

Curriculum vitae of Vincent Torre

Noticeable experiences or achievements are indicated in red

PERSONAL INFORMATION

Name and Surname: Vincent Torre

Date of birth: 24 July 1950

EDUCATION

1973 Laurea in Physics Department of Physics University of Genoa Italy

CURRENT POSITION

1996-present: Full Professor of Physiology, International School for Advanced Studies (SISSA) Trieste, IT

PREVIOUS POSITIONS

1990-1996 Full Professor of Cybernetics Department of Information Science Genoa Univ. (ITA)

1985-1990 Associate Professor in Physics Department of Physics Genoa Univ. (ITA)

1978-1984 Post-doc at the Physiological Laboratory Cambridge (UK) under the supervision of Sir Alan Hodgkin (Nobel Prize in Physiology).

INSTITUTIONAL RESPONSIBILITIES

2013 - 2018: Coordinator of the PhD Course in Neurobiology at SISSA

2006 - 2012: Director of the Interdisciplinary Laboratory of SISSA which has the mission of Science dissemination in the Society

2006 - 2009: Director of the SISSA Masters' Course in Science Communication

2004 - 2007: Neurobiology Sector Coordinator

2001 - 2004: Biophysics Sector Coordinator

1992 - 1996: Full Professor of Cybernetics Department of Information Science Genoa Univ. (ITA)

1990-1992: Responsible for the working group of the EU on Neuroinformatics

1985 - 1990 Associate Professor in Physics Department of Physics Genoa Univ. (ITA)

FELLOWSHIPS AND AWARDS

2014: Fellowship from the Chinese Academy of Sciences

1990-1992: Chief delegate of EU at the OECD forum in Neuroinformatics

1988: Visiting Miller Professor Berkeley (USA) in Biophysics and Medical Physics

1978-1982 EMBO Fellowship in Cambridge UK

SUPERVISION OF GRADUATE STUDENTS AND POSTDOCTORAL FELLOWS

2007-2019: Supervision of 45 PhD students in Biophysics, Neurobiology and Neuroscience at SISSA *do you have a list of PhD students advised? Or at least the ones that became professors/key leaders at important institutions?*

TEACHING ACTIVITIES

1978-1996: Lectures in Physics, Biophysics, Information Theory, Signal and Data processing, Cybernetics and Dynamical Systems at the Department of Physics and Computer Science at Genoa University

1997- present: Lectures in Neuroscience, Biophysics and Bionanotechnologies at SISSA and for the Masters' Degree in Neuroscience for the University of Trieste.

2013-2018 Coordinator of the PhD in Neurobiology at SISSA 2011-2016: Organizer of the annual edition of the SISSA Summer School in Neuronanotechnology

2016-present: courses on Bionanotechnology and Mechanobiology for the PhD students at SISSA.

SCIENTIFIC PROFILE

Vincent Torre has a background in Physics and Mathematics, but he has been working in Neuroscience for several decades. In his scientific career he has provided significant contributions at the interface between Physics and Neuroscience and has contributed to the development of a more quantitative Neuroscience and Computational Neuroscience. *Vincent Torre is highly interdisciplinary and he has proved non trivial mathematical theorems (in the field of dynamical systems, complexity theory,...) and opened new experimental methodologies (force measurements in neurons, SMFS in situ,...)*. He is the author of more than 150 MSs in peer reviewed journals and his H-index is higher to 60, according Google Scholar.

EARLY SCIENTIFIC ACHIEVEMENTS (1975-2005)

Phototransduction and ion channels

He has worked on phototransduction both experimentally and theoretically. He showed that Calcium is not the intracellular messenger, but controls light adaptation, see:

- Matthews HR, Torre V, Lamb TD (1985). Effects on the photoresponse.... *Nature*, (313) pp.582-5.

He has also provided the first quantitative model of phototransduction in:

- Forti S, Menini A, Rispoli G, Torre V. (1989). Kinetics of *J Physiol*. Dec;419 pp.265-95

Moreover, he performed the most detailed experimental description of single channel properties of cyclic nucleotide gated (CNG) channels underlying phototransduction, in

- Bucossi G, Nizzari M, Torre V. (1997). Single-channel properties of ionic channels gated by cyclic nucleotides. *Biophys J*. Mar;72(3) pp.1165-81.

and he pioneered molecular dynamics simulations of ionic channels, in

- Guidoni L, Torre V, Carloni P. (1999). Potassium and sodium binding to the outer mouth of the K⁺ channel. *Biochemistry*, Jul 6;38(27) pp.8599-604.

and modelling of ionic channels in

- Anselmi C, Carloni P, Torre V (2007). Origin of functional diversity among tetrameric voltage-gated channels. *Proteins*. Jan; 1:66 (1) pp. 136-46.

Computational Neuroscience

In the 1980s he contributed to the birth of Computational Neuroscience with two seminal papers, one on biophysical mechanisms underlying direction selectivity and on the computational role of dendrites in neurons, as described in:

- Torre V, Poggio T. (1978). A synaptic mechanism possibly underlying directional selectivity to motion. *Proc. R. Soc. Lond. B.* 202, 1978 pp.409-416
 - Koch C, Poggio T, Torre V. (1982). Retinal ganglion cells: a functional interpretation of dendritic morphology. *Philos Trans R Soc Lond B Biol Sci.* Jul 27;298(1090) pp.227-63
- These are hallmark papers that are still quoted even after several decades . Recently he has analysed information processing in the leech nervous system, as described in:
- Zoccolan D, Pinato G, Torre V. (2002). Highly variable spike trains underlie reproducible sensorimotor responses in the medicinal leech. *J Neurosci.* Dec 15;22(24) pp.10790-800.
 - Garcia-Perez E, Mazzoni A, Zoccolan D, Robinson HP, Torre V. (2005). Statistics of decision making in the leech. *J Neurosci.* Mar 9; 25(10) pp.2597-608.

Computer Vision

In the 1980s and 1990s he provided major contributions to the nascent field of Computer Vision, where he pioneered the use of precise mathematical tools (Regularization Theory,..) to solve classical problems in edge detection, motion analysis and early vision, as described in:

- Poggio T, Torre V, Koch C. (1985). Computational vision and regularization theory. *Nature.* Sep 26-Oct 2; 317(6035):314-9.
- Torre V, Poggio T. (1986). On Edge Detection, *IEEE Trans*, Mar ; on PAMI-8 (2) pp.147-163

According to Google Scholar these MSs have close to 2000 citations respectively.

These two papers are considered as disruptive papers as they have opened new issues and laid down the mathematical foundations of Deep Learning very popular nowadays.

His younger collaborators have used these methods for industrial applications, see

- Vanzella W, Pellegrino FA, Torre V. (2004) Self-adaptive regularization. *IEEE Trans Pattern Anal Mach Intell.* Jun;26(6):804-9 and a spin-off company - GLANCE VISION TECHNOLOGY – has stemmed from these activities. He has also proved some important theorems on the complexity of labeling of line drawings, as described in:
- Parodi P. & Torre V. On the complexity of labeling line drawings of polyhedral scenes. *Artificial Intelligence*, 70 (1994), pp. 239–276.

LATE SCIENTIFIC ACHIEVEMENTS (2006-2018)

Mechanobiology

In the last 15 years, Vincent Torre has acquired methods and expertise from Nanoscience, such as Manipulation and Force measurements with Optical Tweezers, as described in:

-Cojoc D, Difato F, Torre V (2007). Properties of the force exerted by filopodia and lamellipodia and the involvement of cytoskeletal components. *PLoS One*. Oct 24;2(10):e1072

This MS is highly cited and is the first measurement of force generation with pN resolution in neuronal growth cones.

- Pinato G, Cojoc D, Lien LT, Ansuini A, Ban J, D'Este E, Torre V(2012). Less than 5 Netrin-1 molecules initiate attraction but 200 Sema3A molecules are necessary for repulsion. *Sci Rep*. 2012;2:675. Epub 2012

- Cardamone L, Laio A, Torre V., Shahapure R, Desimone A (2011). Cytoskeletal actin networks in motile cells are critically self-organized systems synchronized by mechanical interactions. *PNAS* vol. 108 (84), p. 13978-13983
<http://www.pnas.org/content/108/34/13978.long>

- Iseppon F, Napolitano LM, Torre V, Cojoc D. (2015) Cdc42 and RhoA dynamics in growth cones: a response to locally delivered Semaphorin 3A. *Frontiers in Cellular Neuroscience* Aug 26;9:333. doi:

- Mortal S, Iseppon F, Perissinotto A, D'Este E, Cojoc D, Napolitano LMR, Torre V. Actin Waves Do Not Boost Neurite Outgrowth in the Early Stages of Neuron Maturation. *Front Cell Neurosci*. 2017 Dec 18;11:402. doi: 10.3389/fncel.2017.00402. eCollection 2017.

- Cell Mechanotransduction With Piconewton Forces Applied by Optical Tweezers. Falleroni F, Torre V, Cojoc D. *Front Cell Neurosci*. 2018 May 14;12:130. doi: 10.3389/fncel.2018.00130

Field Code Changed

This MS is particularly relevant to the new field of Mechanobiology as it shows how to apply very weak forces and demonstrates that neurons from the central nervous system respond to very weak mechanical stimulations.

Cyclic nucleotide gated channels and phototransduction

- Marchesi A, Mazzolini M, Torre V (2012). Gating of cyclic nucleotide-gated channels is voltage dependent. *Nature Communications* Jul 24, 2012;3:973, doi: 10.1038/ncomms1972

- Maity S, Mazzolini M, Arcangeletti M, Valbuena A, Fabris P, Lazzarino M and Torre V. (2015). Conformational rearrangements in the transmembrane domain of CNGA1 channels revealed by single molecule force spectroscopy *Nature Communications* May 12, 2015 doi: 10.1038/

- Mazzolini M, Facchetti G, Andolfi L, Proietti Zaccaria R, Tuccio S, Treu J, Altafini C, Di Fabrizio EM, Lazzarino M, Rapp G and Torre V (2015). The phototransduction machinery in the rod outer segment has a strong efficacy gradient *PNAS* May 19, 2015, doi:10.1073/pnas.1423162112 **and recommended by F 1000 as of special interest in its field**

- Napolitano LMR, Bisha I, De March M, Marchesi A, Arcangeletti M, Demitri N, Mazzolini M, Rodriguez A, Magistrato A, Onesti S, Laio A and Torre V (2015). A structural, functional

and computational analysis suggests pore flexibility as the base for the poor selectivity of CNG channels *PNAS*_Jul 7, 2015;112(27):E3619-28. doi: 10.1073/pnas.1503334112 -

- Maity S, Marchesi A, Mazzolini M & Torre V (2016) Structural heterogeneity of CNGA1 channels revealed by electrophysiology and single molecule force spectroscopy. *ACS Omega*, 1 (6), pp 1205–1219. doi: 10.1021

Marchesi A, , Arcangeletti M, Napolitano LMR, Grosa D, Maity S, Anselmi C, Mazzolini M & Torre V (2017). The gating mechanism in cyclic nucleotide-gated ion channels *Scientific Reports*.

This MS shows that the molecular mechanism of gating of CNGA1 channels is different from that previously believed for several decades

- Maity S, Ilieva N, Laio A, Torre V and Mazzolini M (2017). New views on phototransduction from atomic force microscopy and single molecule force spectroscopy on native rods. *Scientific Reports* vol 7, Article #12000 (2017).

-Napolitano LMR, Marchesi A, Rodriguez A, De March M, Onesti S, Laio A, Torre V. Computational Biology 2018 The permeation mechanism of organic cations through a CNG mimic channel. 2018 Aug 2;14(8):e1006295. doi: 10.1371/journal.pcbi.1006295. eCollection 2018 Aug.

Field Code Changed

Gaskell G, Bard I, Allansdottir A, da Cunha RV, Eduard P, Hampel J, Hildt E, Hofmaier C, Kronberger N, Laursen S, Meijknecht A, Nordal S, Quintanilha A, Revuelta G, Saladié N, Sándor J, Santos JB, Seyringer S, Singh I, Somsen H, Toonders W, Torgersen H, Torre V, Varju M, Zwart H. Public views on gene editing and its uses. *Nat Biotechnol*. 2017 Nov 9;35(11):1021-1023. doi: 10.1038/nbt.3958..

Field Code Changed

PRESENT SCIENTIFIC ACTIVITIES (2018-....)

In the last couple of years Vincent Torre has continued his interdisciplinary activities encompassing Artificial Intelligence (AI), Neuroscience and Bionanotechnology. Given his long scientific experience understands very well which experimental tools and theoretical approaches can push forward our understanding of Biology and Medicine. Indeed, Vincent Torre with his younger collaborators have developed new **AI tools for the analysis of SMFS data**:

Galvanetto N, Perissinotto A, Pedroni A, Torre V. Fodis: Software for Protein Unfolding Analysis. *Biophys J*. 2018 Mar 27;114(6):1264-1266. doi: 10.1016/j.bpj.2018.02.004.

N Galvanetto, N Alieva, S Maity, Zhonghie Ye, A Laio & V Torre Unfolding and identification of membrane proteins from native cell membranes (2020 Under Revision *Nature Nanotechnology*)

Vincent Torre with his younger collaborators have also developed **novel 3D nano-structure for culturing neurons and glioma**. These are the MSs which have come out

Improved neuron culture using scaffolds made of three-dimensional PDMS micro-lattices. Li S, Severino FPU, Ban J, Wang L, Pinato G, Torre V, Chen Y. *Biomed Mater*. 2018 Feb 28;13(3):034105. doi: 10.1088/1748-605X/aaa777.

Field Code Changed

Xiao M, Li X, Song Q, Zhang Q, Lazzarino M, Cheng G, Ulloa Severino FP, **Torre V**. A Fully 3D Interconnected Graphene-Carbon Nanotube Web Allows the Study of Glioma Infiltration in Bioengineered 3D Cortex-Like Networks. *Adv Mater*. 2018 Dec;30(52):e1806132.

Textured nanofibrils drive microglial phenotype.

Song Q, Pifferi S, Shi L, Chen C, Proietti Zaccaria R, Menini A, Cao J, Zhang Q, **Torre V**. *Biomaterials*. 2020 Oct;257:120177. doi: 10.1016/j.biomaterials.2020.120177. Epub 2020 Jul 3. PMID: 32682149

Field Code Changed

3D Free-Standing Ordered Graphene Network Geometrically Regulates Neuronal Growth and Network Formation.

Xiao M, Ulloa Severino FP, Iseppon F, Cheng G, **Torre V**, Tang M. *Nano Lett*. 2020 Sep 18. doi: 10.1021/acs.nanolett.0c02107. Online ahead of print. PMID: 32915578

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Vincent Torre with his younger collaborators have started a **new project on the biophysical properties at the basis of glioma malignancy**. In this approach different kind of imaging methods are applied. These are two recently published papers:

Mechanisms of malignancy in glioblastoma cells are linked to mitochondrial Ca²⁺ uniporter upregulation and higher intracellular Ca²⁺ levels.

Li X, Spelat R, Bartolini A, Cesselli D, Ius T, Skrap M, Caponnetto F, Manini I, Yang Y, **Torre V**. *J Cell Sci*. 2020 Mar 24;133(6):jcs237503. doi: 10.1242/jcs.237503. PMID: 32051286

Field Code Changed

Rac1 Promotes Cell Motility by Controlling Cell Mechanics in Human Glioblastoma.

Xu J, Galvanetto N, Nie J, Yang Y, **Torre V**. *Cancers (Basel)*. 2020 Jun 23;12(6):1667. doi: 10.3390/cancers12061667. PMID: 32585958

Field Code Changed

Vincent Torre is also leading an interdisciplinary group for the development of AI approaches to Neurosurgery involving hospitals both in Italy and China

There are also two additional MSs on phototransduction, based on the use of Optical Tweezers and new fluorescent dyes which are expected **to have a major impact on current views of how photoreceptors work:**

Calcium flares and compartmentalization in rod photoreceptors.

Li Y, Falleroni F, Mortal S, Bocchero U, Cojoc D, **Torre V**. *Proc Natl Acad Sci U S A*. 2020 Sep 1;117(35):21701-21710. doi: 10.1073/pnas.2004909117. Epub 2020 Aug 19. PMID: 32817426 **and recommended to Faculty Opinions by the PNAS Editor Gordon Fain as of special interest in its field**

Field Code Changed

Mechanosensitivity is an essential component of phototransduction in vertebrate rods.

Bocchero U, Falleroni F, Mortal S, Li Y, Cojoc D, Lamb T, **Torre V**. *PLoS Biol*. 2020 Jul 15;18(7):e3000750. doi: 10.1371/journal.pbio.3000750. eCollection 2020 Jul. PMID: 32667916.

Field Code Changed

Additional peer reviewed publications from the last 7 years

Pozzi D, Ban J, Iseppon F, Torre V. An improved method for growing neurons: comparison with standard protocols. *J Neurosci Methods*. 2017 Jan 27. pii: S0165-0270(17)30019-5. doi:10.1016/j.jneumeth.2017.01.013. [Epub ahead of print]

Ulloa Severino FP, Ban J, Song Q, Tang M, Bianconi G, Cheng G, Torre V. The role of dimensionality in neuronal network dynamics. *Sci Rep*. 2016 Jul 11;6:29640. doi: 10.1038/srep29640. Free PMC Article

Tang Y, Liu L, Li J, Yu L, Ulloa Severino FP, Wang L, Shi J, Tu X, Torre V and Chen Y. Effective motor neuron differentiation of hiPSCs on a patch made of crosslinked monolayer gelatin nanofibers. *J Mater. Chem. B*, 2016, March 29, 4, 3305-3312 doi: 10.1039/C6TB00351F

Sayyad WA, Fabris P, Torre V. The Role of Rac1 in the Growth Cone Dynamics and Force Generation of DRG Neurons. *PLoS One*. 2016 Jan 14;11(1):e0146842. doi: 10.1371/journal.pone.0146842. Free PMC Article

Sayyad WA, Amin L, Fabris P, Ercolini E, Torre V. The role of myosin-II in force generation of DRG filopodia and lamellipodia. *Sci Rep*. 2015 Jan 19;5:7842. doi: 10.1038/srep07842. Free PMC Article

Marchesi A, Arcangeletti M, Mazzolini M, Torre V. Proton transfer unlocks inactivation in cyclic nucleotide-gated A1 channels. *J Physiol*. 2015 Feb 15;593(4):857-70. doi: 10.1113/jphysiol.2014.284216. Free PMC Article

De Palo G, Facchetti G, Mazzolini M, Menini A, Torre V, Altafini C. Common dynamical features of sensory adaptation in photoreceptors and olfactory sensory neurons. *Sci Rep*. 2013, vol. 3:1251, ISSN: 2045-2322, doi: 10.1038/srep01251

Arcangeletti M, Marchesi A, Mazzolini M, Torre V. Multiple mechanisms underlying rectification in retinal cyclic nucleotide-gated (CNGA1) channels. *Physiol Rep*. 2013 Nov;1(6):e00148. doi: 10.1002/phy2.148.

Moshtagh-Khorasani M, Miller EW, Torre V. The spontaneous electrical activity of neurons in leech ganglia. *Physiol Rep*. 2013 Oct;1(5):e00089. doi: 10.1002/phy2.89.

Juárez-Hernández LJ, Bisson G, Torre V. The use of dendrograms to describe the electrical activity of motoneurons underlying behaviors in leeches. *Front Integr Neurosci*. 2013 Sep 27;7:69. doi: 10.3389/fnint.2013.00069.

Lien TL, Ban J, Tormen M, Migliorini E, Grenzi G, Pozzato A, Torre V. Can hippocampal neurites and growth cones climb over obstacles? *PLoS One*. 2013 Sep 6;8(9):e73966. doi: 10.1371/journal.pone.0073966.

Amin L, Ercolini E, Ban J, Torre V. Comparison of the force exerted by hippocampal and DRG growth cones. *PLoS One*. 2013 Aug 21;8(8):e73025. doi: 10.1371/journal.pone.0073025.

Migliorini E, Ban J, Greci G, Andolfi L, Pozzato A, Tormen M, Torre V, Lazzarino M. Nanomechanics controls neuronal precursors adhesion and differentiation. *Biotechnol Bioeng*. 2013 Aug;110(8):2301-10. doi: 10.1002/bit.24880.

Iacono G, Altafini C, Torre V. Early phase of plasticity-related gene regulation and SRF dependent transcription in the hippocampus. *PLoS One*. 2013 Jul 23; 8(7):e68078. doi: 10.1371/journal.pone.0068078.

Marchesi A, Mazzolini M, Torre V. A ring of threonines in the inner vestibule of the pore of CNGA1 channels constitutes a binding site for permeating ions. *J Physiol*. 2012, vol. 590(Pt20), p. 5075-5090, ISSN: 0928-4257, doi: 10.1113/jphysiol.2012.238352

Amin L, Ercolini E, Shahapure R, Migliorini E, Torre V. The role of membrane stiffness and actin turnover on the force exerted by DRG lamellipodia. *Biophys J*. 2012, June 6, vol. 102(11), p. 2451-2460, ISSN: 0006-3495, doi 10.1016/j.bpj.2012.04.036

Bisson G, Bianconi G, Torre V. The dynamics of group formation among leeches. *Front Physiol*. 2012, May 17, 3: 133. ISSN: 1664-042X, doi: 10.3389/fphys.2012.00133

PREVIOUS FUNDING FROM INTERNATIONAL AGENCIES

Vincent Torre has been the coordinator of several European projects in Nanoscience and in Future Emergent Technologies. **In the last 30 years he has obtained grants for a total value of 25.000.000 Euros. In the 7thWP his success rate for funding on basic research was close to 100%.** These are the projects that he has led in the last ten years:

- 1 – Italian Ministry of Research PRIN 2004 (30/11/2004 – 30/11/2006)
- 2 – EU Contr. NEST 012788 (NEURO) (01/05/2005 - 30/04/2009)
- 3 – Italian Ministry of Research PRIN 2006 (09/02/2007 – 09/02/2009)
- 4 – EU Contr. 214566 (NANOSCALE) (01/07/2008 – 30/06/2011)
- 5 – EU Contr. 201970 (BID) (01/03/2008 – 31/08/2011)
- 6 – EU Contr. 270483 (FOCUS) (01/01/2011 – 31/03/2014)
- 7 – EU Contr.247621 (LAEL) (01/01/2011 – 31/12/2014)
- 8 – EU Contr. 604263 (NEUROSCAFFOLDS) (01/07/2013-30/06/2016) All these projects were successful and had excellent reports.

These are the Projects where he was a consortium partner:

- 9 – EU Contr. RICN-01936 BINASP (27/09/2005-14/03/2009)
- 10 – Italian Ministry of Research FIRB 2005 (01/11/2005-01/05/2009)
- 11 – EU Contr. MRT-CT-“004-005439 VISIONTRAIN (01/05/2005 – 30/04/2009)
- 12 – EU Contr. ICT-2001-284553 SI-CODE (01/03/2012-31/08/2015)
- 13 – EU Contr. 042864 (GAPP) (01/02/2007 – 31/01/2009)
- 14 – EU Contr. 282539 (CommHere) (01/10/2011 - 30/09/2014)
- 15 – EU Contr. 341464 (NERRI) (01/03/2013 – 31/05/2016)
- 16 – Regional contract from FVG (Glioblastoma 01/03/2017 – 31/12/2020)
- 17 – Regional contract from FVG (ARES 01/03/2018-31/06/2021)

Leadership in industrial innovation

During his scientific career Vincent Torre has collaborated with the major electronic European industries (ELSAG, FIAT, MATRA, GE,...). He has contributed to the foundation of two spin-offs: GLANCE VISION TECHNOLOGY and Promoscience active in robotics and software engineering. As coordinator of the FOCUS project, Vincent Torre filed for a patent for a novel use of optical fibers. As coordinator of the Neuroscaffolds project, Vincent Torre is developing a business plan in regenerative medicine in Europe and China. He is establishing a joint SISSA-ISM lab in Suzhou (China) with the aim to develop proficient synergisms between basic research, translational research and interdisciplinary converging technologies. With this action he intends to foster internationalization of macro-areas of cultural exchange between China and EU countries and to establish links and common actions. In fact, high-tech companies in Europe, with which Vincent Torre has contacts thanks to collaborations within EU projects, are interested in the Chinese market and are willing to join the initiative.