

# Timothée Masquelier, PhD

## Researcher in Computational Neuroscience

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### Keywords

Computational neuroscience, neuromorphic engineering, spiking neural networks, vision, learning, plasticity.

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### Experience

#### Academia

- Researcher in Computational Neuroscience (CR1 CNRS)** 09/2015 – present  
**Centre de Recherche Cerveau et Cognition, Toulouse, France**  
*Supervisor: Dr. Simon J. Thorpe (DR CNRS)*  
Spike-based computing and learning.
- Researcher in Computational Neuroscience (CR2 CNRS)** 01/2013 – 08/2015  
**Institut de la Vision, Paris, France**  
*Supervisor: Dr. Angelo Arleo (DR CNRS)*  
Spike-based computing and learning.
- Postdoc in Computational Neuroscience** 01/2011 – 12/2012  
**Computational Neuroscience Group, Universitat Pompeu Fabra, Barcelona, Spain**  
*Supervisor: Pr. Gustavo Deco, ICREA and UPF*  
Neurodynamics of spontaneous activity in cortical cultures. Through numerical simulations, we investigate why and how synchronous events spontaneously occur, with a particular emphasis on the intervals between such events. Funding: *European Project Coronet*
- Postdoc in Computational Neuroscience** 04/2008 – 12/2010  
**Computational Neuroscience Group, Universitat Pompeu Fabra, Barcelona, Spain**  
*Supervisor: Pr. Gustavo Deco, ICREA and UPF*  
Studies of the consequences of Spike Timing Dependent Plasticity (STDP) in neuronal networks. Implications for neural coding and information processing. Applications in the visual system for object and motion recognition. Funding: *European Project Decision in Motion* and *Fyssen Foundation*
- Ph.D. Student in Computational Neuroscience** 11/2004 – 02/2008  
**Brain and Cognition Research Center (CERCO) - CNRS, Toulouse, France**  
*Supervisor: Dr. Simon J. Thorpe, DR CNRS*  
Modeling of the ventral stream of the visual system, involved in object recognition, and studies of the mechanisms which explain how the selectivity increases along the hierarchy, how shift and scale invariance is gained, and how appropriate connectivity is learned. In particular the hypotheses of temporal coding and Spike Timing Dependent Plasticity (STDP) are explored. Funding: *ANRT* and *SpikeNet Technology Inc.* (CIFRE Convention)
- Research Assistant in Human Factors Engineering** 01/2000 – 06/2001  
**MIT Human-Machine Systems Laboratory, Cambridge, MA, USA**  
*Supervisor: Pr. Thomas B. Sheridan, MIT*  
Design and evaluation of a GPS-aided communication device for railroad workers. Experimental measures of mental workload and human errors. Funding: *MIT Aero Astro Department Fellowship* then *Human-Machine Systems Lab.*

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## Experience (continued)

### Industry

- Revenue Management Expert** 05/2004 – 10/2004  
**Avianca, Bogotá, Colombia**  
*Supervisor: Gustavo Cadavid*  
Audited and validated RM processes, defined KPI. Calibrated PROS Revenue Management System. Deep study of forecast module, deviation analysis and recommendations.
- R&D Engineer in Operations Research** 09/2001 – 02/2004  
**Mereo, Paris, France**  
*Supervisor: Abraham Toledano*  
Algorithmic research and implementation. Validated and implemented a probabilistic optimization model for Revenue Management. Designed and developed an innovative algorithm for optimal allocation of advertising.
- Research Internship** 03/1999 – 07/1999  
**SNECMA, Villaroche, France**  
*Supervisor: Olivier Sgarzi, PhD*  
Computational Fluid Dynamics, studied a wall law model, unsteady 3D computations.

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## Education

- Université Paul Sabatier Toulouse III, Toulouse, France** 11/2004 – 02/2008  
**Ph.D. in Computational Neuroscience**  
Ph.D. Thesis: *Learning mechanisms to account for the speed, selectivity and invariance of responses in the visual cortex*, defended on February 15<sup>th</sup> 2008. Committee: Gustavo DECO (reviewer), Olivier FAUGERAS, Yves FRÉGNAC (reviewer), Martin GIURFA, Pascal MAMASSIAN, Simon THORPE (supervisor).
- Massachusetts Institute of Technology, Cambridge, MA, USA** 1999 – 2001  
**M.Sc. in Aeronautics and Astronautics**  
Master Thesis: *Design and evaluation of a GPS-aided communication device for railroad workers*. Courses included T Poggio and W Richards' courses. *Graduation*: June 2001.
- Ecole Centrale Paris, Chatenay-Malabry, France** 1996 – 1999  
**Ingénieur ECP**  
General Engineering. *Graduation*: June 1999.
- Lycée Saint Louis, Paris, France** 1994 – 1996  
**Classes Préparatoires aux Grandes Ecoles**  
Option M<sup>1</sup> (theoretical maths)
- Lycée François Truffaut, Beauvais, France** 1994  
**Baccalauréat C (major: maths and physics)**  
With honors (*mention Très Bien*)

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## Selected Publications

### Peer-reviewed journals

- Tavanaei A, Masquelier T, and Maida A. Representation learning using event-based STDP. *Neural Networks*, in press.
- Mozafari M, Kheradpisheh SR, Masquelier T, Nowzari-Dalini A, and Ganjtabesh M. First-spike based visual categorization using reward-modulated STDP. *IEEE TNNLS*, in press.

## Selected Publications (continued)

- Huth J, Masquelier T, and Arleo A. Convis: A Toolbox to Fit and Simulate Filter-Based Models of Early Visual Processing. *Frontiers in Neuroinformatics*, 12:1–16, 2018.
- Kheradpisheh SR, Ganjtabesh M, Thorpe SJ, and Masquelier T. STDP-based spiking deep convolutional neural networks for object recognition. *Neural Networks*, 99, 2018.
- Ashtiani M, Kheradpisheh SR, Masquelier T, and Ganjtabesh M. Object categorization in finer levels relies more on higher spatial frequencies and takes longer. *Frontiers in Psychology*, 8(1261), 2017.
- Masquelier T. STDP allows close-to-optimal spatiotemporal spike pattern detection by single coincidence detector neurons. *Neuroscience (special issue: Sensory Sequence Processing in the Brain)*, 2017.
- Deneux T, Masquelier T, Bermudez MA, Masson GS, Deco G, and Vanzetta I. Visual stimulation quenches global alpha range activity in awake primate V4: a case study. *Neurophotonics*, 4(3), 2017.
- Kheradpisheh SR, Ghodrati M, Ganjtabesh M, and Masquelier T. Humans and deep networks largely agree on which kinds of variation make object recognition harder. *Frontiers in Computational Neuroscience*, 10(92), 2016.
- Kheradpisheh SR, Ghodrati M, Ganjtabesh M, and Masquelier T. Deep networks can resemble human feed-forward vision in invariant object recognition. *Scientific Reports*, 6(32672), 2016.
- Portelli G, Barrett JM, Hilgen G, Masquelier T, Maccione A, Di Marco S, Berdondini L, Kornprobst P, and Sernagor E. Rank order coding: a retinal information decoding strategy revealed by large-scale multielectrode array retinal recordings. *eNeuro*, 3(3), 2016.
- Kheradpisheh SR, Ganjtabesh M, and Masquelier T. Bio-inspired unsupervised learning of visual features leads to robust invariant object recognition. *Neurocomputing*, 205, 2016.
- Masquelier T, Portelli G, and Kornprobst P. Microsaccades enable efficient synchrony-based coding in the retina: a simulation study. *Scientific Reports*, 6(24086), 2016.
- Masquelier T. Oscillations can reconcile slowly changing stimuli with short neuronal integration and STDP timescales. *Network: Computation in Neural Systems (special issue: Computations in Oscillating Neuronal Networks)*, 25(1-2), 2014.
- Masquelier T and Deco G. Network bursting dynamics in excitatory cortical neuron cultures results from the combination of different adaptive mechanisms. *PLoS ONE*, 8(10), 2013.
- Masquelier T. Neural variability, or lack thereof. *Frontiers in Computational Neuroscience*, 7(7), 2013.
- Serrano-Gotarredona T, Masquelier T, Prodromakis T, Indiveri G, and Linares-Barranco B. STDP and STDP variations with memristors for spiking neuromorphic learning systems. *Frontiers in Neuroscience*, 7(2), 2013.
- Masquelier T. Relative spike time coding and STDP-based orientation selectivity in the early visual system in natural continuous and saccadic vision: a computational model. *Journal of Computational Neuroscience*, 32(3), 2012.
- Gilson M\*, Masquelier T\*, and Hugues E. STDP allows fast rate-modulated coding with Poisson-like spike trains. *PLoS Computational Biology*, 7(10), 2011, \* = equal contribution.
- Masquelier T, Albantakis L, and Deco G. The timing of vision - how neural processing links to different temporal dynamics. *Frontiers in Psychology*, 2(151), 2011.
- Zamarreno-Ramos C, Camunas-Mesa LA, Perez-Carrasco JA, Masquelier T, Serrano-Gotarredona T, and Linares-Barranco B. On Spike-Timing-Dependent-Plasticity, memristive devices, and building a self-learning visual cortex. *Frontiers in Neuroscience*, 5(26), 2011.
- Deco G, Buehlmann A, Masquelier T, and Hugues E. The role of rhythmic neural synchronization in rest and task conditions. *Frontiers in Human Neuroscience*, 5(4), 2011.

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## Selected Publications (continued)

Masquelier T, Hugues E, Deco G, and Thorpe SJ. Oscillations, Phase-of-Firing Coding and Spike Timing-Dependent Plasticity: an efficient learning scheme. *The Journal of Neuroscience*, 29(43), 2009. See also the highlight: Hoyos-Flight M. Neural coding: Oscillations help to decode spike patterns. *Nature Reviews Neuroscience*, 10(12), 2009.

Masquelier T, Guyonneau R, and Thorpe SJ. Competitive STDP-based spike pattern learning. *Neural Computation*, 21(5), 2009.

Masquelier T, Guyonneau R, and Thorpe SJ. Spike Timing Dependent Plasticity finds the start of repeating patterns in continuous spike trains. *PLoS ONE*, 3(1), 2008.

Masquelier T and Thorpe SJ. Unsupervised learning of visual features through Spike Timing Dependent Plasticity. *PLoS Computational Biology*, 3(2), 2007.

### Peer-reviewed proceedings

Yousefzadeh A, Masquelier T, Serrano-Gotarredona T, and Linares-Barranco B. Hardware implementation of convolutional STDP for on-line visual feature learning. *Proc. of IEEE ISCAS*, 2017.

Tavanaei A, Masquelier T, and Maida A. Acquisition of visual features through probabilistic spike-timing-dependent plasticity. *Proc. of IEEE IJCNN*, 2016.

Masquelier T and Thorpe SJ. Learning to recognize objects using waves of spikes and Spike Timing-Dependent Plasticity. *Proc. of IEEE IJCNN*, 2010.

Masquelier T and Thorpe SJ. Face feature learning with Spike Timing Dependent Plasticity. *Proc. of the 1st French conference on computational neuroscience (NeuroComp)*, 2006.

### Reports / book chapters

Masquelier T. Spike-based computing and learning in brains, machines, and visual systems in particular. *HDR manuscript, Université Paul Sabatier Toulouse 3, France*, 2017.

Serrano-Gotarredona T, Masquelier T, and Linares-Barranco B. Spike-timing-dependent plasticity with memristors. *Chapter in Memristor Networks (Eds. A. Adamatzky and L. O. Chua)*. Springer-UK., 2014.

Masquelier T and Deco G. Learning and coding in neural networks. *Chapter in Principles of neural coding*. Ed. R Quiñero and S Panzeri. CRC Press, 2013.

Masquelier T. Learning mechanisms to account for the speed, selectivity and invariance of responses in the visual cortex. *PhD thesis, Université Paul Sabatier Toulouse 3, France*, 2008.

Masquelier T, Serre T, Thorpe SJ, and Poggio T. Learning complex cell invariance from natural videos: a plausibility proof. *CBCL Paper #269/MIT-CSAIL-TR #2007-060, Massachusetts Institute of Technology, Cambridge, MA*, 2007.

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## Diverse

**Valorization:** Two patents submitted to the *European Patent Office* in 11/2016 and 02/2017 (application # EP16306525 and EP17305186; co-inventors: S Thorpe, J Martin, A Yousefzadeh, B Linares). In 03/2017, the Californian start-up BrainChip acquired an exclusive license.

**HDR:** *Habilitation à Diriger des Recherches* (2017).

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## Diverse (continued)

**Ph.D. students:** Saeed Reza Kheradpisheh (2012 – 2017), Amirreza Yousefzadeh (2014 – 2018), Milad Mozafari (2014 – ...), Jacob Huth (2015 – ...), Alexandre Montlibert (2017 – ...).

**Teaching:** Various computational neuroscience modules at Ecole Centrale Paris, Supaero, Univ. Paris 6, Univ. Tehran.

**Invited talks:** *GDR BioComp*, Bordeaux, France, 06/2018. *RIKEN*, Tokyo, Japan, 04/2018. *Vision Institute*, Paris, France, 04/2018. *IRIT*, Toulouse, France, 04/2018. *Univ. of Granada*, Spain, 02/2018. *I3S*, Sophia Antipolis, France, 10/2017. *Instituto de Microelectrónica de Sevilla*, Spain, 06/2017. *NanoInnov*, Palaiseau, France, 06/2017. *IPM*, Tehran, Iran 04/2017. *M4 Conference*, Albi, France 09/2015. *MemoCIS*, CappelCaccia, Sardegna, Italy, 05/2015. *CERCO*, Toulouse, France, 02/2015. *Laboratoire J.A. Dieudonné*, Nice, France, 10/2014. *Oxford Centre for Human Brain Activity*, UK, 06/2014. *INRIA Sophia Antipolis*, France, 11/2013. *Ecole Centrale Paris*, France, 10/2013. *CEA*, Saclay, France, 09/2013. *LIP6*, Paris, France, 03/2013. *Institut de Neurosciences de la Timone*, Marseille, France, 02/2013. *Brain Corporation*, San Diego, CA, USA, 05/2012. *Ruhr-University Bochum*, Germany, 03/2012. *Universitat Autònoma de Barcelona*, Spain, 05/2011. *Instituto Gulbenkian de Ciência*, Lisbon, Portugal, 05/2010. *Instituto de Microelectrónica de Sevilla*, Spain, 04/2010. *INRIA Sophia Antipolis*, France, 02/2010.

**Referee for:** *Advances in Artif. Neur. Sys., Biol. Cybern., Comp. Vision and Image Understanding, Cosyne, Front. Comp. Neurosc., Front. Neuroinform., Front. Neuroinformatics, Front. Neurosci., Front. Perception Sci., IEEE Access, IEEE Trans. Cog. and Dev. Syst., IEEE Trans. Emerging Topics in Comput. Intell., IEEE Trans. Neural Netw., IEEE Trans. Neural Netw. Learn. Syst., IEEE Trans. Patt. Anal. and Mach. Intell., Int. J. Neural Syst., ISCAS, J. Comput. Neurosci., J. Neural Eng., J. Neurosci., J. Physiol.-Paris, J. R. Soc. Interface, Neural Comp., Neural Netw., Neurocomputing, Neuroscience, Nonlinearity, Phil. Trans. R. Soc. B, PLoS Comp. Biol., PLoS ONE, Research Foundation - Flanders (FWO), Sc. Reports.*

**Honors / awards:** Gundishapur PHC grant 2018-2019, together with M. Ganjtabesh (Univ. Tehran). Two-year postdoctoral fellowship from the *Fyssen Foundation* from 01/2009 to 12/2010. *Robert Guenassia Award* in September 2000. Recipient of a one year *MIT Department Fellowship* from the *Department of Aeronautics and Astronautics* of MIT in 1999.

### Bibliometry:

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