

## BIOGRAPHICAL SKETCH

NAME: Herrera, Eloisa

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POSITION TITLE: (Spanish Research Council) CSIC- Research Professor

### EDUCATION/TRAINING

INSTITUTION AND LOCATION	DEGREE (if applicable)	Completion Date MM/YYYY	FIELD OF STUDY
University of Granada, Spain	B.S	06/1995	Biology
University Autónoma of Madrid, Spain	Ph.D.	02/2000	Cancer and Aging
Columbia University, NY, USA	Postdoctoral	09/2004	Developmental Neuroscience

### A. Personal Statement

I am a CSIC-Research Professor at the Institute of Neurosciences (IN) of Alicante. I obtained my PhD in 2000 working in Cancer and Aging under the supervision of María Blasco, obtaining the “Special Mention” for the best doctoral thesis and contributing to this field with relevant publications as a first author ***PNAS (1998), EMBO J (1999a, 1999b, 2000)***. Then, I moved to Columbia University (NY, USA) to work as a postdoctoral researcher in the laboratory of Carol Mason. There, I identified the molecular mechanisms underlying the emergence of binocular vision, and published several papers as first author ***Development (2004), CONB (2004), Cell (2003)***. Since the establishment of my lab (2005), my research has focused on three main lines: 1/ The cellular and molecular mechanisms underlying neurogenesis: We discovered that the ciliary margin zone, the most peripheral part of the embryonic retina, has the capacity to generate ganglion cells ***Cell Reports (2016)*** and described that neural stem cells located in the peripheral adult eye, retain neurogenic potential but are not able to generate retinoids ***PRER (2019); Cells (2023)***. 2/ The molecular mechanisms controlling axon pathfinding: We identified the transcription factor (TF) Foxd1 as important for the polarization of the mammalian retina and for the expression of the guidance molecules EphA/ephrinA ***J Neuroscience (2011)***. We also described that the TF Zic2 controls the receptor EphB1 to regulate axon guidance at the midline ***Development (2008)*** and proved that Zic2 is a general determinant of axon midline avoidance in the CNS ***Neuron (2013)***. We also disentangled the entire set of genes regulated by Zic2 in different cell types ***J Neuroscience (2015)***, and the regulatory mechanisms controlling the axonal trajectories of visual neurons ***Sci Adv (2020); Adv Sci (2022)***. 3/ The mechanisms underlying neural circuits assembly: Among the discoveries related to this line, we reported the transcriptional regulation of the serotonin transporter that modulates eye-specific refinement at the visual targets ***EMBO J (2010)*** and showed that the signaling mediated by EphA/ephrinA during the refinement of the visual system defines axon targeting along the anterior-posterior axis of the visual nuclei in a spontaneous activity-independent manner ***J Neuroscience (2013)***. We also demonstrated the existence of a retino-retinal projection likely emerged in species with retinal waves for the fine-tune refinement of visual axons ***Current Biology (2019)***. We have also published some technical articles including a method to electroporate the embryonic retina ***BMP Dev Biology (2007)*** and a procedure to perform time-lapse imaging and cell tracking of migrating cells *in vitro* and *in vivo* ***Curr Prot in Neurosc (2017)***. Along the years, we have also

contributed to the work of other colleagues: *J Neuroscience (2013)*; *Sci Rep (2015)*; *Cell Death & Differ (2018)*; *Cells (2022)*; *J Neuroscience (2017)*; *Cell Reports (2018)*; *Science (2021)*; *Nat Comm (2021)*; *Neuron (2022)*.

My group has obtained uninterrupted funding from national and international agencies including the Career Development Award (Human Frontiers Science Program Organization, HFSP) and a Consolidator project of the European Research Council (ERC). I was deputy coordinator of the National Research Agency (AEI) (2015-2018) member of a high number of evaluation committees and panels for national and international agencies and invited as a lecturer in more than 60 scientific forums. I have supervised 10 doctoral thesis (+2 ongoing) and 7 TFMs. I belong to the Editorial Board of the journals *IJMS*, *Scientific Reports*, *Molecular Brain* and invited to write review articles for many journals. In 2021, I have been the coordinator of the chapter: Brain, Mind & Behavior for the "CSIC-Scientific Challenges: Towards 2030". I was the president of the Program Committee for the SENC-2021 meeting and belong to the program committee of the IBRO-meeting (2023) and FENS-2024. Among my responsibilities at the IN, I participate as a lecturer in the PhD program, I am member of the Experimental Animal Research Commission, scientific supervisor of the Imaging Facility and coordinator of the IN-Scientific Programs.

## B. Positions and Honors

### Positions and Employment

2000	Predoctoral Fellow. Universidad Autónoma de Madrid
2000-02	Postdoctoral Fellow. Columbia University, NY.
2003-04	Associate Research Scientist. Columbia University, NY.
2005-07	Ramón y Cajal Scientist (Tenure-Track position). Institute of Neurosciences (IN), Alicante.
2007-16	Tenured Assistant Professor of the Spanish Research Council (CSIC), Alicante.
2016-2019	CSIC-Research Scientist, IN, Alicante.
2019-present	CSIC-Research Professor, IN, Alicante.

### Scientific Management Activities, Evaluation Committees and Memberships

2005-present	Grant Evaluator for the National Agency of Evaluation (AEI).
2010-present	Grant Evaluator for the "Agence Nationale de la Recherche", France
2010-present	Grant Evaluator for the "Fondation Recherche Medicale", France
2012-present.	Grant Evaluator for the "Research Foundation Flanders (FWO)" Belgium.
2006-2009.	Member of the PhD Program Commission at the IN
2007-2012	Coordinator of the "Scientific Seminar Series" at the IN
2012-present	Scientific Responsible of the Imaging Facility at the IN
2015	Managing editor of the Journal "Molecular Brain"
	Member of the Editorial Board of the Journal "Scientific Reports" (Nature Group)
2015-2016	Member of the Evaluation Committee Alicia Koplowich Grants
2015-present	Member of the IN Committee on Animal Research and Ethics
2016	Member of the Evaluation Committee BBVA fellowships
2017	Associated Coordinator of the Spanish Research Agency (Neurosciences Section)
2018	Member of the Evaluation Committee "Research Fellowships La Caixa"
2017	Faculty member of F1000Prime
2018	Chair and talk-selection Committee:"Axon Guidance, Synapse Formation & Regeneration". Cold Spring Harbor, New York (USA).
	Co-director of the Cajal Training Program Course FENS-IBRO. France. 2018
2019	Organizer of the international meeting AXON-2019. Alicante, Spain. 2019
	Member of the Evaluation Committee for "Ramón y Cajal" contracts
	Reviewer for the Andalusian Research Agency
	Editor of the special issue "Retinal Ganglion Cells" in <i>IJMS</i> (IP: 4.2).
2021	Coordinator of the chapter "Brain and Aging" for the Spanish Research Council white paper
	President of the Program Committee-International meeting of SENC.
2022	Member of the Program Committee FENS-2024. Vienna, Austria. 2024.

- 2023 Member of the Evaluation Panel for the Cajal Training Program Courses FENS-IBRO.  
 Member of the Committee program IBRO-2023. Granada, Spain 2023.  
 Organizer of the international meeting AXON-2023. Alicante, Spain. 2023.  
 Member of the Evaluation Panel for the Cajal Training Program Courses FENS-IBRO.  
 Member of the Executive Committee of the Spanish Society of Developmental Biology (SEBD)

### Honors

- 2000 PhD special mention to the best PhD thesis work  
 2001 Human Frontiers Science Program (HFSP) long-term postdoctoral fellow  
 2004 HFSP Career Development Award  
 European Neuroscience Institutes (ENI) Young Investigator  
 2012 ERC-Consolidator Grant Holder  
 2014 Alberto Sols Prize to the best research work

## **B. Contribution to Science**

### Contributions on Cancer and Aging

- Martín-Rivera L\*, [Herrera E\\*](#), Albar JP, & Blasco MA (1998). \*Co-authors. Expression of mouse telomerase catalytic subunit in embryos and adult tissues. **PNAS** 95:10471-10476. Key: A
- [Herrera E](#), Samper E, & Blasco MA (1999). Telomere shortening in mTR<sup>-/-</sup> embryos is associated with failure to close the neural tube. **EMBO J.** 18(5): 1172-81. Key: A
- [Herrera E](#), Samper E, Martín-Caballero J, Flores JM, Lee HW, Blasco MA (1999). Disease states associated with telomerase deficiency appear earlier in mice with short telomeres. **EMBO J.** 18(11): 2950-60. Key: A
- [Herrera E](#), Martínez-A C, Blasco MA (2000). Impaired germinal center reaction in mice with short telomeres. **EMBO J.** 19(3): 472-81. Key: A
- Goytisolo FA, Samper E, Martín-Caballero J, Finnon P, [Herrera E](#), Flores JM, Bouffler SD, Blasco MA (2000). Short telomeres result in organismal hypersensitivity to ionizing radiation in mammals. **J Exp Med.** 192(11): 1625-3. Key: A
- Franco S, Alsheimer M, [Herrera E](#), Benavente R, Blasco MA (2002). Mammalian meiotic telomeres: composition and ultrastructure in telomerase-deficient mice. **Eur J Cell Biol.** Jun; 81 (6): 335-40. Key: A
- Ramírez R, Carracedo J, Jiménez R, Canela A, [Herrera E](#), Blasco MA (2003). Massive telomere loss in an early event of DNA damage-induced apoptosis. **J. Biol.Chem.** Jan 10; 278(2): 836-42. Key: A

### Contributions on the formation and assembly of neural circuits

- [Herrera E](#), Brown L, Aruga J, Rachel R, Dolen G, Mikoshiba K, Brown S, Mason CA (2003). The transcription factor Zic2 designates the uncrossed retinal ganglion cell axon projection. **Cell.** 114, 545-557. Cover caption. Key: A
- Williams SW, Mason CA, [Herrera E](#) (2004). The optic chiasm as a midline point choice. **CONB.** 14:1:51-60. Key: R
- [Herrera E](#), Marcus R, Li S, Lai E, Mason CA (2004). The transcription factor FoxD1 is required for the proper establishment of the optic chiasm. **Development.** 131:5727-5739. Key: A
- García-Frigola C, Carreres MI, Vegar C and [Herrera E\\*](#) (2007). Gene delivery in retinal ganglion cells by in utero electroporation. **BMC Developmental Biology.** 2007, 7:103. Key: A
- Erskine L\* and [Herrera E](#). The retinal ganglion cell axon's journey: Insights into molecular mechanisms of axon guidance (2007). **Developmental Biology.** 308: (1)1-14. Invited Review. Key: R
- [Herrera E\\*](#) and García-Frigola C (2008). Genetics and development of the optic chiasm. **Frontiers in Bioscience.** 13, 1646-1653. Key: R
- García-Frigola C, Carreres MA, Vegar C, Mason CA and [Herrera E\\*](#) (2008). Zic2 promotes axonal divergence at the optic chiasm midline by EphB1-dependent and -independent mechanisms. **Development.** 135:1833-1841. Key: A

- [Herrera E](#) and Mason CA\* (2010). Evolution of crossed and uncrossed pathways in mammals. In: Evolution of Nervous Systems, (Ed. J.H. Kaas), Academic Press, Oxford, vol. 3: pp. 307-318. Key: BC
- García-Frigola C and [Herrera E\\*](#) (2010). Zic2 regulates the expression of SERT to modulate eye-specific refinement at the visual targets. **The EMBO Journal**. 15; 29(18): 3037-8. Commentary in the same issue: 15; 29(18): 3037-8. Key: A
- Carreres MI, Escalante A, Murillo B, Chauvin G, Gaspar P, Vegar C and [Herrera E\\*](#) (2011). The transcription factor Foxd1 is required for the specification of the temporal retina in mammals. **The Journal of Neuroscience**. Apr 13;31(15):5673-81. Cover caption.
- Sánchez-Arrones L, Nieto-López F, Sánchez-Camacho C, Carreres MI, [Herrera E](#), Okada A, Bovolenta P\* (2013). Shh/Boc signaling is required for sustained generation of ipsilateral-projecting ganglion cells in the mouse retina. **The Journal of Neuroscience**. 33(20):8596-607. Key: A
- [Herrera E\\*](#) and Erskine L (2012). Visual system Development in vertebrates. Encyclopedia of Life Sciences (eLS) John Wiley & Sons, Ltd. Invited Review. Key: R
- Benjumeda I, Escalante A, Law C, Morales D, Chauvin G, Muca G, Coca Y, López-Bendito G, Kania A, Martínez-Otero L and [Herrera E\\*](#) (2013). Uncoupling of EphA/ephrinA signaling and spontaneous activity in neural circuit wiring. **The Journal of Neuroscience**. 33(46):18208-18218. Cover caption. Key: A
- Escalante E, Murillo B, Morenilla-Palao C, Klar A and [Herrera E\\*](#) (2013). Zic2-dependent axon midline avoidance controls the formation of major ipsilateral tracts in the CNS. **Neuron** 80, 1392–1406. Key: A
- Erskine L and [Herrera E\\*](#) (2014). Connecting the eye to the brain. *ASN Neuro*. October-December 2014:1–26. Review.
- Murillo B, Ruiz-Reig N, Herrera M, Fairén A and [Herrera E\\*](#) (2015). Zic2 controls the migration of specific neuronal populations in the developing forebrain. **The Journal of Neuroscience** 35(32):11266–11280. Key: A
- Scandaglia M, Benito E, Morenilla-Palao C, Fiorenza A, del Blanco B, Coca Y, [Herrera E\\*](#) Barco A\* (2015). Fine-tuned SRF activity controls asymmetrical neuronal outgrowth: implications for cortical migration, neural tissue lamination and circuit assembly. **Scientific Reports** 5, 17470. Key: A
- Tiveron MC, Beclin C, Murgan S, Wild S, Angelova A, Coré N, Chevigny A, [Herrera E](#), Bosio A, Bertrand V, Cremer H\* (2017). Zic proteins are evolutionary conserved repressor of dopaminergic fate. **The Journal of Neuroscience**. 37 (44) 10611-10623. Key: A
- [Herrera E\\*](#), Sitko AA, Bovolenta P\* (2018). Shh-ushing Midline Crossing through Remote Protein Transport. **Neuron**. 97(2):256-258. Key: R
- [Herrera E\\*](#). Rodent Zic genes in neural network wiring (2018). Book chapter in the book: Zic family Evolution, Development and Disease. **Adv Exp Med Biol**. 1046:209-230. Key: BC
- Del Blanco B, Guiretti D, Tomasoni R, Lopez-Cascales MT, Muñoz-Viana R Lipinski M, Scandaglia M, Coca Y, Olivares R, Valor LM, [Herrera E](#), Barco A (2019). CBP and SRF co-regulate dendritic growth and synaptic maturation. **Cell Death Differ**. doi: 10.1038/s41418-019-0285-x. Key: A.
- [Herrera E](#), Erskine L Morenilla C (2019). Guidance of retinal axons in mammals. **Seminars in Cell and Developmental Biology**. Jan; 85: 48-59. Key: R
- 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. **Current Biology**. 2019 Apr 1;29(7):1149-1160.e4. doi: 10.1016/j.cub.2019.02.052. Key: A
- Morenilla-Palao C, López-Cascales MT, López-Atalaya JP, Baeza D, Calvo L, Barco A, [Herrera E\\*](#) (2020). A Zic2-regulated switch in a non-canonical Wnt/ $\beta$ -catenin pathway is essential for the formation of bilateral circuits. **Science Advances**. 6(46): eaaz8797. DOI: 10.1126/sciadv.aaz8797.
- Alvarez-Vergara MI, Rosales-Nieves AE, March-Diaz R, Rodriguez-Perinan G, Lara-Urena N, Ortega-de San Luis C, Sanchez-Garcia MA, Trillo-Contreras JL, Martin-Bornez M, Gómez-Gálvez P Vicente-Munuera P, Fernandez-Gomez B, Marchena MA, Bullones-Bolanos AS, Davila JC, Gonzalez-Martinez R, Sanchez-Hidalgo AC, Scholl FG, [Herrera E<sub>1</sub>](#) et al. (2021). Non-productive angiogenesis disassembles A $\beta$  plaque-associated blood vessels. **Nat Communications**. 12(1):3098. doi: 10.1038/s41467-021-23337-z.
- Vigouroux RJ, Duroure K, Voungny J, Albadri S, Kozulin P, [Herrera E<sub>1</sub>](#) Nguyen-Ba-Charvet K, Braasch, Del Bene P\* & Chédotal A\* (2021). Bilateral visual projections exist in non-teleost bony fish and predate the emergence of tetrapods. **Science**. 372(6538):150-156. Slavi N, Balasubramanian R, Lee MA, Liapin M, Oaks-Leaf R, Peregrin J, Potenski A, Troy CA, Ross ME, [Herrera E](#), Kosmidis S, John SW, Mason CA\* (2022).

CyclinD2-mediated regulation of neurogenic output from the retinal ciliary margin is perturbed in albinism. *Neuron*. doi: 10.1016/j.neuron.2022.10.025.

- Fernández-Nogales M, López-Cascales MT, Murcia-Belmonte V, Escalante A, Fernández-Albert J, Muñoz-Viana R, Barco, A & [Herrera E\\*](#) (2022). Multiomic Analysis of Neurons with Divergent Projection Patterns Identifies Novel Regulators of Axon Pathfinding. *Advanced Science*. doi: 10.1002/advs.202200615.
- [Herrera E](#) & Escalante A (2022). Transcriptional Control of Axon Guidance at Midline Structures. *Frontiers in Cell and Developmental Biology*. 21 Feb 2022 10:840005. doi: 10.3389/fcell.2022.840005.
- Sánchez-Huertas C & [Herrera E](#) (2021). With the Permission of Microtubules: An Updated Overview on Microtubule Function During Axon Pathfinding. *Frontiers in Molecular Neuroscience* 14. 2 Dec 2021. doi: 10.3389/fnmol.2021.759404

#### Contributions on the mechanisms controlling neural progenitor differentiation and their applications to palliate degenerative pathologies.

- Marcucci F, Murcia-Belmonte V, Coca Y, Kuwajima T, Khalid S, Ferreiro S, Mason C\* & [Herrera E\\*](#) (2016). The ciliary margin zone of the mammalian retina generates retinal ganglion cells. *Cell Reports* Dec 20;17(12):3153-3164. doi: 10.1016/j.celrep.2016.11.016. Cover caption. Key: A
- Ruiz-Reig N, Andrés B, Huilgol D, Grove EA, Tissir F, Tole S, Theil T, [Herrera E\\*](#) & Fairén A\* (2017). Lateral Thalamic Eminence: A novel origin for mGluR1/lot cells. \* Corresponding authors. *Cerebral Cortex*. 27(5):2841-2856. Key: A
- Murcia-Belmonte V, Exposito G, [Herrera E\\*](#) (2018). Time-lapse imaging and cell tracking of migrating cells in slices and flattened telencephalic vesicles. *Current Protocols in Neurosciences*. 79:3.31.1-3.31.12. doi: 10.1002/cpns.24
- [Herrera E\\*](#), Agudo-Barriuso M, Murcia-Belmonte V. Cranial Pair II: The Optic Nerves (2019). *Anatomical Records*. 302(3):428-445. Key: R
- Fernández-Nogales M, Murcia V Chen Y and [Herrera E\\*](#). The peripheral eye: A neurogenic area with potential to treat retinal pathologies? (2019). *Progress in Retinal and Eye Research*. Jan; 68 :110-123. Key: A/R
- González-Martínez R, Márquez-Galera A, DelBlanco B, López-Atalaya JP, Barco A\* & [Herrera E\\*](#) (2022). CBP and p300 jointly maintain neural progenitor viability but play unique roles in the differentiation of neural lineages. *Cells*. DOI: [10.3390/cells11244118](https://doi.org/10.3390/cells11244118)

**Complete List of Published Work in MyBibliography:** <https://eloisahgm.wixsite.com/herrerelab/publications>

#### **D. Additional Information: Research Support and/or Scholastic Performance**

Research Support (As a PI)

Title: *A strategy to guide and promote spinal and visual axons regeneration after injury*. Funding Agency: **Fundación La Caixa – Proyectos de Investigación en Salud 2020** (Neurociencias). 01/12/2021 – 30/11/2024. Budget: 495.500,00 €:

Title: *Desregulación transcripcional y epigenética en trastornos del desarrollo del sistema nervioso*. Funding Agency: Generalitat Valenciana- Programa de **Excelencia Prometeo**. 08/07/2020 – 31/12/2023. Budget: 195.602,00 €.

Title: *Desregulación transcripcional y epigenética en trastornos del desarrollo del sistema nervioso*. Funding Agency: Programa de Excelencia Prometeo-Generalitat Valenciana. 01/09/2016 – 31/12/2020. Budget 275.000 €.

Title: *Mecanismos moleculares de la holoprosencefalia asociada a Zic2*. Funding Agency: **Fundación Ramón Areces**. 2019-2021. Budget: 125.545€.

Title: Regulación de la guía axonal y la conectividad neuronal durante la formación de los circuitos cerebrales. Funding Agency: MINECO (Proyectos de Excelencia, I+D). 2017-2019. Budget: 332.500 €.

Title: Identifying reliable sources of stem cells for cell replacement therapy in retinal degeneration diseases. Funding Agency: **Marató Foundation-TV3**. 2015-2017. Budget: 233.261,25€.

Title: Identificación y caracterización de células madre de retina para su uso en terapias de reemplazo en enfermedades neurodegenerativas de la retina. Funding Agency: **Tatiana Foundation**. 2015-2017. Budget: 52.250€.

Title: Mecanismos que regulan la navegación axonal y la conectividad neuronal. Funding Agency: MINECO. 2014-2016. Budget: 302.500 €.

Title: Síndromes de discapacidad intelectual relacionales con alteraciones en la cromatina: Etiología Molecular y terapia. 2012-15. **ERA-NET: European Research Area-Networks**. Budget: 75.000,00 €.

Title: Síndrome de Rubinstein-Taybi: disección de la enfermedad, etiología molecular y terapia. Funding Agency: Regional Government- Valencia Region. 2012-2015. Budget: 202.132€.

Title: Wiring up visual circuits: Interplay between gene expression and spontaneous and experience dependent activity. Funding Agency: **European Research Council-CoGrant**. 2012-2016. Budget: 1.500.000 €.

Title: Mecanismos implicados en la formación de circuitos bilaterales en el sistema nervioso de mamíferos. Funding Agency: Spanish Ministry of Science and Economy (MINECO). 2011-2013. Budget: 242.000 €.

Title: Identificación de moléculas que interactúan con el factor de transcripción Zic2 durante el desarrollo embrionario de ratón. Funding Agency: MEC. 2007. Budget: 30.000€.

Title: Molecular mechanisms underlying axonal laterality in the developing nervous system of mammals. Funding Agency: MEC. 2007- 2010. Budget: 200.000 €.

Title: Bases Moleculares de la Visión Binocular. Funding Agency: Spanish Ministry of Science and Education (MEC). Duration from: 2005 to 2007. Budget: 90.000€. Role PI.

Title: Mechanisms underlying neuronal specification and axon trajectory in the developing nervous system. Funding Agency: **Human Frontiers Science Program**. 2005-2007. Budget: \$180.00.

Title: Wiring up visual circuits: Interplay between gene expression and spontaneous and experience dependent activity. Funding Agency: **European Research Council-CoGrant**. 2012-2016. Budget: 1.500.000 €. Role: PI.

Title: Síndrome de Rubinstein-Taybi: disección de la enfermedad, etiología molecular y terapia. Funding Agency: Regional Government- Valencia Region. 2012-2015. Budget: 202.132€. Role: PI.

Title: Mecanismos que regulan la navegación axonal y la conectividad neuronal. Funding Agency: MINECO. 2014-2016. Budget: 302.500 €. Role PI.

Title: Identifying reliable sources of stem cells for cell replacement therapy in retinal degeneration diseases. Funding Agency: **Marató Foundation-TV3**. 2015-2017. Budget: 233.261,25€. Role PI.

Title: Identificación y caracterización de células madre de retina para su uso en terapias de

reemplazo en enfermedades neurodegenerativas de la retina. Funding Agency: **Tatiana Foundation**. 2015-2017. Budget. 52.250€. Role PI.

Title: Síndromes de discapacidad intelectual relacionales con alteraciones en la cromatina: Etiología Molecular y terapia. **ERA-NET: European Research Area-Networks**. Budget: 75.000,00 €. Role PI.

