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Symposium: Biological and social communications

Cosponsored by International Institute for Advanced Studies (IIAS), Kyoto, Japan.

Communication is one of the most elaborate and sophisticated "extended phenotype [1]". There are various types of communication, e.g. chemical and electric communications in/between cells, visual, auditory and biochemical communications between individuals in ecological communities, and nonverbal, verbal, written and digital communications among humans who are separated in time and space and sometimes even never meet. In this interdisciplinary symposium speakers and participants of a broad range of backgrounds among biological, social and information sciences will discuss the biological and social communications from a unified point of view and will explore a guiding principle to solve "communication problems" such as free riders, social dilemmas, the tragedy of the commons, etc.

Program:

15:45-16:15: **Ulf Dieckmann** (Keynote, IIASA, Austria)
16:15-16:35: **Masa-aki Sakagami** (Kyoto U.)
16:35-17:00: **Lira Yu** (Kyoto U.)
17:00-17:20: **Toru Ohira** (Nagoya U.)

17:20-17:30: **Break**

17:30-17:55: **Susumu Ohnuma** (Hokkaido U.
17:55-18:15: **Kazutoshi Sasahara** (Nagoya U.)
18:15-18:35: **Tetsu Sato** (RIHN)

18:35-18:45: **Discussion**

This symposium is cosponsored by the Research Project "General Communication Studies" in International Institute for Advanced Studies, Kyoto, Japan [2] and "Creation and Sustainable Governance of New Commons through Formation of Integrated Local Environmental Knowledge (ILEK Project), Research Institute for Humanity and Nature (RIHN), Kyoto [3].

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How Science Can Help Moving Human Communication beyond Misperception, Polarization, and Distrust

Human communication is highly complex, and successful communication is fraught with challenges. Building on research projects at the International Institute for Applied Systems Analysis near Vienna in Austria, this presentation addresses three of these challenges:

(1) *Misperception.* Human perceptions often suffer from cognitive biases. For example, the global financial crisis of 2008 has been attributed to the underestimation of systemic risk, defined as the propensity of local failures to cascade across networks of interacting agents. In a trial survey eliciting 2500+ responses, we quantify how humans systematically underestimate systemic risk, and which factors determine the degree of their misperceptions.

(2) *Polarization.* Compromises among human agents can be impeded by the polarization of dialogue. This problem arises, for example, in discussions concerning the sustainability of fisheries. Using an integrative model of two Norwegian fisheries – involving fish dynamics, fishery economics, and stakeholder preferences – we demonstrate the existence of a "zone of consensus" in the design of fishing regimes. Within this zone, the interests of stakeholders are maximally aligned and reaching compromises is therefore most likely.

(3) *Distrust.* When selfish free-riders can exploit altruistic behaviors, social trust dissipates, cooperative enterprises falter, and common goods collapse. Social institutions can prevent this "tragedy of the commons" by providing positive or negative incentives. Investigating the evolution of cooperation in well-mixed and spatially structured agent-based models, we show how trusting social interactions are effectively and efficiently nurtured and protected by the adaptive hybridization of rewards and penalties, using an incentive policy we call "first carrot, then stick."

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Information transfer in fish schools

We investigate mechanism of information transfer in fish schools by analyzing the moving images filmed from the bottom of a tank of an aquarium. We focus on torus state of sardine schools among several ones of group, i.e. swarm, torus and parallel states. Through using automatic measurement velocity vector data based on evaluation of optical flows[1], we review that the analyses based on several averaging procedures are quite useful [2, 3].

It is well-known that two activities of fishes, *agitation* and *burst*, have an important role for swift reaction and information transfer of fish schools[4, 5], which are ignited in cases of strong predations. We show that agitation and burst, both of which have significant role for swift reaction of fish schools, can be quantitatively detected by observing propagation of wave over neighboring regions. In addition, we frequently observe the process called weak agitation, which is modest type of agitation. Non-stationarity and unceasing large fluctuation, which are remarkable natures of fish schools, might be related to weak agitation and its ubiquity.

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Experimental studies on interactional synchrony in chimpanzees (*Pan troglodytes*)

One of the distinctive characteristics of synchronous behavior in humans that differs from other animals is that it also occurs within only pairs of individuals. Experimental studies in adult humans had reported that humans tend to mutually couple a tempo of the movement with a partner while producing repetitive and rhythmic movement simultaneously. When might this type of pair-based mutual synchrony have emerged phylogenetically? To understand the evolutionary origin of mutual synchrony in pairs of humans, the current study targeted chimpanzees who are phylogenetically the closest living relatives to humans. Four pairs, consisting of five female chimpanzees at Primate Research Institute, Kyoto University, Japan, participated in the current study. A finger-tapping task was introduced to produce repetitive and rhythmic movement from each chimpanzee. The study was conducted in two different experimental setups: side-by-side setup and face-to-face setup. In the side-by-side setup, auditory information of a partner's tapping movement was available. On the other hand, in the face-to-face setup, auditory and visual information of a partner's tapping movement was available. In both setups, I found that unidirectional tempo convergence occurs in pairs of the chimpanzees when they perceive a partner's movement while producing simultaneous tapping movement. The current finding demonstrated that humans and chimpanzees may share an ability to produce tempo convergence whereas directionality of the convergence differs between the two species.

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Communication among Self-driven Particles

Flocks of birds, school of fish and other collective motions of living creatures can present rather intricate shapes and behaviors. Studying these collective motions of so-called "self-driven particles" has been an active research area. In contrast to "physical particles", interactions or communications among self-driven particles are more complex, and inferring how they communicate at the individual levels is a challenging research issue. In this talk, we give examples of such collective motions and theoretical models.

In particular, we discuss a simple model of collective chase and escape problem, in which one group chases the other. It will be shown that even a simple interaction can lead to rather intricate collective motions. We will also present possible applications of collective motions of self-driven particles to engineering problems such as constraint optimizations.

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Resolving a social dilemma through dialogues: social psychological approach to environmental issues

This presentation introduces studies in social psychology toward resolving a social dilemma, which is a conflict between personal profit and social benefit.

One of the major theories guiding mutual cooperation in social dilemmas is goal expectation theory (Pruitt & Kimmel, 1977; Yamagishi, 1986), which consists of two steps: (1) individuals recognize the importance of group or societal benefit and becomes to aim for mutual cooperation and (2) the individuals can believe that others also realize the importance of common benefit and mutual cooperation; hence they can have expectation that others will cooperate if they witness cooperation. Therefore, the research question is how people can have an expectation of mutual cooperation.

Many experimental studies in social psychology have shown that communication can lead people to mutual cooperation as communication brings about trust and expectation to the others, although it is not unconditional. In contrast, a mere implementation of sanctions such as surveillance and penalty often fails to guide mutual cooperation due to the limited resource for maintaining the sanction system that requires additional costs. A gaming study revealed that strengthening sanction increased non-cooperative behavior because participants failed to share relevant information obtained from communication (Kitakaji & Ohnuma, 2014).

Furthermore, filed studies have shown the significance of dialogues in terms of procedural fairness, which refers the decision process. For example, case studies about waste management policy for waste reduction and recycling promotion, which is regarded as a social dilemma, suggested that evaluations of public benefit and procedural fairness were the determinants of the policy support (Ohnuma et al., 2005). Ohnuma (2009) found from a case study of implementing a charge system for household waste that it was hard to engage in a constructive discussion when focusing only on the charge system, but was successful when focusing on public benefit, such as how to direct a circulative society and how to reduce waste and inappropriate disposal. By focusing on public benefit, people began to consider and discuss what can be done and what type of rules should be implemented for directing the common goal beyond the controversy over the charge system. Throughout the discussion of a participatory program, citizens began to share a concrete image of a common goal.

Finally, this presentation remarks the importance of creating recognition of a common goal throughout dialogues.

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Tweet communication in birds and humans: A network perspective

Birds and humans tweet for communication. A bird tweet or birdsong is an acoustic communication signal primarily used in male-male competition and male-female attraction. As with human language, birdsong has a syntactic structure (i.e., transition rule among notes) that is closely related to the generation of complex vocal sequences [1]. When considering networks, we model two types of birdsong syntax in the California Thrasher and the Bengalese finch, showing their distinct structural properties, such as a large note repertoire with a "small-world" structure and an automaton-like song syntax [2]. Humans tweet online, though not like birds. A tweet (a short text message posted to Twitter) is a form of online communication in the age of social media that facilitates a rapid and massive information diffusion, thereby connecting people instantly. We demonstrate dynamic communication patterns on Twitter in terms of word-usage networks and social interaction networks [3, 4]. In particular, retweet networks related to major disasters and sporting events show notable online communication patterns, such as a scale-free degree distribution and distinct community clusters. Exploring tweet communication in birds and humans from a network perspective can contribute to our understanding of the structure and evolution of communication.

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Knowledge translation for integrating environmental knowledge to support adaptive societal transformation toward sustainability

Issue-driven and solution oriented knowledge bases are required for effective decisions and actions of diverse stakeholders to mobilize collective actions toward solutions of various complex social issues including global environmental problems. Communication mediates circulation of various types of knowledge, produced by diverse actors through scientific as well as daily-life and livelihood knowledge production processes. Knowledge translation plays critical roles to fill gaps and mediate communication and interactions among various knowledge producers and users with different world views, value systems and empirical backgrounds.

I focus on construction and circulation of a novel concept of local knowledge (Integrated Local Environmental Knowledge, ILEK), a blend of scientific and local knowledge produced by interaction and interpenetration of knowledge systems among various societal actors including scientists, skilled workers from primary industries (farmers and fishers), local companies, NGOs and local government officials, most of them conventionally categorized as knowledge users. Therefore, ILEK is inevitably of a transdisciplinary nature as it has to incorporate every needed domain of science and technology, as well as local wisdoms, experiences and insights of diverse actors required for complicated decision-making and actions in complex, local social-ecological systems. ILEK is an integrated knowledge base for decision-making and actions by diverse local stakeholders including scientists and experts to mobilize collaborative actions toward sustainability.

We produced a conceptual model of knowledge-based adaptive societal transformation based on world-wide case studies of dynamic production, circulation and utilization of ILEK mobilizing local communities toward sustainability. This ILEK Triangle model is composed of interactive triangle of "knowledge production", "decision-making and actions (individuals and/or small groups)" and "institutional change (formal and informal)", which is mediated by bilateral knowledge translation and mutual learning. Residential researchers living in local communities as a stakeholder to produce solution-oriented transdisciplinary knowledge sets were found to play important roles to co-produce and co-deliver ILEK. Bilateral translators of knowledge promoted circulation of ILEK across different framing among stakeholders, including circulation of knowledge across multiple scales from local to global. Such cross-level knowledge translations suggested potentials of multi-scale collaborative actions to tackle with global level problems. Based on these results, we developed hypothetical sets of enablers of adaptive decision making and actions. This paper will introduce these results to try to clarify way forwards for formation of "science with society" and "society making full use of science" to live with complex and dynamic social-ecological systems.

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