Brief Curriculum Vitae - Víctor BORRELL

1- Personal Data

Name: Víctor Borrell
Age: 50
Nationality: Spanish
ORCID: 0000-0002-7833-3978

2- Current position

Research Professor, Institute of Neuroscience Alicante
BorrellLab

3- Professional Experience

2023-present	Research Professor, Spanish Superior Council of Scientific Research (CSIC), Institute of Neuroscience Alicante
2017-2023	Scientific Researcher, Spanish Superior Council of Scientific Research (CSIC), Institute of Neuroscience Alicante
2016-2020	Vicedirector, Institute of Neuroscience Alicante (Spain)
2008-2017	Staff Scientist, Spanish Superior Council of Scientific Research (CSIC), Institute of Neuroscience Alicante
2004-2008	Ramon y Cajal Senior Researcher (CSIC), Institute of Neuroscience Alicante
2001-2004	HFSP post-doctoral fellow, The Salk Institute for Biological Studies, (U.S.A.), with Dr. E. Callaway
1995-2001	PhD, Neurodevelopment Laboratory, University of Barcelona, Spain. Dir. Prof. E. Soriano

4- Academic training

PhD in Biology	University of Barcelona	2001
BS Biology	University of Barcelona	1995

5- Indicators of Scientific Productivity

PhD Theses mentored: **13**
Total peer-reviewed publications: **70**
Total citations: **7500**
Cites/paper: **107**
Average annual citations (2018-2022): **646**
Publications in Q1: **55** Publications in D1: **29**
H-index: **42** i10-index: **56**

→ Top 2% researchers most cited worldwide (2017, 2019)

→ Top 0.01% experts in Cerebral Cortex worldwide (2011 - 2021)

6- Awards

2020 “Alberto Sols” Award 2020 to the best research paper
2013 Olympus – SENC Award to Young Neuroscience Researcher
2012 European Research Council (ERC) Consolidator Grant
2007 Human Frontier Science Program (HFSP) Career Development Award
2002 Extraordinary PhD Thesis Award, University of Barcelona
2001 Postdoctoral Fellowship Human Frontier Science Program (HFSP)

7- Main research interests

My scientific career has always been focused on understanding mechanisms of embryonic brain development, publishing in top journals since my PhD Thesis and post-doc days (*Nature* 1997; *J Neurosci* 1998, 1999, 2002, 2011; *Development* 1998, 1999, 2000; *Cer Cortex* 2006; *Nat Neurosci* 2006). In 2008, I established my laboratory as CSIC Staff Scientist at the Instituto de Neurociencias, promoted to CSIC Scientific Researcher in 2017, and finally to CSIC Research Professor in 2022 (to be made official).

Research in my laboratory aims at understanding the cellular, molecular and genetic mechanisms underlying the expansion and folding of the cerebral cortex during development of large mammals, and how these mechanisms evolved from reptiles. The cerebral cortex is the largest structure in the brain and is responsible, among others, of our higher cognitive functions. The extraordinary increase in cerebral cortex size observed along vertebrate evolution is thought to underlie the concomitant growth in intellectual capacity. This evolutionary expansion is recapitulated during development in higher mammals, when the embryonic cortex undergoes massive growth in surface area, and folds into stereotypic patterns. We want to identify and understand the basic developmental mechanisms involved in the evolutionary expansion and folding of the cerebral cortex. Our research combines single-cell transcriptomics, proteomics, genetic manipulation (electroporation, viral vectors, transgenesis), experimental embryology, state-of-the-art live imaging techniques and standard histological, cellular and molecular biology methods. We study a variety of species with evolutionarily strategic value, including house snake, chick, mouse, ferret and human. Genetic analysis and experimental manipulation of cortex growth and folding during *in vivo* development are done primarily on mouse and ferret, a naturally gyrencephalic species, and importantly using human cerebral organoids *in vitro*. My lab was the first to implement human cerebral organoids in Spain, and remains as the national reference.

Work from my lab first demonstrated the key relevance of the thick cortical germinal zone OSVZ for cortex folding, found in all species with cortical folds and absent in those without (*Cer Cortex* 2011, 2012a). In this context, a groundbreaking discovery was our identification of a new type of progenitor cell very abundant in the OSVZ of folded brains: basal Radial Glia (bRG) (*Cer Cortex* 2011, 2012b, *Nat Comm* 2013). Genetically manipulating bRG in various animal models, we demonstrated its central role in the expansion and folding of the cerebral cortex (*EMBO J* 2013, *Cell* 2013, *Cur Opin Neuro* 2014, *Glia* 2015, *J Neurosci* 2018). Later on, we contributed to demonstrate that cortical folding is also regulated by neuronal migration (*Cell* 2017). We have found the genetic bases of cortical folding and its patterns, identifying genes involved in the formation of OSVZ and a genetic protomap that defines the pattern of folds and fissures (*EMBO J* 2015, 2016, *Nat Comm* 2016).

The use of human cerebral organoids in our studies since 2018 has been key to frame our findings in animal models in the context human brain development and evolution. On this regard, we have discovered that the evolution of cortex size from reptiles to mammals was linked to the differential regulation of signaling pathways that otherwise are highly conserved (*Cell* 2018), particularly a pathway that we newly discovered regulates the lineage of cortical progenitor cells (*Neuron* 2012). More recently, we have identified the first genetic mechanism selected during evolution for the secondary reduction of cortex size in rodents, from their ancestor with primates (*Sci Adv* 2022), and the key importance of microRNAs in embryonic brain development (*EMBO J* 2020), possibly related with the origin of pediatric brain tumors.

Our current focus is on the diversity and biology of progenitor cell populations at the genomic and cellular levels, aiming to unravel the cellular and molecular basis of cortical expansion and folding in health and disease, and the underlying evolutionary mechanisms. The relevance and impact of our discoveries is reflected in the high number of citations to our studies (649 cites/year, 107 cites/article), beyond being published in top journals, which set our laboratory among the top 2% most cited worldwide in 2017 and 2019. This is further recognized with the awarding of prestigious research projects (ERC, HFSP, FP7, AECC), invitation as expert reviewer for national and international funding agencies, editor in top scientific journals, invitations to write review articles (*Nat Rev Neurosci*, *Phys Rev*, *EMBO J*, *Curr Opin*), and impart lectures at the most prestigious research centers worldwide.

8- Selected publications

1. Chinnappa K, Villalba A, Márquez-Galera A, Prieto-Colomina A, Nomura Y, Cárdenas A, Llorens E, Soler R, Tomasello U, López-Atalaya JP, **Borrell V** (2022) *Secondary loss of miR-3607 reduced cortical progenitor amplification during rodent evolution*. **Science Advances** 8 (2), eabj4010
2. Vílchez-Acosta A, Manso Y, Cárdenas A, Elias-Tersa A, Martinez-Losa M, Pascual M, Álvarez-Dolado M, Nairn AC, **Borrell V**, Soriano E (2022) *Specific contribution of Reelin expressed by Cajal-Retzius cells or GABAergic interneurons to cortical lamination*. **PNAS** 119 (37) e2120079119
3. Cárdenas A., **Borrell V** (2021) *A protocol for in ovo electroporation of chicken and snake embryos to study forebrain development*. **STAR Protocols,** 2:100692.
4. Fernández V, Martínez-Martínez MA, Prieto-Colomina A, Cárdenas A, Soler R, Dori M, Tomasello U, Nomura Y, López-Atalaya JP, Calegari C, **Borrell V** (2020) *Repression of Irs2 by let-7 miRNAs is essential for homeostasis of the telencephalic neuroepithelium*. **EMBO J** 19:e105479 Cover
5. Murcia-Belmonte V, Coca Y, Vegar C, Negueruela S, de Juan C, Valiño A, da Silva R, Kania A, Martínez-Otero L, **Borrell V**, Erskine L and Herrera E (2019) *A retino-retinal projection guided by Unc5c emerged in species with retinal waves*. **Curr Biol** 29(7):1149 -1160.e4
6. Camargo Ortega G, Falk S, Johansson PA, Peyre E, Broic L, Kumar Sahu S, Hirst W, Schlichthärle T, De Juan Romero C, Draganova K, Vinopal S, Chinnappa K, Gavranovic A, Karakaya T, Staininger T, Merl-Pham J, Feederle R, Shao W, Shi SH, Hauck SM, Jungmann R, Bradke F, **Borrell V**, Geerlof A, Reber S, Tiwari VK, Huttner WB, Wilsch-Bräuninger M, Nguyen L, Götz M (2019) The centrosome protein Akna regulates neurogenesis via microtubule organization. **Nature** 567:113-117.
7. Martínez-Martínez MA*, Ciceri G*, Espinós A*, Fernández V, Marín O, **Borrell V** (2019) Extensive branching of radially-migrating neurons in the mammalian cerebral cortex. **J Comp Neurol** 527:1558-1576. (*co-authors)
8. Cárdenas A, Villalba A, De Juan Romero C, Picó E, Kyrousi C, Tzika AC, Tessier-Lavigne M, Ma L, Drukker M, Cappello S, **Borrell V** (2018) *Evolution of cortical neurogenesis in amniotes controlled by Robo signaling levels*. **Cell** 174:590-606.e21 Highlighted in Faculty 1000Prime
9. Reillo I*, De Juan Romero C*, Cárdenas A, Clascá F, Martínez-Martínez MA, **Borrell V** (2017) *A complex code of extrinsic influences on cortical progenitor cells of higher mammals*. **Cerebral Cortex** 27:4586-4606. Cover
10. Del Toro D, Ruff T, Cederfjäll E, Villalba A, Seyit-Bremer G, **Borrell V**, Klein R (2017) *Regulation of cerebral cortex folding by controlling neuronal migration via FLRT adhesion molecules*. **Cell** 169:621-635. Cover, Highlighted in Developmental Cell previews (22/5/2017), Faculty 1000Prime
11. Martínez-Martínez M, De Juan Romero C, Fernández V, Cárdenas A, Götz M, **Borrell V** (2016) *A restricted period for formation of outer subventricular zone defined by Cdh1 and Trnp1 levels*. **Nat Comm** 7:11812
12. de Juan Romero C, Bruder C, Tomasello U, Sanz-Anquela JM, **Borrell V** (2015) *Discrete domains of gene expression in germinal layers distinguish the development of gyrencephaly.* **EMBO J,** 34:1859–1874, Cover, Highlighted in *EMBO J*
13. Pilz GA, Shitamukai A, Reillo I, Pacary E, Schwausch J, Stahl R, Ninkovic J, Snippert HJ, Clevers H, Godinho L, Guillemot F, **Borrell V**, Matsuzaki F, Götz M (2013) *Amplification of progenitors in the mammalian telencephalon includes a novel radial glia cell type*. **Nat Comm** 4:2125
14. Stahl R, Walcher T, De Juan Romero C, Pilz GA, Capello S, Irmler M, Sanz-Anquela JM, Beckers J, Blum R, **Borrell V**, Götz M (2013) *TRNP1 regulates expansion and folding of the mammalian cerebral cortex by control of radial glial fate*. **Cell** 153:535-549. Highlighted in *Science Now* (26/4/2013)

15. Nonaka-Kinoshita M, Reillo I, Artegiani B, Martínez-Martínez MA, Nelson M, **Borrell V***, Calegari F* (2013) *Regulation of cerebral cortex size and folding by expansion of basal progenitors*. **EMBO J** 32:1817-1828 (*co-corresponding) Highlighted in *EMBO J* "Have you seen?" and *Science* "Editor's choice"
16. **Borrell V***, Cárdenas A, Garcia-Frigola C, Galcerán J, Flames N, Ciceri G, Pla R, Nóbrega S, Peregrín S, Ma L, Tessier-Lavigne M, Marín O* (2012) *Slit/Robo signaling modulates the proliferation of central nervous system progenitors*. **Neuron** 76:338-352 (*co-corresponding) Highlighted in *Video Abstracts*
17. Kelava I, Reillo I*, Murayama A*, Kalinka AT, Stenzel D, Tomancak P, Matsuzaki F, Lebrand C, Sasaki E, Schwamborn J, Okano H, Huttner WB‡, **Borrell V‡** (2012) *Abundant occurrence of basal radial glia in the subventricular zone of embryonic neocortex of a lissencephalic primate, the common marmoset* Callithrix jacchus. **Cerebral Cortex** 22:469-481 (‡co-corresponding) Cover
18. Reillo I, De Juan Romero C, García-Cabezas MA, **Borrell V** (2011) *A role for Intermediate Radial Glia in the tangential expansion of the mammalian cerebral cortex*. **Cerebral Cortex** 21:1674-1694 Cover
19. **Borrell V**, Marin O (2006) *The meninges control the tangential migration of hem-derived Cajal-Retzius cells via CXCL12/CXCR4 signaling*. **Nat Neurosci** 9:1284-1293 Highlighted in *Faculty of 1000*

Invited reviews

1. Fernández V, **Borrell V** (2023) *Developmental mechanisms of gyrification*, **Curr Opin Neurobiol** 80:102711
2. Del Valle Anton L, **Borrell V** (2022) *Folding brains: from development to disease modeling*. **Physiological Reviews** 102:511-550.
3. **Borrell V** (2021) *Protomaped by the pros: proneural factors pattern cortex folding*. **Neuron** 109:2797-2798.
4. Prieto A, Fernández V, Chinnappa K, **Borrell V** (2021) *MiRNAs in early brain development and pediatric cancer*. **Bioessays** 2100073.
5. Villalba A, Götz M, **Borrell V** (2021) *The regulation of cortical neurogenesis*. **Current Topics in Developmental Biology** 142:1-66. Cover
6. Cárdenas A and **Borrell V** (2019) *Molecular and cellular evolution of corticogenesis in amniotes*. **Cell Mol Life Sci** 77(8):1435-1460.
7. Llinares-Benadero C and Borrell V (2019) *Deconstructing cortical folding: genetic, cellular and mechanical determinants*. **Nat Rev Neurosci** 20(3):161-176. Cover
8. Borrell V (2018) *How cells fold the cerebral cortex*. **J Neurosci** 38:776-783.
9. De Juan Romero C, Borrell V (2017) *Genetic maps and patterns of cerebral cortex folding*. **Curr Opin Cell Biol** 49:31-37.
10. Fernández V, Llinares-Benadero C, Borrell V (2016) *Cerebral cortex expansion and folding: what have we learned?* **EMBO J,** 35:1021–1044.
11. Borrell V*, Götz M* (2014) *Role of Radial Glia cells in cerebral cortex folding*. **Curr Opin Neurobiol,** 27:39–46. (*co-corresponding)

9- Community service

- **Expert grant reviewer**: European Research Council, Spanish Evaluation Agency, Israel Science Foundation, French National Research Agency, BBS Research Council UK, DFG Germany, FNRS Belgium
- **Editorial Board**: *iScience* (since 2017)

10- Scientific Society committees

2014 – 2022 Executive Committee Spanish Society for Developmental Biology
2015 – 2019 Executive Committee Spanish Society for Neuroscience
2013 – 2019 Young Investigators Committee Spanish Society for Neuroscience