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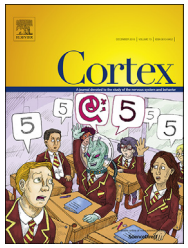

Editorial

Clinical neuroanatomy, five years on: Mini-Geschwinds with fancy toys?

*Marco Catani**

NatBrainLab, Department of Forensic and Neurodevelopmental Sciences, Institute of Psychiatry, Psychology and Neuroscience, King's College London, London, United Kingdom

The year 2015 has marked a double anniversary for the readers of *Cortex*. It is 50 years since Norman Geschwind published his influential two-parts 'Disconnexion syndromes in animals and man' in *Brain* (Geschwind, 1965a, 1965b). The paper contained an alluring mixture that proved irresistible to the generations that followed. Solidly grounded in axonal tracing studies in animals and highly perceptive clinical observations, and topped with bold claims as to comparative anatomy as well as authoritative historical cross-referencing, the paper became an instant classic. Arguably, for many it signposted the beginning of a new approach to studying the link between the brain and the mind (Catani & ffytche, 2005). With the same spirit the founding members of *Cortex* gathered together to create our journal in 1964 (Della Sala & Grafman, 2014).

Norman Geschwind (Boston) was part of the original editorial board of *Cortex* together with Julian de Ajuriaguerra (Geneva), Eberhard Bay (Dusseldorf), Arthur Benton (Iowa), Macdonald Critchley (London), George Ettlinger (London), Françoise Lhermitte (Paris), and Alexander Luria (Moscow). The diverse professional background of the original board truly reflected the pluralist principles governing their editorial actions. de Ajuriaguerra was a psychiatrist who promoted cross talk between psychoanalysis and neurology. Eberhard Bay was professor of neurology in Dusseldorf and the leading German aphasiologist of the time. Arthur Benton pioneered modern neuropsychology testing. George Ettlinger was among those researchers who, under the mentorship of Karl Pribram, would later constitute the first group of 'neuro-scientists'. Macdonald Critchley and Françoise Lhermitte were regarded as the direct heirs of a class of academics that had dominated Europe's clinical neuroscience for more than 100 years. Alexander Luria was the last representative of the great Russian school of psychological neurophysiology. Although from a different perspective, each had a stake in the development of the tools that could lead to a better understanding of the neuroanatomical basis of cognition and behaviour. In the ensuing years those tools were finally delivered.

Cortex, like many other journals that flourished at the time, recorded the excitement on paper. Fifty years on and we still try to live up to that legacy. The section of Clinical Neuroanatomy (CN), was devised to attempt to capture the original spirit of the journal (Catani & ffytche, 2010). We now celebrate the section's 5th anniversary. Thus far CN has published over 80 papers in the form of original manuscripts, reviews, and letters, but also discussion forum and special issues. One such discussion revolved around the question 'Do brain tumours allow valid conclusions on the localisation of human brain functions?' elicited by a paper published by Shallice, Mussoni, D'Agostino, & Skrap (2010). The topic is timely as many novel speculations on localisation of function have recently been put forward by neurosurgeons. By way of example, the inferior fronto-occipital fasciculus (IFOF) (Catani, Dell'Acqua, Bizzi, et al., 2012; Forkel, Thiebaut de Schotten, Kawadler, et al., 2014) is considered to be an important pathway for semantic cognition currently (Martino, Brogna, Robles, Vergani, & Duffau, 2010). But the evidence is weak and solely derived from intraoperative stimulation of patients with low grade gliomas undergoing tumour resection. The stimulation of the fibres in the extreme capsule elicits, admittedly on a small number of patients, semantic paraphasias; but this should not be taken as direct evidence of the role of the IFOF in semantics. Indeed, other more plausible explanations should be considered. It is likely that the neurosurgeon stimulates the

* Department of Forensic and Neurodevelopmental Sciences, Institute of Psychiatry, Psychology and Neuroscience, King's College London, London, SE5 8AF, United Kingdom.

E-mail address: m.catani@iop.kcl.ac.uk.

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underlying fibres of the uncinate fasciculus, which has been shown to hold a prominent role in semantic tasks (Catani & Bambini, 2014; Catani, Mesulam, Jakobsen, et al., 2013). This example demonstrates the potential but also the limitations of performing clinico–anatomical correlation in patients with brain tumours (Bartolomeo, 2011; Bizzi, 2011; Duffau, 2011; Karnath & Steinbach 2011; Shallice & Skrap, 2011), a challenging task that will require rigorous longitudinal (pre- and post-operative) neuropsychological testing and neuroimaging.

In 2013 only six manuscripts were published under the banner of CN. Remarkably, three of them were original single cases or reports on multiple single cases (Mariën et al., 2013; Couto et al., 2013; Yeatman & Feldman, 2013). The contribution of single cases to our understanding of cognitive neuroscience is unquestionable albeit increasingly it has become difficult to publish them in traditional neurological journals. The fallacious belief that progress in neuroscience can only originate from large data is nowadays fashionable. Notwithstanding the CN section is committed to continue publishing well documented single cases.

The first special issue of CN was in two volumes and dedicated to the Frontal Lobes (Catani & Stuss, 2012). Most papers in this special issue have been highly cited, especially those in which the authors tried to bridge the gap between anatomy and function (Bizzi et al., 2012; Catani, Dell'Acqua, Vergani, et al., 2012; Thiebaut de Schotten, Dell'Acqua, Valabregue, & Catani, 2012; Zappalá et al., 2012). The success of the frontal lobe special issues went beyond expectations and this has prompted the extension of the project to other lobes. In 2014 the special issue dedicated to the occipital lobe discussed a variety of topics including novel methods for study visual regions and connections in the healthy brain (Thiebaut de Schotten, Urbanski, Valabregue, Bayle, & Volle, 2014; Whittingstall, Bernier, Houde, Fortin, & Descoteaux, 2014), anatomical changes in preterm infants (Groppo et al., 2014), in people with albinism (Bridge et al., 2014), stroke (Bartolomeo, Bachoud-Lèvi, & Thiebaut de Schotten, 2014; Lazzarino De Lorenzo, Ffytche, Di Camillo & Buiatti, 2014; Kraft et al., 2014; Mah, Jager, Kennard, Husain, & Nachev, 2014), progressive prosopagnosia (Grossi et al., 2014) and macular degeneration (Hernowo et al., 2014). The special issue also gathered contributions also from papers that were read at the second yearly meeting of the International School of Clinical Neuroanatomy, held in Ragusa, Sicily, and chaired by Mortimer Mishkin (Fig. 1) (Berlucchi, 2014; Forkel, Mahmood, Vergani, & Catani, 2015; Haak et al., 2014; Macmillan, 2014; Vergani, Mahmood, Morris, Mitchell, & Forkel, 2014). In addition, in the same year the section received five papers focused on the white matter damage of patients with epilepsy (McDonald et al., 2014), Amyotrophic Lateral Sclerosis (Crespi et al. 2014), dementia with Lewy Bodies (Delli Pizzi et al., 2014), and Huntington's disease (Novak et al., 2014). This was followed in 2015 by the special issue dedicated to the limbic lobe and related structures (Ameis & Catani, 2015; Rolls, 2015). This was a controversial choice considering that many researchers

1. Sergio Della Sala
2. Marina Fernández-Andújar
3. Malcolm Bruce Macmillan
4. Stephanie Jacqueline Forkel
5. Michel Thiebaut de Schotten
6. Alberto Bizzi
7. Amelia Draper
8. Nina Reislev
9. Ron Kupers
10. Anoushka Leslie
11. David Slater
12. Rainer Goebel
13. Walter Rocca
14. Henrietta Howells
15. Arjun Sethi
16. Adam Cunningham
17. Edward Owen
18. Edith Bavin
19. Giovanni Berlucchi
20. Paolo Bartolomeo
21. Anne-Marie van Cappellen
22. Dominic ffytche
23. Imma Clemente
24. Michiel Kleinnijenhuis
25. Maria Mataró Serrat
26. Michael Dayan
27. Francesco Vergani
28. Marzena Wasilewska
29. Marco Catani
30. Lucio D'Anna
31. Franco Iemolo
32. Mortimer Mishkin
33. Gianfranco Spalletta
34. Fabrizio Piras
35. Giuseppe Zappala'
36. Stephen Jackson
37. Laurent Cohen
38. Sebastiano D'Anna
39. Luigi Pastore
40. Luis Lacerda
41. Ivan Alvarez
42. Jamie Kawadler

Fig. 1 – Participants in the second meeting of the International School of Clinical Neuroanatomy, held in Ragusa, Sicily in 2012.

would argue that the limbic system is not a proper lobe (Catani, Dell'Acqua, & Thiebaut de Schotten, 2013).

Beyond complacent remarks, anniversaries should represent an occasion for criticism and speculating on future directions. It thus remains to establish whether the contributions under the CN tag and contribution from neuroimaging in general embody a well-rehearsed story, or if they truly add to the field novel findings and insights. This is a valid conundrum that was raised at the John Marshall debate hosted by the last annual meeting of the British Neuropsychological Society in London. The motion debated was 'Human lesion neuropsychology will be inevitably replaced by neuroimaging as research tool for understanding cognition'. In the heat of intellectual joshing Kopelman threw a painful shaft of sarcasm by calling us, clinical neuroimagers, 'mini-Geschwinds with fancy toys'. The jest contains its truth. In the last 50 years there have been little conceptual breakthrough in neuropsychology. Likewise, neuroimaging methods have, so far, failed to inform us on the neurophysiological mechanisms of cognition and behaviour. 'Fancy toys' are good for fanciful activities, like tracking connections, measuring cortical thickness, parcellating areas, visualise task-dependent activity, etc. However, the complexity of the phenomena is challenging and it is clear that we need both neuropsychology and neuroimaging to tackle it. The problem is that we still fail to grasp the real dynamics of cognition and behaviour. In a fraction of a second, hundreds of millions of neurons interact and from their interaction cognition emerges. Why should we be concerned with how often and where these neurons activate? What is this going to tell us about the mechanisms of human cognition? Perhaps for now we should be content with turning 'fancy toys' into useful clinical tools for the benefit of our patients (Forkel, Thiebaut de Schotten, Dell'Acqua, et al., 2014). This goal is achievable and realistic. This may not be the grand plan that Geschwind concocted in his 1965 paper, but at least it is within our reach.

REFERENCES

Ameis, S. H., & Catani, M. (2015). Altered white matter connectivity as a neural substrate for social impairment in Autism Spectrum Disorder. *Cortex, 62*, 158–181. http://dx.doi.org/10.1016/j.cortex.2014.10.014.

Bartolomeo, P. (2011). The quest for the 'critical lesion site' in cognitive deficits: problems and perspectives. *Cortex, 47*(8), 1010–1012. http://dx.doi.org/10.1016/j.cortex.2010.11.007.

Bartolomeo, P., Bachoud-Lèvi, A. C., & Thiebaut de Schotten, M. (2014). The anatomy of cerebral achromatopsia: a reappraisal and comparison of two case reports. *Cortex, 56*, 138–144. http://dx.doi.org/10.1016/j.cortex.2013.01.013.

Berlucchi, G. (2014). Visual interhemispheric communication and callosal connections of the occipital lobes. *Cortex, 56*, 1–13. http://dx.doi.org/10.1016/j.cortex.2013.02.001.

Bizzi, A. (2011). Clinico-anatomical correlation in gliomas: a new frontier in clinical neuroscience? *Cortex, 47*(8), 1013–1015. http://dx.doi.org/10.1016/j.cortex.2010.11.009.

Bizzi, A., Nava, S., Ferrè, F., Castelli, G., Aquino, D., Ciaraffa, F., et al. (2012). Aphasia induced by gliomas growing in the ventrolateral frontal region: assessment with diffusion MR tractography, functional MR imaging and neuropsychology. *Cortex, 48*(2), 255–272. http://dx.doi.org/10.1016/j.cortex.2011.11.015.

Bridge, H., von dem Hagen, E. A., Davies, G., Chambers, C., Gouws, A., Hoffmann, M., et al. (2014). Changes in brain morphology in albinism reflect reduced visual acuity. *Cortex, 56*, 64–72. http://dx.doi.org/10.1016/j.cortex.2012.08.010.

Catani, M., & ffytche, D. (2005). The rise and fall of disconnection syndromes. *Brain, 128*(10), 2224–2239. http://dx.doi.org/10.1093/brain/awh622.

Catani, M., & Bambini, V. (2014). A model for social communication and language evolution and development (SCALED). *Currunt Opinion in Neurobiology, 28*, 165–171. http://dx.doi.org/10.1016/j.conb.2014.07.018.

Catani, M., Dell'Acqua, F., Bizzi, A., Forkel, S. J., Williams, S. C., Simmons, A., et al. (2012). Beyond cortical localisation in clinico-anatomical correlation. *Cortex, 48*(10), 1262–1287. http://dx.doi.org/10.1016/j.cortex.2012.07.001.

Catani, M., Dell'Acqua, F., & Thiebaut de Schotten, M. (2013). A revised limbic system model for memory, emotion and behaviour. *Neuroscience & Biobehavioral Reviews, 37*(8), 1724–1737. http://dx.doi.org/10.1016/j.neubiorev.2013.07.001.

Catani, M., Dell'Acqua, F., Vergani, F., Malik, F., Hodge, H., Roy, P., et al. (2012). Short frontal lobe connections of the human brain. *Cortex, 48*(2), 273–291. http://dx.doi.org/10.1016/j.cortex.2011.12.001.

Catani, M., & ffytche, D. H. (2010). New section: cortex clinical neuroanatomy. *Cortex, 46*(1), 1. http://dx.doi.org/10.1016/j.cortex.2009.03.009.

Catani, M., Mesulam, M. M., Jakobsen, E., Malik, F., Martersteck, A., Wieneke, C., et al. (2013). A novel frontal pathway underlies verbal fluency in primary progressive aphasia. *Brain, 136*(8), 2619–2628. http://dx.doi.org/10.1093/brain/awt163.

Catani, M., & Stuss, D. T. (2012). At the forefront of clinical neuroscience. *Cortex, 48*(1), 1–6. http://dx.doi.org/10.1016/j.cortex.2011.11.001.

Couto, B., Sedeño, L., Sposato, L. A., Sigman, M., Riccio, P. M., Salles, A., et al. (2013). Insular networks for emotional processing and social cognition: comparison of two case reports with either cortical or subcortical involvement. *Cortex, 49*(5), 1420–1434. http://dx.doi.org/10.1016/j.cortex.2012.08.006.

Crespi, C., Cerami, C., Dodich, A., Canessa, N., Arpone, M., Iannaccone, S., et al. (2014). Microstructural white matter correlates of emotion recognition impairment in Amyotrophic Lateral Sclerosis. *Cortex, 53*(1), 1–8. http://dx.doi.org/10.1016/j.cortex.2014.01.002.

Della Sala, S., & Grafman, J. (2014). Happy 50th anniversary cortex! *Cortex, 50*, 1–6. http://dx.doi.org/10.1016/j.cortex.2013.10.008.

Delli Pizzi, S., Maruotti, V., Taylor, J. P., Franciotti, R., Caulo, M., Tartaro, A., et al. (2014). Relevance of subcortical visual pathways disruption to visual symptoms in dementia with Lewy bodies. *Cortex*, 5912–5921. http://dx.doi.org/10.1016/j.cortex.2014.07.003.

Duffau, H. (2011). Do brain tumours allow valid conclusions on the localisation of human brain functions? *Cortex, 47*(8), 1016–1017. http://dx.doi.org/10.1016/j.cortex.2010.11.010.

Forkel, S. J., Mahmood, S., Vergani, F., & Catani, M. (2015). The white matter of the human cerebrum: part I the occipital lobe by Heinrich Sachs. *Cortex, 62*, 182–202. http://dx.doi.org/10.1016/j.cortex.2014.10.023.

Forkel, S. J., Thiebaut de Schotten, M., Dell'Acqua, F., Kalra, L., Murphy, D. G., Williams, S. C., et al. (2014). Anatomical predictors of aphasia recovery: a tractography study of bilateral perisylvian language networks. *Brain, 137*(7), 2027–2039. http://dx.doi.org/10.1093/brain/awu113.

Forkel, S. J., Thiebaut de Schotten, M., Kawadler, J. M., Dell'Acqua, F., Danek, A., & Catani, M. (2014). The anatomy of fronto-occipital connections from early blunt dissections to

contemporary tractography. *Cortex, 56*, 73–84. http://dx.doi.org/10.1016/j.cortex.2012.09.005.

Geschwind, N. (1965a). Disconnexion syndromes in animals and man. I. *Brain, 88*(2), 237–294.

Geschwind, N. (1965b). Disconnexion syndromes in animals and man. II. *Brain, 88*(3), 585–644.

Groppo, M., Ricci, D., Bassi, L., Merchant, N., Doria, V., Arichi, T., et al. (2014). Development of the optic radiations and visual function after premature birth. *Cortex, 56*, 30–37. http://dx.doi.org/10.1016/j.cortex.2012.02.008.

Grossi, D., Soricelli, A., Ponari, M., Salvatore, E., Quarantelli, M., Prinster, A., et al. (2014). Structural connectivity in a single case of progressive prosopagnosia: the role of the right inferior longitudinal fasciculus. *Cortex, 56*, 111–120. http://dx.doi.org/10.1016/j.cortex.2012.09.010.

Haak, K. V., Langers, D. R., Renken, R., van Dijk, P., Borgstein, J., & Cornelissen, F. (2014). Abnormal visual field maps in human cortex: a mini-review and a case report. *Cortex, 56*, 14–25. http://dx.doi.org/10.1016/j.cortex.2012.12.005.

Hernowo, A. T., Prins, D., Baseler, H. A., Plank, T., Gouws, A. D., Hooymans, J. M., et al. (2014). Morphometric analyses of the visual pathways in macular degeneration. *Cortex, 56*, 99–110. http://dx.doi.org/10.1016/j.cortex.2013.01.003.

Karnath, H.-O., & Steinbach, J. P. (2011). Clinical neuroanatomy: discussion forum. Do brain tumours allow valid conclusions on the localisation of human brain functions? – Objections. *Cortex, 47*(8), 1004–1006. http://dx.doi.org/10.1016/j.cortex.2010.08.006.

Kraft, A., Grimsen, C., Kehrer, S., Bahnemann, M., Spang, K., Prass, M., et al. (2014). Neurological and neuropsychological characteristics of occipital, occipito-temporal and occipito-parietal infarction. *Cortex, 56*, 38–50. http://dx.doi.org/10.1016/j.cortex.2012.10.004.

Lazzarino De Lorenzo, L. G., Ffytche, D. H., Di Camillo, E., & Buiatti, T. (2014). The Dide–Botcazo syndrome: forgotten and misunderstood. *Cortex, 56*, 182–190. http://dx.doi.org/10.1016/j.cortex.2013.01.011.

Mah, Y.-H., Jager, R., Kennard, C., Husain, M., & Nachev, P. (2014). A new method for automated high-dimensional lesion segmentation evaluated in vascular injury and applied to the human occipital lobe. *Cortex, 56*, 51–63. http://dx.doi.org/10.1016/j.cortex.2012.12.008.

Macmillan, M. (2014). Alfred Walter Campbell and the visual functions of the occipital cortex. *Cortex, 56*, 157–181. http://dx.doi.org/10.1016/j.cortex.2012.10.007.

Mariën, P., Jung De Smet, H., Wijgerde, E., Verhoeven, J., Crols, R., & De Deyn, P. P. (2013). Posterior fossa syndrome in adults: a new case and comprehensive survey of the literature. *Cortex, 49*(1), 284–300. http://dx.doi.org/10.1016/j.cortex.2011.06.018.

Martino, J., Brogna, C., Robles, S. G., Vergani, F., & Duffau, H. (2010). Anatomic dissection of the inferior fronto-occipital fasciculus revisited in the lights of brain stimulation data. *Cortex, 46*(5), 691–699. http://dx.doi.org/10.1016/j.cortex.2009.07.015.

McDonald, C. R., Leyden, K. M., Hagler, D. J., Kucukboyaci, N. E., Kemmotsu, N., Tecoma, E. S., et al. (2014). White matter microstructure complements morphometry for predicting verbal memory in epilepsy. *Cortex, 58*, 139–150. http://dx.doi.org/10.1016/j.cortex.2014.05.014.

Novak, M. J. U., Seunarine, K. K., Gibbard, C. R., Hobbs, N. Z., Scahill, R. I., Clark, C. A., et al. (2014). White matter integrity in premanifest and early Huntington's disease is related to caudate loss and disease progression. *Cortex, 52*(1), 98–112. http://dx.doi.org/10.1016/j.cortex.2013.

Rolls, E. T. (2015). Limbic systems for emotion and for memory, but no single limbic system. *Cortex, 62*, 119–157. http://dx.doi.org/10.1016/j.cortex.2013.12.005.

Shallice, T., Mussoni, A., D'Agostino, S., & Skrap, M. (2010). Right posterior cortical functions in a tumour patient series. *Cortex, 46*(9), 1178–1188. http://dx.doi.org/10.1016/j.cortex.2010.04.005.

Shallice, T., & Skrap, M. (2011). Localisation through operation for brain tumour: a reply to Karnath and Steinbach. *Cortex, 47*(8), 1007–1009. http://dx.doi.org/10.1016/j.cortex.2010.12.006.

Thiebaut de Schotten, M., Dell'Acqua, F., Valabregue, R., & Catani, M. (2012). Monkey to human comparative anatomy of the frontal lobe association tracts. *Cortex, 48*(1), 82–96. http://dx.doi.org/10.1016/j.cortex.2011.10.001.

Thiebaut de Schotten, M., Urbanski, M., Valabregue, R., Bayle, D. J., & Volle, E. (2014). Subdivision of the occipital lobes: an anatomical and functional MRI connectivity study. *Cortex, 56*, 121–137. http://dx.doi.org/10.1016/j.cortex.2012.12.007.

Vergani, F., Mahmood, S., Morris, C. M., Mitchell, P., & Forkel, S. J. (2014). Intralobar fibres of the occipital lobe: a post mortem dissection study. *Cortex, 56*, 145–156. http://dx.doi.org/10.1016/j.cortex.2014.03.002.

Whittingstall, K., Bernier, M., Houde, J. C., Fortin, D., & Descoteaux, M. (2014). Structural network underlying visuospatial imagery in humans. *Cortex, 56*, 85–98. http://dx.doi.org/10.1016/j.cortex.2013.02.004.

Yeatman, J. D., & Feldman, H. M. (2013). Neural plasticity after pre-linguistic injury to the arcuate and superior longitudinal fasciculi. *Cortex, 49*(1), 301–311. http://dx.doi.org/10.1016/j.cortex.2011.08.006.

Zappalá, G., Thiebaut de Schotten, M., & Eslinger, P. J. (2012). Traumatic brain injury and the frontal lobes: what can we gain with diffusion tensor imaging? *Cortex, 48*(2), 156–165. http://dx.doi.org/10.1016/j.cortex.2011.06.020.