



Département Sciences de la vie

CONFÉRENCES JACQUES-MONOD

**Jacques-Monod conference, Roscoff,
France, July 13 - July 17**

**Synaptic Communication in Neuronal
Networks: From Molecule to Neural
Code**

Organizers:

**Peter Jonas (Freiburg, Germany)
Serge Charpak (Paris, France)**

Report on the conference

1. Report on administrative aspects

The conference “Synaptic Communication in Neuronal Networks: From Molecule to Neural Code” took place in Roscoff from July 13 to July 17, 2005. In total, 90 scientists participated. 28 were invited speakers and 62 were selected applicants. The national composition of the participants was as follows:

Country	Invited speakers	Student / Postdoc applications
USA	10	4
UK	2	5
France	10	31
Germany	4	14
Switzerland	2	2
Italy	0	3
Hungary	0	3
Total	28	62

The meeting was composed of two main lectures, six sessions with scientific talks (~25 minutes duration each), a session with minitalks (~10 minutes duration each), and two poster sessions.

In total, we invited 30 speakers. The invited speakers were selected to cover both the molecular / cellular level and the network level of brain function. The main criterion for the selection was scientific excellence. The list of speakers was very different from that of previous meetings. From the list of invited speakers in this conference (“Synaptic Communication in Neuronal Networks: From Molecule to Neural Code”), only 9 had spoken in the previous conference (“Imaging in Neurobiology”, organized by Alain Marty). This new composition of speakers allowed us to establish a new scientific focus.

The meeting was advertised by two different strategies. First, Mme Lidoreau send out several advertisement posters, covering the interested labs within France. Second, the organizers sent approximately 300 posters to selected labs in the USA and in Germany. As a result of this advertisement, we received 67 applications. 5 applications obviously did not meet the requirements and were not considered further. 62 applications were approved. Based on the quality and the topic of the submitted abstracts, four were selected for short oral presentations (minitalks). From a total of 62 applicants, 44 were postdocs, and 18 were students. Thus, although the applications were dominated by postdocs, all levels of scientific careers were represented at the conference.

The large majority of the invited speakers who had agreed to participate came to the conference. Only two of the invited speakers (Abbott and Sejnowski) in the end

were unable to attend, due to family problems. The talks of the invited speakers were of extremely high quality. In most cases, the scientific material presented was unpublished, and in many cases, the data had not even been shown at prior scientific conferences. The sessions of the meeting were arranged in a bottom-up manner, proceeding from the molecular level to the network level, whereas the chairpersons were selected in opposite order. This was done on purpose to enhance scientific interactions between different levels. The session of minitalks (10 minutes duration) and the poster sessions were also highly successful. Posters were of consistently high quality. The poster sessions were strongly visited, and several intense scientific discussions took place during and after these sessions.

The organization of the meeting, mainly performed by Dominique Lidoreau, was perfect, as it was for the prior meetings. The lecture theater near the coast provided an excellent environment for scientific discussions. The technical support was extremely good, without exceptions.

The funding the meeting was to a large extent provided by the CNRS, which we very gratefully acknowledge. Additional industrial sponsoring made it possible to increase the proportion of USA speakers to 10. The three sponsors were:

- Boehringer, Ingelheim
- Leica, Nusloch, and
- Hofmann-La Roche, Basel.

The traditional excursion to the island of Batz was particularly pleasant, as the weather was unusually nice at that time. The free evening (on Friday) was also very well received, and was used extensively for informal talks and discussions. Both the excursion and the free evening enabled us to establish several new scientific and social interactions.

At the business meeting on Saturday morning, Serge Charpak, Paris, France, was confirmed as the president of the next meeting. Furthermore, Arthur Konnerth, Munich, Germany, was unanimously elected as the new vice-president. This choice of president and vice-president indicate the new direction into which the conference series will develop. Based on the success of the present meeting, which for the first time brought together scientists working at the level of molecules and cells and scientists working at the level of neuronal networks, increasing focus will be placed on the analysis of network function in vivo in the future meetings.

In summary, the organizers feel that the meeting was a great success. Many participants confirmed that it was one of the best meetings they ever attended, and some said that it was the best conference in which they had ever participated.

2. Report on scientific aspects

Understanding the function of the brain is a central goal of modern life sciences. A main motivation of brain research is that we ultimately want to understand how cognition, learning, or consciousness are implemented in the brain. Another main motivation is that we want to derive consequent strategies for the treatment of diseases of the brain. However, many questions have remained unresolved, due to the enormous complexity of neuronal networks. What, for example, are the functional properties of synaptic communication sites between different types of neurons? How is information in brain networks encoded? How is information stored and retrieved? If we want to address these questions, we need to examine the problem at very different levels: at the levels of molecules, cells, and networks.

In the conference “Synaptic communication in neuronal networks: From molecule to neural code”, we tried to introduce such a multi-level approach to brain function. In particular, the goal of the present meeting was to examine the properties of synaptic signaling and plasticity in neuronal networks both *in vitro* and *in vivo*. The key idea of the meeting was to boost the interaction between scientists working at different levels of brain research.

The main lectures were chosen to cover both the molecular / cellular and the network level. One main lecture was given by Dick Tsien (Stanford, USA) and the other by Gyorgy Buzsáki (Newark, USA). Dick Tsien talked about molecular approaches to synaptic gain and circuit function. Using the vestibulo-ocular reflex as a robust paradigm, he analyzed changes in gene expression during learning. Gyorgy Buzsáki (Newark, USA) talked about oscillatory groupings of cell assemblies in the hippocampus. He gave an excellent overview over the function of the hippocampus in episodic memory. Both lectures very nicely showed the way for future neuroscience research. In particular, combination of molecular and cellular techniques with behavioral approaches may be extremely powerful.

The scientific sessions were structured in a bottom up manner, beginning at the molecular level and ending at the level of highest complexity. A first session addressed the function of pre- and postsynaptic molecules in synaptic transmission. Erwin Neher (Göttingen, Germany) examined the specific roles of SNARE-proteins in exocytosis at the calyx of Held, revealed by the effects of different clostridial neurotoxins. He showed that cleavage of SNAP 25 produced a change in the Ca^{2+} -sensitivity of transmitter release at the calyx, whereas cleavage of syntaxin and synaptobrevin doesn't. Daniel Choquet (Bordeaux, France) showed recent data on the mobility of postsynaptic glutamate receptors in dendrites of neurons. Finally, Gary Westbrook (Portland, USA) talked about the functional coupling of AMPA receptors and gap junctions in olfactory bulb glomeruli.

A second session addressed the properties of synaptic transmission. Peter Jonas (Freiburg, Germany) talked about tonic inhibition by asynchronous release at a

synapse formed between cholecystokinin-positive interneurons and granule cells in the dentate gyrus of the hippocampus. Isabel Llano (Paris, France) talked about interactions between ryanodine and IP3 receptors in GABAergic interneurons in the cerebellum. Etienne Audinat (Paris, France) addressed tonic and phasic excitation of neurons by glial cells. Finally, Beat Gähwiler (Zürich, Switzerland) talked about a frequency-dependent switch from inhibition to excitation in a hippocampal unitary circuit, formed between mossy fibers (the axons of granule cells) and pyramidal neurons and interneurons in the CA3 region of the hippocampus.

A third session addressed the issue of synaptic dynamics and plasticity. Wade Regehr (Boston, USA) talked about associative plasticity mediated by endocannabinoids. He showed data that establish a central role of presynaptic CB1 receptors in cerebellar long-term depression. Arthur Konnerth (München, Germany) presented data on single-shock long-term potentiation and depression in neocortical neurons. Dan Johnston (Austin, USA) addressed bi-directional changes in neuronal excitability associated with long-term potentiation or depression. Finally, Chris McBain (Bethesda, USA) showed novel data on the mechanisms of plasticity in the hippocampal mossy fiber system, regulating the detonator function of this synapse.

A fourth session was devoted to synaptic integration. Angus Silver (London, UK) talked about gain control by shunting inhibition. In particular, he examined the mechanisms of gain control in cerebellar granule cells using dynamic-clamp experiments. Dominique Debanne (Marseille, France) presented evidence for common learning rules for plasticity of synaptic integration and plasticity of synaptic transmission in CA1 pyramidal neurons, in agreement with the data previously presented by Dan Johnston. Finally, Alain Marty (Paris, France) talked about synaptic integration in cerebellar interneurons. In particular, he examined the role of the axon in determining the integrative properties of these neurons.

A fifth session addressed the function of networks and the properties of network dynamics. Michael Häusser (London, UK) presented the first in vivo and in vitro recordings from cerebellar mossy fiber boutons. Massimo Scanziani (La Jolla, California, USA) showed data on routing of spike series by dynamic circuits in the hippocampus. In particular, he showed that parvalbumin-positive basket cells and cholecystokinin-expressing basket cells are activated at different phases during repetitive activity. Yezekiel Ben-Ari (Marseille, France) talked about synaptic and nonsynaptic communication in developing networks. Richard Miles (Paris, France) showed data on threshold phenomena in neurons and networks. Henry Markram (Lausanne, Switzerland) showed a summary of his recent work to establish a library of synaptic and cellular properties in the neocortex and to develop a network model based on these experimentally determined properties. Wolf Singer (Frankfurt, Germany) talked about gamma oscillations and their role in coding. He also presented evidence that gamma oscillations are altered in schizophrenic patients. Finally, Roger Traub (Brooklyn, USA) showed recent data on electrical coupling of

neurons and subcellular elements, which play a key role in the generation of fast network oscillations and seizures.

Finally, a sixth session was devoted to the issue of coding in neuronal networks. Gilles Laurent (Pasadena, USA) talked about circuit configuration and computation in an olfactory system. Serge Charpak (Paris, France) addressed the mechanisms of neurovascular coupling in the rat olfactory bulb. Bruce McNaughton (Tucson, USA) examined factors underlying the systematic variation in the septotemporal axis of the intrinsic spatial metric of the hippocampal ensemble code. David Hansel (Paris, France) talked about the role of electrical coupling, chemical synapses, and intrinsic currents in the emergence of synchronization during gamma oscillations. Finally, Nicolas Brunel (Paris, France) presented data addressing the issue of whether information storage and the distribution of synaptic weights in cerebellar circuits is optimized.

In addition to these talks, four minitalks were given by selected applicants.

- Olaf Pongs (Hamburg, Germany) talked about the role of M-type K⁺ channels in excitability and integration in neurons,
- Henrique von Gersdorff (Portland, USA) presented data on the role of mGluR1 in plasticity of retinal reciprocal synapses,
- Andreas Lüthi (Basel, Switzerland) talked about the synaptic substrate of fear conditioning in the amygdala, and
- Imre Vida (Freiburg, Germany) addressed the mechanisms of gamma oscillations in interneuron networks, in particular the role of shunting inhibitory synaptic conductances.

The session of minitalks was very well received. The structure recapitulated the bottom-up structure of the large meeting, and thus the session provided a nice total summary.

The conference provided insights into several extremely interesting molecular, cellular, and network aspects of brain function. In addition, the meeting has led to three more general conclusions which show the way for the future development of neuroscience.

First, although the gaps between the different levels of brain research remain large, a conclusion of the present meeting is that there is both a common denominator of understanding and a common language. This was impressively demonstrated in the scientific discussions, which indicated a high level of mutual understanding. We are confident that the meeting may serve as a primer to intensify the interactions between different levels.

Second, a major conclusion of the meeting was that we are beginning to obtain increasingly complete databases of the functional properties of cell and synapse types. These data will be extremely important to develop realistic models of

neuronal networks, to simulate complex phenomena such as oscillations, and to make experimentally testable predictions from these simulations. Following the Hopfield quote “built it, and you understand it”, this could lead to a quantum leap in our understanding of how the brain works.

Third, the meeting showed that, despite the large number of labs working on the function of the brain, activities converge on a surprisingly small number of model systems, particularly the hippocampus, the olfactory bulb, and the cerebellum. Furthermore, the conference very nicely identified several general principles that are common between the different systems (e.g. the very similar properties of mossy fiber terminals in hippocampus and cerebellum). Thus, the conference provided hope that the function of the brain, although it may seem overwhelmingly complex at this point, may in the end be based on a relatively small number of general principles.

In summary, the conference successfully brought together scientists working on the function of the brain at very different levels. Thus, the meeting made an important contribution to current attempts to merge bottom-up and top-down approaches, leading to a more unified understanding of higher brain functions. We found this interdisciplinary approach to the problem of communication between neurons extremely stimulating, and hope that this outstanding series of conferences will continue.

3. Concluding remarks and recommendations for future meetings

The conference was a big success at all levels. The main purpose of the meeting, to foster interactions between scientists working at the molecular, the cellular, and the network level, was achieved. For possible future conferences, the organizers would like to make the following suggestions:

- Strengthening of the in vivo part of the meeting. This may also imply reversal of the sequence of presentations from bottom-up to top-down. The choice of the new president and vice-president indicates a development of the topic of the conference along these lines.
- Extension of the minitalks sessions. Based on the extremely positive resonance, it would seem appropriate to extend this session. This would give an increasing number of young scientists early in their career the opportunity to present their results to a high-profile scientific audience.
- Specific invitations of editors of scientific journals to the meeting. Although advertisements were sent to the editors of scientific journals (such as Trends in Neuroscience, Science, and others), future advertisements should probably be made more aggressively.
- Improve wireless network support. A wireless internet system in all hotels and the lecture hall would be appreciated by many participants.
- US scientists as presidents and vice-presidents of Jacques-Monod conferences. As mentioned during the business meeting, scientists from the USA should be eligible as chairpersons of this conference. As several high-profile neuroscientists work in the USA, this would definitely help to maintain the very high quality of the meeting.

September 18, 2005

Peter Jonas
President

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