

# Synchrony and Rhythmic Interaction : From Neurons to Ecology

29 July 2019 through 2 August 2019

The workshop 'Synchrony and rhythmic interaction' was held at the Lorentz Center from 29 July through 2 August 2019 to address collective phenomena organized in time and/or space that arise in many biological systems. Such phenomena occur at the level of organs, of individual organisms engaging behaviorally with neighbors, and of entire populations. The events may be remarkable displays of precise synchrony, but other temporal formats are known. Synchrony and interactive rhythmic phenomena have been studied by neuroscientists, physiologists, cognitive scientists - including musicologists and linguists - animal behaviorists, evolutionary biologists, and population ecologists. However, precisely timed synchrony and rhythmic interaction occur much more widely in nature, attracting the attention of scholars in physics, earth sciences, and astronomy, with applied mathematicians modeling the various events. **Our workshop brought scholars from these several disciplines together for the first time to exchange insights from their own methods, approaches, and models.** Overall, we asked how and why rhythms within and between biological organisms interact in time? What are the salient temporal and spatial features of collective productions of multiple, interacting rhythms? Are the elaborate features of collective, rhythmic productions adaptive per se, or do they merely emerge as byproducts of simpler processes? Do common principles account for the emergence of collective rhythmic productions in diverse biological processes and organisms and more generally among natural phenomena?

Our workshop included 4 organizers (Michael Greenfield USA / FR, Henkjan Honing NL, Sonja Kotz NL, Andrea Ravignani BE) and 46 invited participants. A fifth organizer, Patricia Backwell AU, was unable to attend but made funds from her institution, Australian National University, available to help defray workshop expenses. The 50 attendees came from 12 countries (USA, CA, MX, IS, JP, KOR ; UK, FR, BE, NL, D, IT, AT), represented senior and junior scholars as well as doctoral students, and covered all of the disciplines listed above. **From Monday through Thursday each morning began with a talk by a senior scholar presenting the current state and major questions in his or her discipline** : Judith Holler, timing in multimodal aspects of communication ; Laurel Trainor, developmental aspects of language, music and rhythm ; Aniruddh Patel, rhythm and rhythmic interaction across animal species ; Jean-Louis Deneubourg, collective decision making and synchronization. Tuesday featured two 'tutorials' that offered practical information on methodology : Molly Henry, experimental methods ; Manfred Hartbauer, modeling. 15 additional short talks by junior and senior scholars were presented from Monday through Thursday. **A novel part of the program was a public lecture at the Rijksmuseum Boerhaave on Thursday evening by Robin Meier**, a musician and artist whose works have been inspired by synchronous phenomena from the living world.

Approximately 20 workshop attendees made poster presentations. The posters were the focus of a special session on Monday evening, and they remained on exhibit throughout the week and were used as focus of attention for discussion during the (lengthy) breaks.

The talks and tutorials were interspersed with discussions that served as question and answer sessions and addressed more general issues and future directions for the discipline. These were chaired by two moderators, often a combination of a junior and senior scientist/scholar. From Wednesday through Friday we organized ourselves into 5 'theme groups' that were oriented toward writing synthesis and opinion articles for a special issue of a journal. All workshop attendees, including doctoral students, were full participants in this activity.

Our aim is to prepare a set of 12-15 articles for submission to the *Philosophical Transactions of the Royal Society B*. A list of proposed articles, with tentative titles or subjects, is given in an Appendix.,

## **Appendix**

1. Mapping physical properties of oscillations onto specific biological functions. Coordinated by Sophie Bagur and Laura Verga.
2. What non-human animals and humans can do with rhythm and how to study it. Coordinated by Fleur Bower, Molly Henry and Andrew Rouse.
3. Ontogeny of rhythm and timing ; atypical development. Coordinated by TBD.
4. Modeling social connections in space and time ; network (small world) analyses. Coordinated by Guy Amichay.
5. Clinical applications of rhythmic interaction. Coordinated by TBD.
6. Temporal structure in multimodal behavior and communication. Coordinated by Chris Kello, Wim Pouw.
7. Duetting : analyses based on rhythmic interaction. Coordinated by Masayo Soma.
8. Selective attention. Coordinated by Michael Greenfield.

Additional articles / titles, complementing the themes mentioned above, will be invited from scholars in the field who could not attend the workshop.

**Michael Greenfield** (USA / France)

**Henkjan Honing** (Netherlands)

**Sonja Kotz** (Netherlands)

**Andrea Ravignani** (Belgium)

**Patricia Backwell** (Australia)