CORTEX 73 (2015) 112–130

Available online at www.sciencedirect.com

ScienceDirect

Journal homepage: www.elsevier.com/locate/cortex

Research report

Double-letter processing in surface dyslexia and dysgraphia following a left temporal lesion: A multimodal neuroimaging study

Barbara Tomasino [a,*], *Dario Marin* [a,1], *Marta Maieron* [b], *Serena D'Agostini* [c], *Franco Fabbro* [a,e], *Miran Skrap* [d] *and Claudio Luzzatti* [f]

[a] *IRCCS "E. Medea", Polo FVG, San Vito al Tagliamento (PN), Italy*
[b] *Fisica Medica A.O. Santa Maria della Misericordia, Udine, Italy*
[c] *Unità Operativa di Neuroradiologia, A.O. Santa Maria della Misericordia, Udine, Italy*
[d] *Unità Operativa di Neurochirurgia, A.O. Santa Maria della Misericordia, Udine, Italy*
[e] *Dipartimento di Scienze Umane, Università di Udine, Italy*
[f] *Dipartimento di Psicologia, Università di Milano-Bicocca, Italy*

ARTICLE INFO

Article history:
Received 26 August 2014
Reviewed 10 November 2014
Revised 18 January 2015
Accepted 12 August 2015
Action editor Roberto Cubelli
Published online 19 August 2015

Keywords:
Spelling
Reading
Double-letter processing
Lexical route
Sub-lexical route
Surface dyslexia
Surface dysgraphia
fMRI
DTI
Temporal lobe

ABSTRACT

Neuropsychological data about acquired impairments in reading and writing provide a strong basis for the theoretical framework of the dual-route models. The present study explored the functional neuroanatomy of the reading and spelling processing system. We describe the reading and writing performance of patient CF, an Italian native speaker who developed an extremely selective reading and spelling deficit (his spontaneous speech, oral comprehension, repetition and oral picture naming were almost unimpaired) in processing double letters associated with surface dyslexia and dysgraphia, following a tumor in the left temporal lobe. In particular, the majority of CF's errors in spelling were phonologically plausible substitutions, errors concerning letter numerosity of consonants, and syllabic phoneme-to-grapheme conversion (PGC) errors. A similar pattern of impairment also emerged in his reading behavior, with a majority of lexical stress errors (the only possible type of surface reading errors in the Italian language, due the extreme regularity of print-to-sound correspondence).

CF's neuropsychological profile was combined with structural neuroimaging data, fiber tracking, and functional maps and compared to that of healthy control participants. We related CF's deficit to a dissociation between impaired ventral/lexical route (as evidenced by a fractional anisotropy – FA decrease along the inferior fronto-occipital fasciculus – IFOF) and relatively preserved dorsal/phonological route (as evidenced by a rather full integrity of the superior longitudinal fasciculus – SLF). In terms of functional processing, the lexical-semantic ventral route network was more activated in controls than in CF, while the network supporting the dorsal route was shared by CF and the control

* *Corresponding author*. IRCCS "E. Medea", Polo Regionale del Friuli Venezia Giulia, via della Bontà, 7, San Vito al Tagliamento, PN, 33078 Italy.
E-mail address: btomasino@ud.lnf.it (B. Tomasino).
[1] Co-first author.
http://dx.doi.org/10.1016/j.cortex.2015.08.010
0010-9452/© 2015 Elsevier Ltd. All rights reserved.

participants. Our results are discussed within the theoretical framework of dual-route models of reading and spelling, emphasize the importance of the IFOF both in lexical reading and spelling, and offer a better comprehension of the neurological and functional substrates involved in written language and, in particular, in surface dyslexia and dysgraphia and in doubling/de-doubling consonant sounds and letters.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

Combining neuropsychological data about cognitive neurosurgical deficits with results from multiple brain mapping techniques – such as functional and structural magnetic resonance (MRI) and lesion reconstruction analysis – is a promising approach to examine neuropsychological effects before and after a brain tumor removal. During reading and writing, cortical circuits communicate with specific and targeted distant cortical regions via long-range axon bundles. The possibility to combine functional magnetic resonance (fMRI), diffusion tensor imaging (DTI) and neuropsychological data is a unique opportunity to highlight how networks operate and what happens when a small and selective brain damage in areas involved in reading and spelling occurs. In the present multi-modal imaging study we applied these multiple approaches to investigate the functional neuroanatomy of written language in an Italian patient (CF), who developed surface dyslexia and dysgraphia also involving the double-letter processing, as a consequence of a brain tumor affecting the left temporal lobe. CF's deficit was extremely selective (his spontaneous speech, oral comprehension, repetition and oral picture naming were almost unimpaired), whereas the majority of the cases with surface dyslexia and dysgraphia after focal brain damage do generally present with a severe fluent language impairment.

A crucial issue in the neurolinguistic research of reading and writing is the underlying neuroanatomical foundation. It is usually held that the *lexical-semantic route* for reading, which promotes direct access from word shape to meaning, includes the left occipito-temporal region near the fusiform gyrus (Cohen et al., 2000). In fact, when reading, these areas are often activated together with semantic areas, such as the posterior portion of the middle and inferior temporal gyri and the triangular part of the inferior frontal gyrus (Jobard, Crivello, & Tzourio-Mazoyer, 2003). The inferior fronto-occipital fasciculus (IFOF) and the inferior longitudinal fasciculus (ILF) (Catani & Thiebaut de Schotten, 2008; Fernández-Miranda et al., 2008; Martino, Brogna, Robles, Vergani, & Duffau, 2010), have been proposed as the neuroanatomical correlates of the *ventral* reading route (Epelbaum et al., 2008; Schlaggar & McCandliss, 2007). It has been reported (Catani & Thiebaut de Schotten, 2008) that the ILF arises in extrastriate visual areas and projects to anterior temporal regions. The IFOF projects from the ventral occipital lobe to the orbitofrontal cortex. This latter path includes a dorsal segment, connecting the middle occipital gyrus with the frontal lobe and a ventral segment connecting the inferior occipital gyrus with the frontal lobe (Martino et al., 2010). The IFOF shares with the ILF most of its posterior path in the temporal and occipital lobes, whereas it diverges from the ILF when approaching the anterior temporal lobe and directs towards the inferior frontal gyrus (Catani & Thiebaut de Schotten, 2008). The ILF is part of the ventral route. Specifically, the posterior part of the ILF has a role in the early pre-lexical processing (e.g., Epelbaum et al., 2008) as it connects the early visual analysis to the visual word form area (VWFA), thus to a pre-lexical part of the ventral reading route (e.g., Ripamonti et al., 2014). The *phonological route,* which allows grapheme-to-phoneme mapping (Jobard et al., 2003; Simos et al., 2002), has been found to be associated with activation of the left temporo-parietal junction (including the posterior superior temporal gyrus, the angular gyrus and the supramarginal gyrus), in addition to the opercular part of Broca's area (Burton, Small, & Blumstein, 2000; Pugh et al., 2000). The left arcuate fasciculus (AF) sustains the sublexical *grapheme-to-phoneme conversion (GPC)* reading route (Vandermosten, Boets, Poelmans, et al., 2012; Vandermosten, Boets, Wouters, & Ghesquiere, 2012). Functional neuromaging data are consistent with data arising from anatomo-clinical correlative studies in patients suffering of surface dyslexia (see Ripamonti, et al., 2014 for a review).

A lexical route and a sub-word-level routine are also necessary for spelling. Neuropsychological studies showed that lesions to the left fusiform/inferior temporal, middle and superior temporal, inferior frontal, angular, and supramarginal gyri cause acquired dysgraphia (Beauvois & Dérouesné, 1981; Philipose et al., 2007; Rapcsak & Beeson, 2004; Roeltgen & Heilman, 1984; Shallice, 1981; Tsapkini & Rapp, 2010). All of these areas were also found to be activated in neuroimaging studies of spelling (for a meta-analysis of neuroimaging findings see (Purcell, Napoliello, & Eden, 2011). Few fMRI studies have examined both reading and spelling within the same study. It has been shown that the left fusiform gyrus and the inferior temporal gyrus and the inferior frontal gyrus share activations for both tasks (Purcell, Napoliello, et al., 2011; Rapp & Dufor, 2011; Rapp & Lipka, 2011).

Our patient presents with a selective deficit both in reading and spelling. In particular, the majority of CF's spelling errors were phonologically plausible substitutions, errors concerning letter numerosity of consonants (doubling of simple consonants and de-doubling of double consonant letters), and syllabic phoneme-to-grapheme conversion (PGC) errors, i.e., the realization of the phones /k/, /g/, /tʃ/, /dʒ/, whose sub-word-level transcription is fully regular in Italian but requires taking into account the following sound. Italian is a language with a shallow orthography, where the sub-word-level routine is sufficient for reading and writing the great majority of words. There are, however, exceptions in reading,

Download English Version:

https://daneshyari.com/en/article/7313570

Download Persian Version:

https://daneshyari.com/article/7313570

Daneshyari.com