortex préfrontal
ventrolatéral

Hippocampe

Parahippocampal / Fusiform Gyri



Conclusion

Évaluation = mesure + norme

Activité
cérébrale

Repose sur notre compréhension
incomplète du cerveau

Normes provenant d'études de groupe
Évaluation individuelle vs évaluation de groupe

L'activité cérébrale ne peut pas remplacer
les autres types de mesure.

Mais elle peut enrichir ou compléter.

Utiliser l'imagerie cérébrale pour évaluer en éducation?

1
Processus cognitifs/
stratégies

2
Trouble/difficultés
d'apprentissage

3
Effets de
l'apprentissage

4
Effets de
l'enseignement