Linguaggio: disturbi evolutivi e trattamento 10. Reading and the brain

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Ipotesi fonologiche

- **Tallal (1980 e seguenti):** *Temporal perception hypothesis:* deficit nella identificazione di due brevi toni, solo se l'intervallo fra di loro è molto breve; prestazioni scadenti in compiti di discriminazione uditiva
- **Ehri (1992):** Phonological recoding is the foundation for early reading, a foundation that is then replaced when specific connections link a letter sequence with its pronunciation and meaning. The final step of this early development is when fully amalgamated orthographic representations are made
- **Perfetti (1992)** : "the heart of lexical access is the activation of a phonologically referenced name code"(pp. 164-165). Perfetti, like Ehri, emphasized the phonological underpinnings of lexical knowledge
- Il deficit di elaborazione fonologica è considerato un fattore causale delle difficoltà di decodifica (**Peterson e Pennington, 2012**) responsabile di uno scarso "input tuning" nelle regioni che mediano l'integrazione grafema-fonema (**Dehaene et al., 2015**); una disfunzione nella connettività orthografia–fonologia (**Wimmer & Schurz, 2010**)

- ***Core phonological hypothesis*** (**Snowling & Hulme, 1995; Stanovitch & Siegel, 1994**): I dislessici hanno difficoltà specifiche nella rappresentazione, immagazzinamento e recupero dei fonemi. Imparare a leggere richiede le corrispondenze tra grafemi e fonemi; se i fonemi sono rappresentati, immagazzinati o recuperati in modo deficitario, il fondamento della lettura verrà meno.

Secondo alcune visioni, l'origine del disturbo sarebbe una disfunzione congenita delle aree perisilviane dell'emisfero sinistro che sottendono all'elaborazione fonologica o connettono la fonologia con l'ortografia (ad es. Paulesu et al.,1996; 2000).

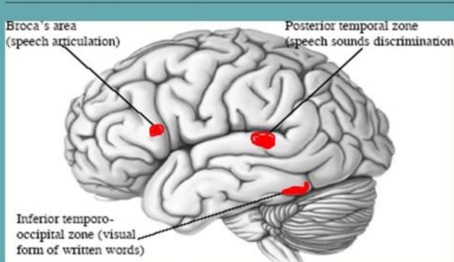
Brain (1996), 119, 143–157

Is developmental dyslexia a disconnection syndrome? Evidence from PET scanning

Eraldo Paulesu,[1,5] Uta Frith,[2,3] Margaret Snowling,[4] Alison Gallagher,[2] John Morton,[2,3] Richard S. J. Frackowiak[1] and Christopher D. Frith[1,3]

A rhyming and a short-term memory task with visually presented letters were used to study brain activity in five compensated adult developmental dyslexics. Their only cognitive difficulty was in phonological processing, manifest in a wide range of tasks including spoonerisms, phonemic fluency and digit naming speed. PET scans showed that for the dyslexics, a subset only of the brain regions normally involved in phonological processing was activated: Broca's area during the rhyming task, temporo-parietal cortex during the short-term memory task. **In contrast to normal controls these areas were not activated in concert.** Furthermore the left insula was never activated. We propose that the defective phonological system of these dyslexics is due to weak connectivity between anterior and posterior language areas. This could be due to a dysfunctional left insula which may normally act as an anatomical bridge between Broca's area, superior temporal and inferior parietal cortex. The independent activation of the posterior and anterior speech areas in dyslexics supports the notion that representations of unsegmented and segmented phonology are functionally and anatomically separate.

L'emisfero sinistro del cervello umano e le aree corticali relative ai compiti di lettura



BRAIN RESEARCH 1356 (2010) 73–84

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Research Report

Children with reading difficulties show differences in brain regions associated with orthographic processing during spoken language processing

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Auditory rhyming task with unimpaired adults
(Tanenhaus & Seidenberg, 1978)

/baɪt/ - /kaɪt/ < /faɪt/ - /kaɪt/
(BITE - KITE) (FIGHT - KITE)
70 ms faster

Auditory rhyming task (Desroches et al., 2010)

	Non-conflicting Phon/Orth	Conflicting Phon/Orth
Rhyming	/geɪt/ - /heɪt/ (GATE – HATE)	/dʒæz/ - /hæz/ (JAZZ - HAS)
Non-rhyming	/prɛs/ - /lɪst/ (PRESS – LIST)	/paɪnt/ - /mɪnt/ (PINT - MINT)

ABSTRACT

We explored the neural basis of spoken language deficits in children with reading difficulty, specifically focusing on the role of orthography during spoken language processing. We used functional magnetic resonance imaging (fMRI) to examine differences in brain activation between children with reading difficulties (aged 9-to-15 years) and age-matched children with typical achievement during an auditory rhyming task. Both groups showed activation in bilateral superior temporal gyri (BA 42 and 22), a region associated with phonological processing, with no significant between-group differences. Interestingly, typically achieving children, but not children with reading difficulties, showed activation of left fusiform cortex (BA 37), a region implicated in orthographic processing. Furthermore, this activation was significantly greater for typically achieving children compared to those with reading difficulties. These findings suggest that typical children automatically activate orthographic representations during spoken language processing, while those with reading difficulties do not. Follow-up analyses revealed that the intensity of the activation in the fusiform gyrus was associated with significantly stronger behavioral conflict effects in typically achieving children only (i.e., longer latencies to rhyming pairs with orthographically dissimilar endings than to those with identical orthographic endings; jazz-has vs. cat-hat). Finally, for reading disabled children, a positive correlation between left fusiform activation and nonword reading was observed, such that greater access to orthography was related to decoding ability. Taken together, the results suggest that the integration of orthographic and phonological processing is directly related to reading ability.

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articles

A cultural effect on brain function

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We present behavioral and anatomical evidence for a multi-component reading system in which different components are differentially weighted depending on culture-specific demands of orthography. Italian orthography is consistent, enabling reliable conversion of graphemes to phonemes to yield correct pronunciation of the word. English orthography is inconsistent, complicating mapping of letters to word sounds. In behavioral studies, Italian students showed faster word and non-word reading than English students. In two PET studies, Italians showed greater activation in left superior temporal regions associated with phoneme processing. In contrast, English readers showed greater activations, particularly for non-words, in left posterior inferior temporal gyrus and anterior inferior frontal gyrus, areas associated with word retrieval during both reading and naming tasks.

12 soggetti (studenti universitari) 6 inglesi 6 Italiani

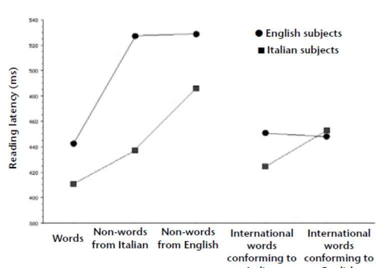
Compiti di lettura

✓di parole bisillabe ad alta frequenza d'uso
✓di non parole derivate dalle stesse parole modificando uno o due fonemi ma mantenendo la struttura sillabica

Es. GB cabin, market, cottage, apron
cagin, marnet, connage, afton

I marmo, ponte, moto, carta
margo, ponda, moco, corla

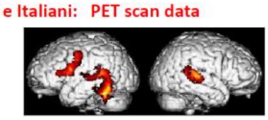
✓ di parole internazionali (tennis, boiler, basket, corner, partner, bitter, coma, taxi, panda, bravo, villa, pasta)

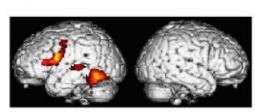


Gruppi equivalenti nei compiti di controllo (tempo di reazione vocale semplice, velocità di articolazione, denominazione, fluenza verbale (fonemica e semantica)

Inglesi e Italiani: PET scan data

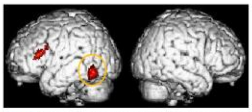
Sistema comune di lettura per Inglesi e Italiani*



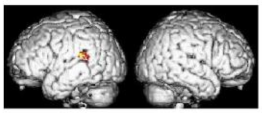


Lettura di non parole meno Lettura di parole

Nessuna differenza significativa nella lettura di parole una volta sottratta la lettura di non-parole
* inferior frontal and premotor cortex, superior, middle and inferior temporal gyri and fusiform gyrus on the left, and superior temporal gyrus on the right.



GB>IT i soggetti inglesi mostrano in compiti di **lettura NP** una maggiore attivazione a carico della porzione posteriore del giro temporale inferiore (WFA) e nel giro frontale inferiore anteriore, aree associate con compiti di recupero di parole in compiti di lettura e denominazione



IT>GB i soggetti italiani mostrano nella **lettura di P e NP** una maggior attivazione nella giunzione parieto-temporale di sinistra (*planum temporale*) associata a compiti di elaborazione fonologica

Dyslexia: Cultural Diversity and Biological Unity

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

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

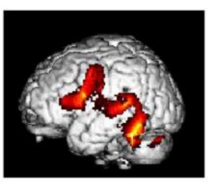
www.sciencemag.org SCIENCE VOL 291 16 MARCH 2001

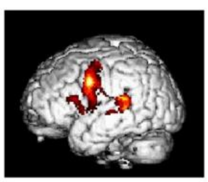
Attivazione cerebrale durante compiti di lettura

Controlli

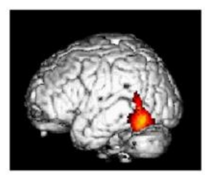
network perisilviano (area di Broca, area di Wernike incluso il planum temporale), giri temporale medio e inferiore, giro fusiforme, emisferi cerebellari e strutture sottocorticali (talamo e gangli della base)

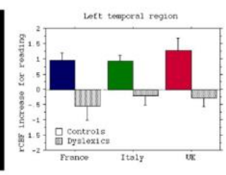
Dislessici





Controlli > Dislessici





Regioni cerebrali maggiormente attivate nei gruppi di controllo rispetto ai dislessici durante i due compiti di lettura (giro temporale superiore; giro temporale medio; giro temporale inferiore; giro occipitale medio)

Ipotesi interpretative

- ✓IPOTESI FONOLOGICA
- ✓IPOTESI ELABORAZIONE UDITIVA
- ✓IPOTESI VISIVA
- ✓DELL'AUTOMATIZZAZIONE O CEREBELLARE

DE e sistema magnocellulare

✓ Alcuni autori hanno considerato la possibilità che la dislessia sia dovuta a un'anomalia nel sistema magnocellulare sia a livello anatomico che funzionale.

✓ Questo sistema è implicato nel rilevamento dei movimenti veloci ed è stato dimostrato che i dislessici hanno alte soglie nella percezione di oggetti in movimento

IPOTESI Magnocellulare

la **corteccia parietale posteriore** costituisce la principale afferenza del sistema magnocellure, presiede tre importanti funzioni implicate nel processo di lettura

- ✓ regolazione dei movimenti oculari

  DE compie più saccadi per parola, di ampiezza ridotta e le fissazioni avvengono anche su funtori.
- ✓ visione periferica

  Scarsa abilità di elaborare stimoli provenienti dalla periferia, inoltre eccessiva suscettibilità al 'rumore' che fa da mascheramento a stimoli salienti (sia uditivi che visivi)
- ✓ attenzione visuo-spaziale

  Difficoltà nell'orientamento implicito dell'attenzione;

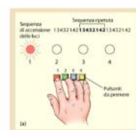
4. Ipotesi cerebellare – deficit di automatizzazione

Ruolo del cervelletto:

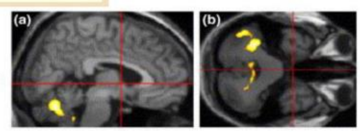
- ✓ nel controllo motorio
- ✓ nell'**articolazione** del linguaggio (lentezza o disfunzione nel processo di articolazione determinerebbe una rappresentazione fonologica povera)
- ✓ **automatizzazione** di procedure (una ridotta capacità di automatizzazione interferirebbe con il processo di apprendimento delle regole di corrispondenza grafema-fonema)

DISFUNZIONE CEREBELLARE: evidenze comportamentali

- ✓ prestazione ridotta in compiti di tipo motorio
- ✓ ridotto equilibrio e coordinazione motoria in paradigmi di tipo dual task
- ✓ difficoltà nell'acquisizione e automatizzazione di nuove abilità motorie



L'apprendimento implicito di una sequenza motoria di tapping coinvolge il cervelletto. Sia l'esecuzione di una sequenza nota che l'apprendimento di una nuova si associa ad attivazione cerebellare.



DISLEXIC VS NORMAL READERS. Regions where the dyslexic group showed significantly less relative activation compared with controls. The only regions of significantly different relative activation are the right hemisphere of the cerebellum, together with the cerebellar vermis.

Cerebellum (2013) 12:267–276
DOI 10.1007/s12311-012-0407-1

REVIEW

Cerebellar Function in Developmental Dyslexia

Catherine J. Stoodley · John F. Stein

Abstract

Developmental dyslexia is a genetically based neurobiological syndrome, which is characterized by reading difficulty despite normal or high general intelligence. Even remediated dyslexic readers rarely achieve fast, fluent reading. Some dyslexics also have impairments in attention, short-term memory, sequencing (letters, word sounds, and motor acts), eye movements, poor balance, and general clumsiness. The presence of "cerebellar" motor and fluency symptoms led to the proposal that cerebellar dysfunction contributes to the etiology of dyslexia. Supporting this, functional imaging studies suggest that the cerebellum is part of the neural network supporting reading in typically developing readers, and reading difficulties have been reported in patients with cerebellar damage. Differences in both cerebellar asymmetry and gray matter volume are some of the most consistent structural brain findings in dyslexics compared with good readers. Furthermore, cerebellar functional activation patterns during reading and motor learning can differ in dyslexic readers. Behaviorally, some children and adults with dyslexia show poorer performance on cerebellar motor tasks, including eye movement control, postural stability, and implicit motor learning. However, many dyslexics do not have cerebellar signs, many cerebellar patients do not have reading problems, and differences in dyslexic brains are found throughout the whole reading network, and not isolated to the cerebellum. Therefore, impaired cerebellar function is probably not the primary cause of dyslexia, but rather a more fundamental neurodevelopmental abnormality leads to differences throughout the reading network.

Freedman et al. Journal of Neurodevelopmental Disorders (2017) 9:36
DOI 10.1186/s11689-017-9218-5

Journal of Neurodevelopmental Disorders

RESEARCH Open Access

Saccade adaptation deficits in developmental dyslexia suggest disruption of cerebellar-dependent learning

Edward G. Freedman[1*], Sophie Molholm[1,2,3], Michael J. Gray[2,4], Daniel Belyusar[2,3] and John J. Foxe[1,2,3]

Abstract

Background: Estimates of the prevalence of developmental dyslexia in the general population range from 5% to as many as 10%. Symptoms include reading, writing, and language deficits, but the severity and mix of symptoms can vary widely across individuals. In at least some people with dyslexia, the structure and function of the cerebellum may be disordered. Saccadic adaptation requires proper function of the cerebellum and brainstem circuitry and might provide a simple, noninvasive assay for early identification and sub-phenotyping in populations of children who may have dyslexia.

Methods: Children between the ages of 7 and 15 served as participants in this experiment. Fifteen had been diagnosed with developmental dyslexia and an additional 15 were typically developing children. Five of the participants diagnosed with dyslexia were also diagnosed with an attention deficit hyperactivity disroder and were excluded from further analyses. Participants performed in a saccadic adaptation task in which visual errors were introduced at the end of saccadic eye movements. The amplitudes of primary saccades were measured and plotted as a function of the order in which they occurred. Lines of best fit were calculated. Significant changes in the amplitude of primary saccades were identified.

Results: 12/15 typically developing children had significant adaptation of saccade amplitude in this experiment. 1/10 participants with dyslexia appropriately altered saccade amplitudes to reduce the visual error introduced in the saccade adaptation paradigm.

Conclusions: Proper cerebellar function is required for saccadic adaptation, but in at least some children with dyslexia, cerebellar structure and function may be disordered. Consistent with this hypothesis, the data presented in this report clearly illustrate a difference in the ability of children with dyslexia to adapt saccade amplitudes in response to imposed visual errors. Saccadic adaptation might provide a noninvasive assay for early identification of dyslexia. Future work will determine whether reduced saccadic adaptation is pervasive in dyslexia or whether this identifies a sub-phenotype within the larger population of people identified with reading and language deficits.

Keywords: Dyslexia, Eye movements, Adaptation, Saccades, Cerebellum, Reading