

# Lubomír Košťál

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## Affiliation and positions

<b>2014 – 2013</b>	Researcher (team leader): Department of Computational Neuroscience, Institute of Physiology Associated scientist at the Department of Computational Neuroscience, Institute of Physiology
<b>2007–2012</b>	Postdoc
<b>2004–2007</b>	PhD student
<b>2004</b>	Assistant at the Department of Neurophysiology of Memory and Computational Neuroscience, Institute of Physiology

## Research interests

- Applications of information theory and estimation theory to computational neuroscience
- Metabolic cost of neuronal information and coding efficiency
- Measures of neuronal spiking variability
- Signal processing in moth olfactory system









## Education




























<b>2007</b>	PhD, Institute of Physiology and Charles University Prague (supervisor: Prof. Petr Lansky)
<b>2003</b>	MSc (physics), Faculty of Mathematics and Physics, Charles University Prague




## Visiting and temporal positions

Long-term stay in the lab of Prof. Jean-Pierre Rospars, INRA, Versailles, France (intermittently 2005–2009), team member in the projects: Barrande and ECO-NET 12644PF




## Publications in journals

38. Tomar, R.  & Kostal, L. (2021) Variability and Randomness of the Instantaneous Firing Rate. *Front. Comput. Neurosci.*, **15**, 620410.
37. Barta, T.  & Kostal, L. (2021) Regular spiking in high conductance states: The essential role of inhibition. *Phys. Rev. E*, **103**, 022408.
36. Rajdl, K. , Lansky, P. & Kostal, L. (2020) Fano factor: a potentially useful information. *Front. Comput. Neurosci.*, **14**, 569049.
35. Ascione, G., D'Onofrio, G., Kostal, L. & Pirozzi, E.  (2020) An optimal Gauss-Markov approximation for a process with stochastic drift and applications. *Stoch. Proc. Appl.*, **130**, 6481–6514.
34. Barta, T.  & Kostal, L. (2019) The effect of inhibition on rate code efficiency indicators. *PLoS Comput. Biol.*, **15**, e1007545.
33. Kostal, L.  & Kobayashi, R. (2019) Critical size of neural population for reliable information transmission. *Phys. Rev. E (Rapid Commun.)*, **100**, 050401(R).
32. Levakova, M. , Kostal, L., Monsempès, C., Lucas, P. & Kobayashi, R. (2019) Adaptive integrate-and-fire model reproduces the dynamics of olfactory receptor neuron responses in moth. *J. R. Soc. Interface*, **16**, 20190246.
31. Levakova, M. , Kostal, L., Monsempès, C., Jacob, V. & Lucas, P. (2018) Moth olfactory receptor neurons adjust their encoding efficiency to temporal statistics of pheromone fluctuations. *PLoS Comput. Biol.*, **14**, e1006586.

30. Kostal, L. , Lansky, P. & Stiber, M. (2018) Statistics of inverse interspike intervals: the instantaneous firing rate revisited. *Chaos*, **28**, 106305.
29. Kostal, L.  & D'Onofrio, G. (2018) Coordinate invariance as a fundamental constraint on the form of stimulus-specific information measures. *Biol. Cybern.*, **112**, 13–23.
28. Rajdl, K. , Lansky, P. & Kostal, L. (2017) Entropy factor for randomness quantification in neuronal data. *Neural Netw.*, **95**, 57–65.
27. Levakova, M. , Tamborrino, M., Kostal, L. & Lansky, P. (2017) Accuracy of rate coding: When shorter time window and higher spontaneous activity help. *Phys. Rev. E*, **95**, 022310.
26. Levakova, M. , Tamborrino, M., Kostal, L. & Lansky, P. (2016) Presynaptic spontaneous activity enhances the accuracy of latency coding. *Neural Comput.*, **28**, 2162–2180.
25. Kostal, L.  (2016) Stimulus reference frame and neural coding precision. *J. Math. Psychol.*, **71**, 22–27.
24. Kostal, L.  & Lansky, P. (2016) Coding accuracy on the psychophysical scale. *Sci. Rep.*, **6**, 23810.
23. Kostal, L.  & Shinomoto, S. (2016) Efficient information transfer by Poisson neurons. *Math. Biosci. Eng.*, **13**, 509–520.
22. Kostal, L. , Kobayashi, R. (2015) Optimal decoding and information transmission in Hodgkin-Huxley neurons under metabolic cost constraints. *BioSystems*, **136**, 3–10.
21. Kostal, L. , Lansky, P. & Pilarski, S. (2015) Performance breakdown in optimal stimulus decoding. *J. Neural Eng.*, **12**, 036012.
20. Kostal, L.  & Lansky, P. (2015) Coding accuracy is not fully determined by the neuronal model. *Neural Comput.*, **27**, 1051–1057.
19. Koyama, S.  & Kostal, L. (2014) The effect of interspike interval statistics on the information gain under the rate coding hypothesis. *Math. Biosci. Eng.*, **11**, 63–80.
18. Kostal, L. , Lansky, P. & Pokora, O. (2013) Measures of statistical dispersion based on Shannon and Fisher information concepts. *Inform. Sciences*, **235**, 214–223.
17. Kostal, L. , Lansky, P. (2013) Information capacity and its approximations under metabolic cost in a simple homogeneous population of neurons. *BioSystems*, **112**, 265–275.
16. Kostal, L. , Lansky, P. & McDonnell, M. D. (2013) Metabolic cost of neuronal information in an empirical stimulus-response model. *Biol. Cybern.*, **107**, 355–365.
15. Kostal, L. & Pokora, O.  (2012) Nonparametric estimation of information-based measures of statistical dispersion. *Entropy*, **14**, 1221–1233.
14. Kostal, L.  (2012) Approximate information capacity of the perfect integrate-and-fire neuron using the temporal code. *Brain Res.*, **1434**, 136–141.
13. Kostal, L. , Lansky, P. & Pokora, O. (2011) Variability measures of positive random variables. *PLoS ONE*, **6**, e21998.
12. Kostal, L.  (2010) Information capacity in the weak-signal approximation. *Phys. Rev. E*, **82**, 026115.
11. Kostal, L.  & Marsalek, P. (2010) Neuronal jitter: can we measure the spike timing dispersion differently? *Chin. J. Physiol.*, **53**, 454–464.
10. Kostal, L.  & Lansky, P. (2010) Information transfer with small-amplitude signals. *Phys. Rev. E (Rapid Commun.)*, **81**, 050901(R).
9. Kostal, L.  & Lansky, P. (2008) Randomness of spontaneous activity and information transfer in neurons. *Physiol. Res.*, **57**, S133–S138.
8. Kostal, L., Lansky, P. & Rospars, J.-P.  (2008) Efficient olfactory coding in the pheromone receptor neuron of a moth. *PLoS Comput. Biol.*, **4**, e1000053.
7. Kostal, L. , Lansky, P. & Rospars, J.-P. (2007) Encoding of pheromone intensity by dynamic activation of pheromone receptors. *Neurocomputing*, **70**, 1759–1763.
6. Kostal, L. , Lansky, P. & Rospars, J.-P. (2007) Review: Neuronal coding and spiking randomness. *Eur. J. Neurosci.*, **26**, 2693–2701.
5. Kostal, L.  & Lansky, P. (2007) Variability and randomness in stationary neuronal activity. *BioSystems*, **89**, 44–49.
4. Kostal, L. , Lansky, P. & Zucca, C. (2007) Randomness and variability of the neuronal activity described by the Ornstein-Uhlenbeck model. *Netw. Comput. Neural Syst.*, **18**, 63–75.

3. Kostal, L.  & Lansky, P. (2006) Classification of stationary neuronal activity according to its information rate. *Netw. Comput. Neural Syst.*, **17**, 193–210.
2. Kostal, L.  & Lansky, P. (2006) Similarity of interspike interval distributions and information gain in a stationary neuronal firing. *Biol. Cybern.*, **94**, 157–167.
1. Duchamp-Viret, P., Kostal, L., Chaput, M., Lansky, P. & Rospars, J.-P.  (2005) Patterns of spontaneous activity in single rat olfactory receptor neurons are different in normally breathing and tracheotomized animals. *J. Neurobiol.*, **65**, 97–114.

## Publications in books and peer-reviewed proceedings, editorials

5. Christodoulou, C., Kostal, L. & Sacerdote, L. (2020) Editorial, Special issue of BioSystems on Selected papers presented at the Thirteenth International Workshop on Neural Coding, Torino, Italy, 2018. *BioSystems*, **187**, 104049.
4. Kostal, L., Sacerdote, L. & Tamborrino, M. (2019) Special Issue: Neural Coding 2018. *Math. Biosci. Eng.*, **16**, 8214–8216.
3. Christodoulou, C. , Kostal, L. & Büschges, A. (2017) Editorial, Special issue of BioSystems on Selected papers presented at the Twelveth International Workshop on Neural Coding, Cologne, Germany, 2016. *BioSystems*, **161**, 1–2.
2. Kostal, L. , Lansky, P. & Pokora, O. (2012) How regular is neuronal activity? In *ESANN 2012: The 20th European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning*. ESANN, Bruges, Belgium, pp. 495–500.
1. Kostal, L. , Lansky, P. & Rospars, J.-P. (2008) The Adaptation of the Moth Pheromone Receptor Neuron to its Natural Stimulus. In Ricciardi, L., Buonocore, A. & Pirozzi, E. (eds.), *AIP Conference Proceedings, Collective Dynamics: Topics on Competition and Cooperation in the Biosciences: A Selection of Papers in the Proceedings of the BIOCAMP2007 International Conference*. AIP, Melville, New York, pp. 147–161.

## Invited talks

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|-------------|---|
| <b>2019</b> | Lecture at the National Institute of Informatics, Tokyo, Japan  |
| <b>2017</b> | Lecture at the University of Naples Federico II, Naples, Italy  |
| <b>2016</b> | Lecture at the Institute for Stochastics, Johannes Kepler University, Linz, Austria                                   |
| <b>2016</b> | <i>Workshop on multitrack event-trains in neural, social, seismological, and financial data</i> ,<br>Karuzaiwa, Japan |
| <b>2014</b> | <i>Biological and Bio-Inspired Information Theory</i> , Banff International Research Station, Canada                  |
| <b>2014</b> | <i>Mathematical Modeling and Statistical Analysis in Neuroscience</i> ,<br>University of Copenhagen, Denmark          |
| <b>2014</b> | Lecture at RIKEN, Tokyo, Japan  |
| <b>2014</b> | Lecture at the National Institute of Informatics, Tokyo, Japan  |
| <b>2013</b> | <i>Matematické modely a aplikace</i> , Podlesí, Czech Republic  |
| <b>2013</b> | <i>CNS 2013 Workshop on Methods of Information Theory in Computational Neuroscience</i> ,<br>Paris, France            |
| <b>2013</b> | <i>Workshop on the Applications of Information Theory</i> , Ritsumeikan University, Japan                             |
| <b>2013</b> | Lecture at the Kyoto University, Japan  |
| <b>2009</b> | <i>Workshop on Sensory Neuroinformatics</i> , Pilsen, Czech Republic  |

## Funding

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| <b>2020–2022</b> | <i>Optimality of neuronal communication: an information-theoretic perspective</i> ,<br>The Czech Science Foundation (GACR), principal investigator         |
| <b>2020–2022</b> | <i>Stochastic Models and Methods for the Study of Olfaction</i> ,<br>International (Lead Agency) project between Austrian FWF and GACR, team member        |
| <b>2017–2018</b> | <i>Neural coding in the moth olfactory sensory system</i> ,<br>Project MOBILITY (The Czech Republic and France), principal investigator                    |
| <b>2017–2019</b> | <i>Neural coding precision and its adaptation to the stimulus statistics</i> ,<br>The Czech Science Foundation (GACR), principal investigator              |
| <b>2017–2018</b> | <i>Perturbed stochastic point processes as a novel tool for neural coding analysis</i> ,<br>Project MOBILITY (The Czech Republic and Austria), team member |

- 2015–2017** *Efficiency of information transfer and the role of energetic constraints in neuronal systems*, The Czech Science Foundation (GACR), principal investigator
- 2015–2016** *Statistical inference for perturbed stochastic processes with applications to neuroscience*, Project MOBILITY (The Czech Republic and Austria), team member
- 2012–2013** *Information beyond Shannon*, European Office of Aerospace Research and Development, support for the Information Beyond Shannon 2013 workshop, principal investigator
- 2012–2014** *Information-theoretic analysis of stimulus coding in sensory neurons*, The Czech Science Foundation (GACR), principal investigator
- 2011–2012** *Neural Coding*, Office of Naval Research Global, support for the Neural Coding 2012 workshop, principal investigator
- 2011–2013** *The role of noise in neuronal information processing*, The Czech Science Foundation (GACR), team member
- 2007–2009** *Signal processing in olfactory flux detector*, Grant Agency of the Academy of Sciences of the Czech Republic, principal investigator
- 2005** *Marie-Curie fellowship at INRA*, Versailles (France)
- 2004–2008** *Principles of information processing in neurons and their application*, Project Information Society, Academy of Sciences of the Czech Republic, team member

## Awards

- 2012** *Otto Wichterle Award* from the Academy of Sciences of the Czech Republic

## Pedagogical activities

- Teaching in the post-gradual course “Progress in Neuroscience” (PhD programme Neurosciences, *Doctoral Study Programmes in Biomedicine*) and in the “Opening Course” for PhD students at the Institute of Physiology, CAS
- Supervisor of diploma thesis in the master programme *Mathematical Modelling in Physics and Technology*, Faculty of Mathematics and Physics, Charles University, Prague
- Supervisor in the PhD programme *Biomedical Informatics*, First Faculty of Medicine, Charles University, Prague
- Co-supervisor in the PhD programme *Probability, Statistics and Mathematical Modelling*, Faculty of Science, Masaryk University, Brno
- University of Geneva and Lemanic Neuroscience Doctoral School: member of the PhD thesis committee (external expert)

## Professional service

### ■ Editorial duties

- *Neural Processing Letters*: member of the Editorial Board since 2016
- *BioSystems*: associate editor of the *Neural Coding 2016* and *Neural Coding 2018* special issues
- *Mathematical Biosciences and Engineering*: associate editor of the *Neural Coding 2018* special issue

### ■ External assessor

- *The French National Research Agency (ANR)*: project reviewer
- *The Agency for the Evaluation of Universities and Research Centers (ANVUR)*, Italy: peer reviewer
- *The National Science Centre (NCN)*, Poland: project reviewer
- *The Czech Science Foundation (GAČR)*: member of the evaluation panel *P103 Cybernetics and information processing* (2017–2020)

■ **Reviewer for scientific journals and proceedings**

*Biological Cybernetics; BioSystems; Brain Research; Brazilian Journal of Probability and Statistics; Entropy; Frontiers in Computational Neuroscience; IEEE Journal on Selected Areas in Communications, Mathematical Biosciences and Engineering; IEEE Transactions on Molecular, Biological, and Multi-Scale Communications; IEEE Transactions on NanoBioscience; IEEE Wireless Communications and Networking Conference; Journal of Neural Engineering; Journal of Theoretical Biology; Neural Computation; Neural Networks; Neural Processing Letters; Neurocomputing; Physical Review E; PLoS Computational Biology; PLoS ONE; Scientific Reports*

■ **Organization of workshops and conferences, committee memberships**

- *CNS 2020: Workshop on Methods of Information Theory in Computational Neuroscience* (Online, 21–22, 2020)  
<http://lizier.me/joseph/conferences/202007-CNS2020-ITW/>  
member of the organizing committee
- *The 28th European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning, ESANN 2020* (Bruges, Belgium, April 22–24, 2020)  
<http://www.esann.org/>  
member of the technical program committee
- *Latin American Workshop on Computational Neuroscience* (Sao Joao del-Rei, Brazil, September 18-20, 2019)  
<http://www.lawcn.com.br/>  
member of the program committee
- *CNS 2019: Workshop on Methods of Information Theory in Computational Neuroscience* (Barcelona, Spain, July 16–17, 2019)  
<http://www.biomed.cas.cz/~kostal/CNS2019-ITW>  
chair of the organizing committee
- *5th International Conference on Mathematical NeuroScience, ICNMS 2019* (Copenhagen, Denmark, June 23–16, 2019)  
<http://icmns2018.inria.fr/>  
member of the scientific committee
- *The 27th European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning, ESANN 2019* (Bruges, Belgium, April 24–26, 2019)  
<http://www.esann.org/>  
member of the technical program committee
- *Neural Coding 2018* (Torino, Italy, September 9–14, 2018)  
<http://www.neuralcoding2018.unito.it/>  
member of the scientific committee
- *CNS 2018: Workshop on Methods of Information Theory in Computational Neuroscience* (Seattle, USA, July 17–18, 2018)  
<http://lizier.me/joseph/conferences/201807-CNS2018-ITW/>  
member of the organizing committee

- *International Conference on Mathematical NeuroScience, ICNMS 2018*  
(Antibes, Juan les Pins, France, June 10–13, 2018)  
<http://icmns2018.inria.fr/>  
member of the program committee
- *The 26th European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning, ESANN 2018*  
(Bruges, Belgium, April 25–27, 2018)  
<http://www.esann.org/>  
member of the technical program committee
- *CNS 2017: Workshop on Methods of Information Theory in Computational Neuroscience*  
(Antwerp, Belgium, July 19–20, 2017)  
<http://lizier.me/joseph/conferences/201707-CNS2017-ITW/>  
member of the organizing committee
- *CNS 2016: Workshop on Methods of Information Theory in Computational Neuroscience*  
(Jeju, South Korea, July 6–7, 2016)  
<http://lizier.me/joseph/conferences/201607-CNS2016-ITW/>  
member of the organizing committee
- *CNS 2015: Workshop on Methods of Information Theory in Computational Neuroscience*  
(Prague, July 22–23, 2015)  
<http://www.biomed.cas.cz/~kostal/CNS2015-ITW>  
main organizer (jointly with A. Dimitrov, M. Gastpar, T. Sharpee, S. Schultz)
- *Neural Coding 2014*  
(Versailles, France, October 6–10, 2014)  
[http://colloque.inra.fr/neural\\_coding\\_2014](http://colloque.inra.fr/neural_coding_2014)  
member of the organising committee
- *Information beyond Shannon 2013*  
(Prague, July 3–4, 2013)  
<http://www.biomed.cas.cz/~kostal/IBS2013>  
main organizer
- *Neural Coding 2012*  
(Prague, September 2–7, 2012)  
<http://nc2012.biomed.cas.cz>  
main organizer (jointly with P. Lansky)
- **Popularization of science**
  - Interviews for radio and TV: programmes of Czech Radio Vltava and Leonardo in 2008, 2012; radio Impuls 2012, main news programme of Czech TV in 2012 (coverage of Wichterle prize reception and Neural Coding 2012 workshop); participation in the Brain Awareness Week 2018 (public event)
- **Miscellaneous**
  - Initiated (jointly with Dr. R. Kobayashi) the *Memorandum of Understanding* between the *Institute of Physiology of the Czech Academy of Sciences, Czech Republic*, and the *National Institute of Informatics, Japan*, in the area of research and education in the fields of artificial intelligence and computational neuroscience (signed by the directors in 2016)