



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

Cristina Burani

Istituto di Scienze e Tecnologie della Cognizione,
CNR, Roma

Università degli studi di Trieste,
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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 & Pennington, 2012**) responsabile di uno scarso "input tuning" nelle regioni che mediano l'integrazione grafema-fonema (**Dehaene et al., 2015**); **una disfunzione nella connettività ortografia-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; 2001).

Brain (1996), 119, 143–157

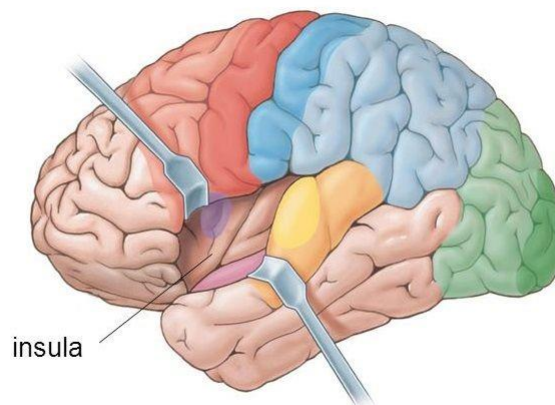
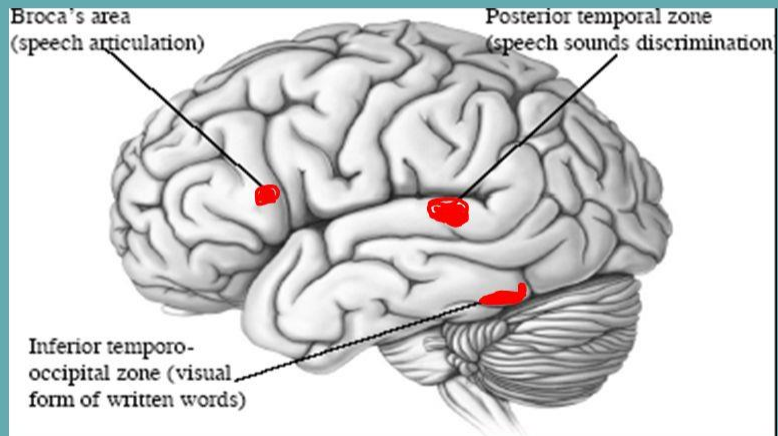
Is developmental dyslexia a disconnection syndrome?

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. Frackowiak¹ and Christopher D. Frith^{1,3}

A **rhyiming** 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 rhyiming 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





Research Report

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

Amy S. Desroches^a, Nadia E. Cone^a, Donald J. Bolger^b, Tali Bitan^c,
Douglas D. Burman^a, James R. Booth^{a,*}

^aDepartment of Communication Sciences and Disorders, Northwestern University, USA

^bDepartment of Human Development, University of Maryland, USA

^cDepartment of Communication Sciences and Disorders, Haifa University, Israel

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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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	/preʃ/ - /lɪst/ (PRESS - LIST)		/paɪnt/ - /mɪnt/ (PINT - MINT)

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articles

A cultural effect on brain function

E. Paulesu¹, E. McCrory², F. Fazio¹, L. Menoncello¹, N. Brunswick³, S. F. Cappa^{4,5}, M. Cotelli⁴, G. Cossetti⁶, F. Corte⁶, M. Lorusso², S. Pesenti⁷, A. Gallagher², D. Perani¹, C. Price³, C. D. Frith³, and U. Frith³.

¹ Scientific Institute H.S. Raffaele, INB-CNR, University of Milan-Bicocca, Milan, Italy

² Institute of Cognitive Neuroscience, University College London, 7 Queen Square, London WC1N 3AR, UK

³ Wellcome Department of Cognitive Neurology, Institute of Neurology, 12 Queen Square, London WC1N 3BG, UK

⁴ Neurology Department, University of Brescia, Brescia, Italy

⁵ Psychology Department, University Vita e Salute H San Raffaele, Milan, Italy

⁶ Istituto di Fisiologia Umana, University of Parma, Parma, Italy

⁷ Scientific Institute Eugenio Medea, La Mucosa Emulsion, Doccia, Piacenza, Italy

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

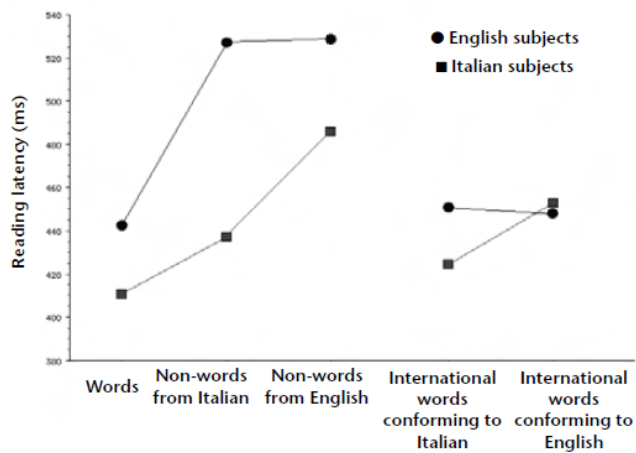
✓ di parole bisillabe ad alta frequenza d'uso

✓ 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

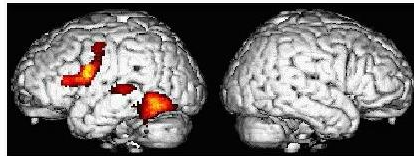
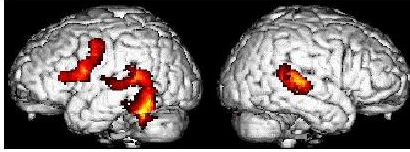
✓ di parole internazionali (tennis, boiler, basket, corner, partner, bitter, coma, taxi, panda, bravo, villa, pasta)



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

Inglese e Italiani: PET scan data

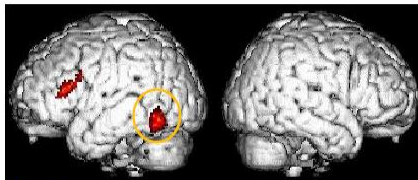
Sistema
comune di
lettura
per
Inglese e
Italiani*



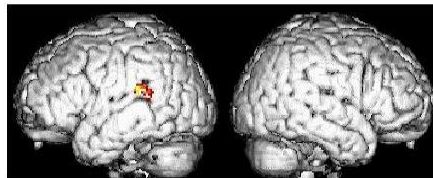
Lettura di
non parole
meno
Lettura di parole

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 (riconoscimento visivo di target conosciuti)



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. Frith⁵

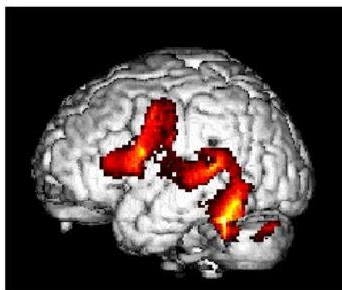
The recognition of dyslexia as a neurodevelopmental disorder has been hampered by the belief that it is not a specific diagnostic entity because it has variable and culture-specific manifestations. In line with this belief, we found that Italian dyslexics, using a shallow orthography which facilitates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

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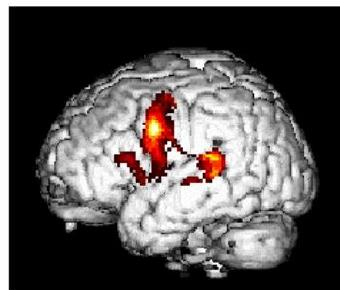
Attivazione cerebrale durante compiti di lettura

Controlli

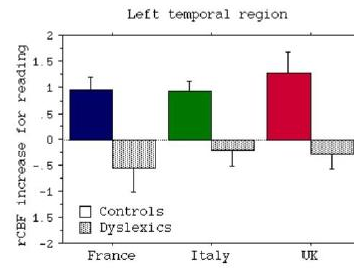
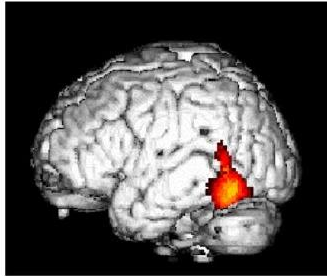
network perisilviano (area di Broca, area di Wernike incluso il planum temporale), giri temporale medio e inferiore, giro fusiforme, emisferi cerebellari e strutture sottocorticali (talamo e gangli della base)



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 magnocellulare, 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

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 Belyusa^{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 disorder 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