



Networking / Dissemination Activity Scientific Report Form

Form (Word or PDF file) to be completed and uploaded via the online system within two months of the completion of the event for the following activities: working group meetings, seminars, workshops, symposia, conferences, summer schools, training programmes and specialised courses (graduate-level and continuing education), EUROCORES programme invited sessions at larger conferences, working group meetings (e.g. publication meetings).

a) **Summary**

The scientific objective of the workshop was to highlight issues surrounding consensus and misunderstanding, from the level of the single individual, to pairs in interaction, to populations of heterogeneous agents or speakers, by showcasing two core lines of research: theoretical modelling and experiments. Modelling is a crucial tool in the investigation of how consensus and dominant norms emerge in societies, or rather, how fragmentation and misunderstanding phenomena occur. This is relevant for the dynamics of language, opinions and other cultural traits, and the processes of individual and collective decision making. From the level of the single individual, to pairs in interaction, to populations of heterogeneous agents, formal models are ubiquitously used to make systematic observations, uncover regularities, advance hypotheses, and test their predictions. However, while such “bare-bones” models can illuminate the skeletal dynamics at work, it is becoming more and more urgent to parallel computational investigations with carefully devised social experiments. Such experiments must aim to investigate specific aspects of how individuals make decisions and how these decisions affect large-scale dynamics at the population level. Increasingly, the opportunity to run large-scale web-based experiments makes the collection of data regarding actual social behaviour more feasible.

The workshop centered around two days of talks and discussions featuring ongoing modelling and empirical work relevant to emergent consensus and misunderstanding, from disciplines as diverse as complex systems physics, ecology and evolutionary biology, anthropology, psychology and linguistics. Talks took place over two full days in either 30 or 45 minute slots (with 10 and 15 minutes for discussion, respectively), interspersed with group coffee breaks, lunch, and a social dinner during which more informal discussion continued. The second day also featured a panel (Luc Steels, Andreas Roepstorff, Vittorio Loreto) which led general discussion on the themes and outcomes of the workshop.

b) **Final programme of the event**

MONDAY, 24TH FEBRUARY
9:30-10:00: Registration and Welcome

10:00-10:30: Opening
10:30-11:15: Simon Kirby
11:15-11:45: Coffee break
11:45-12:30: Andrea Baronchelli
12:30-13:15: Francesca Tria
13:15-15:00: Lunch (provided)
15:00-15:45: Seán Roberts
15:45-16:30: Gerhard Jäger
16:30-17:00: Coffee break
17:00-17:30: Piera Filippi
17:30-18:00: Martina Pugliese
20:30-22:00: Social dinner

TUESDAY, 25TH FEBRUARY

10:15-11:00: Francesca Colaiori
11:00-11:30: Coffee break
11:30-12:15: Peter Turchin
12:15-12:45: Andres Roepstorff
13:00-15:00: Lunch (provided)
15:00-16:00: Round table
16:00-16:45: Martin Hilpert
16:45-17:30: Bruno Galantucci
17:30-18:00: Concluding remarks and Coffee break

c) Description of the scientific content of the event (abstracts can be provided)

The workshop focused on two main themes that emerged from the talks and discussion sessions and were further developed during the final round table: the idea of misunderstanding as opportunity, and the need to take a more holistic view of communication. Several of the talks pointed out that misunderstandings can be framed in terms of variations, particularly in linguistic data. These variations are often the source of later changes or innovations. In this way, the group discussed the idea that misunderstanding is a by-product of forces that preserve variation within communication systems to ensure their flexibility over time and also over diverse speaker populations. In this vein, there was a discussion about viewing individual misunderstandings not necessarily as failures of communication or consensus, but as opportunities for innovation. Several talks dealt with different aspects of linguistic structure (compositionality, syntax, prosody, other-initiated discourse repair), and the group discussed the need to move towards holistic approaches which consider the effects of these levels of structure in concert, creating an ever-clearer picture of language emergence.

List of the abstracts

- **Simon Kirby**, University of Edinburgh, Language Evolution

Cumulative cultural evolution of systematically structured behaviour in a non-human primate

A striking feature of much human behaviour is its systematic structure. Language is the paradigm case of this. Elements of a language work together systematically so that each utterance does not stand alone, but rather forms part of a web of interdependencies at various levels of structure. The emergence of systematic structure in language has been explored extensively over the past decade or two using both computational simulations and laboratory experiments that point to cumulative cultural evolution as the source of this structure. Since cumulative cultural evolution is not found in other primates, this suggests an explanation for the uniqueness of language in humans. In this talk, I will present joint work with Nicolas Claidiere, Kenny Smith and Joel Fagot: an experiment in which we observe, for the first time, cumulative cultural evolution of systematically structured behaviour in a population of captive baboons. Our animals reproduce a set of visual stimuli through social learning, and these sets of stimuli are passed on over several cultural generations. The patterns that gradually evolve exhibit lineage-specific system-wide structuring. I will end with a discussion of the implications of this result for the origins of complex consensus formation in humans.

- **Andrea Baronchelli**, City University London, Mathematics

Consensus and Misunderstanding: Foes Or Friends?

How a community manages to establish a consensus on an opinion, on a behavior, or even simply on the name for an object, is a crucial issue in the Cognitive and Social Sciences. In this talk I will address this problem through a simple model able to account for the bottom-up emergence of shared vocabularies in a population. I will then examine some of the possible reasons underlying the lack of consensus and the emergence of misunderstanding, ranging from topological constraints (the existence of separated communities, the emergence of distinct linguistic groups within the same spatially extended community, etc.) to individual behaviors (reluctance of the individuals to abandon their previous convention, the asymmetry of information exchange in pairwise communications, etc.). Finally, I will discuss more complex situations where consensus and misunderstanding, rather than being mutually exclusive, become inextricably connected. This is the case of category systems, which I will consider with the aid of a second multi-agent model. Here, individuals can coordinate their language in order to attain common goals, but they remain unable to access the internal representations of their peers, thus leaving space for an intrinsic (and ideally small) possibility of misunderstanding.

- **Francesca Tria**, Institute for Scientific Interchange

A language games perspective with two different focal lenses

Language games proved to be a powerful tool to investigate to which extent shared communication systems can emerge out of repeated interactions among individuals, aimed at success in communication. The generality of this modelling scheme allows to investigate language origin and evolution at different scales. In particular, I will give an example where the emergence of a fine structure of language is investigated, and an example where we focus on the emergence of a new language out of two existing ones. Namely, I will talk about the emergence of duality of patterning in human language and about the emergence of creole

languages. In both cases I will compare theoretical predictions of a proposed multi-agent modelling scheme with related measures on real language data.

- **Seán Roberts**, Nijmegen, MPI Psycholinguistics

Building abstract models of other-initiated repair

People use conversation to establish common ground, and this can involve a series of misunderstandings and 'repair'. There is an established lineage of computational models that explore the dynamics of this process, with the paradigmatic sequence being a proposition uttered by a speaker, indication that the listener did or did not understand and then corrective feedback. However, Conversation Analysis research has demonstrated that humans have a much richer system for repairing misunderstandings in conversation. There are two basic ways an interlocutor can initiate repair: 'Open' repair simply indicates that there is some problem with communication (e.g. "huh?"). 'Restricted' repair targets a specific part of the conversation as problematic (e.g. "Whose baby?"). The Interactional Foundations of Language project has built a corpus of sequences of misunderstandings from real conversations in many different languages. I will present recent findings that there are striking regularities in the way repair happens across languages and argue that this derives from a universal need for a framework for resolving misunderstandings. For instance, the factors that affect the choice of open or restricted repair are the same across languages, and listeners demonstrate a pro-social bias by attempting to be as specific as possible. This points towards the possibility of modelling interaction in a way that reflects how real conversation works. In turn, this kind of model can help answer the question of whether the universal tendencies we see in conversation are emergent properties or prior constraints.

- **Gerhard Jäger**, University of Tübingen, Linguistics

Vagueness, Signalling & Bounded Rationality

Vagueness is a pervasive feature of natural language, but indeed one that is troubling for leading theories in linguistic pragmatics and language evolution. As pointed out in an influential paper by the economist Bart Lipman (Lipman, B., 2009, Why is language vague?), under very general assumptions vague languages are necessarily sub-optimal. Briefly put, he shows that a vague language will always be Pareto-dominated by a non-vague one, provided the communicators are rational. Lipman's argument directly carries over to an evolutionary setting where the effects of replication and selection mimic rational behavior. Therefore both rational utility maximization and fitness-maximizing cultural evolution should weed out vagueness from signalling systems that are adapted for efficient communication. Still, vagueness is wide-spread both within and across natural languages. In this talk I will argue that vagueness necessarily emerges in cultural language evolution if the interacting agents are boundedly rational. This involves both limited memory resources and the kind of human stochastic optimization that has repeatedly been observed in experimental settings.

- **Piera Filippi**, University of Vienna, Cognitive Biology

The interactional Value of prosody

This talk will focus on the faculty of interactional prosody (FIP), which includes the following abilities: (i) to actively control and modulate frequency, tempo and loudness of vocalizations; (ii) to combine sounds flexibly; (iii) to coordinate sound production with one or more individuals; (iv) to express or evoke emotions, arousal, or states of mind. I hypothesize that FIP constrained the emergence of language on a phylogenetic and ontogenetic level. I review three research fields relevant to this hypothesis: Developmental effects of FIP in human infants. Second, based on

recent studies, I pinpoint the evolutionary relationship between FIP, the faculty of music and of verbal language. Third, based on a functional definition of the faculty of music and on the clarification of the conceptual link between animals' musical competences and FIP, I suggest an empirically grounded interpretation of Darwin's hypothesis, according to which the first utterances produced by hominids were musical. Based on recent findings on the positive effects of interactive sound modulation on cognition and physiology in primates, nonhuman mammals and songbirds, I emphasize the key role of the social aspect of FIP in relation to language emergence within both an ontogenetic and a phylogenetic scale.

- **Martina Pugliese**, Sapienza University of Rome, Physics Dept.

Rules and exceptions: examining internal and external factors in verb regularity

Languages are structured around rules, but such rules almost always have exceptions. This indicates that regularity and irregularity exist together over time, despite the more parsimonious strategy of universally applying a single rule. To examine this paradox, this talk will present a detailed look at past tense verb formation in the Corpus of Historical American English (CoHA), which shows a highly porous system where new verbs enter and other verbs die. As for external dynamics, verb birth overshadows verb death, resulting in an overall expansion of the verb set. However, because new verbs adopt the dominant regular rule, this expansion also produces an increase in the number of regular verbs over time. At the same time, the verb set undergoes internal changes: we observe some existing verbs regularizing as well as an opposite process of roughly equal strength: irregularization. Overall, internal dynamics contribute to a stable level of irregularity in the system while external forces contribute to increasing regularity. In order to account for stable irregularity, we propose a mechanism for irregularization based on phonological similarity among verbs, supporting a model of rules in competition for the formation of the past tense.

- **Peter Turchin**, University of Connecticut, Ecology and Evolutionary biology;
University of Oxford, Anthropology; The Evolution institute

Explaining the evolution of social complexity: cultural selection of 'ultrasocial' norms and institutions

What are the social forces that hold together complex societies encompassing hundreds of millions of people? How did human ultrasociality – extensive cooperation among large numbers of unrelated individuals – evolve? In particular, how do ultrasocial norms and institutions, cultural elements that make cooperation in large-scale societies possible, evolve despite their significant costs? The theory of cultural group selection is a powerful theoretical framework for addressing these questions. I use this framework to investigate a major transition in human social evolution, from small-scale egalitarian groups to large-scale hierarchical societies such as states and empires. A key mathematical result in the theory is that large states should arise in regions where interpolity competition – warfare – is particularly intense, resulting in high probability of cultural trait extinction. I explore the implications of this theoretical result with a spatially explicit model of sociocultural evolution and find that the model does a remarkably good job predicting where and when large states appeared in Afroeurasia between 1500 BCE and 1500 CE.

- **Andreas Roepstorff**, University of Aarhus, Interacting Minds Centre

Mapping optimally interacting minds

The Optimally Interacting Minds Experiment (Bahrami et al., 2010) allows the somewhat systematic study of a perceptual decision making task where two people could (sometimes) solve the task better than the best person on his own, simply by talking to each other. The paradigm has since been extended across a number of different contexts and situations. On the whole, the findings suggest that the process critically depends on a shared understanding of uncertainty to emerge through interactions. I will review key findings and ask the question, what might it take for a psychophysical experiment to reach out to a larger social and political landscape?

- **Francesca Colaiori**, CNR, Institute for Complex Systems

Antagonistic interactions in social networks: the theory of structural balance revisited

Social network analysis is a well-established approach for studying patterns of relationships connecting social actors. The linkages contained in these networks are generally assumed to have positive connotations: ties typically indicate friendship, collaboration, or membership in a group. However, in most social settings, relations between people are regularly plagued by controversies, disputes, or even conflicts. Hence, any realistic social network model must involve a mixture of friendly and antagonistic interactions. An important issue in social network studies is to understand the interplay between these two ingredients. The theory of structural balance from social psychology is the basic frameworks for this analysis. In this talk, I will present ongoing work with Steven Strogatz (Cornell) and Andrea Baldassarri (ISC-CNR) that examines a natural generalization of structural balance theory. While classical balance theory postulates that the human tendency to minimize distress acts as a drive toward psychological balance, selecting special (balanced) network configurations, the generalized theory predicts that some degree of unbalance survives at equilibrium. I will discuss how the persistence of tension in some individual relations could have a role in maintaining social cohesion on a global scale. I will show how these predictions compare with experimental data from contact networks in a primary school.

- **Martin Hilpert**, University of Neuchâtel, Linguistics

What do misunderstanding and consensus have to do with language change?

This talk will relate the theme of the workshop, misunderstanding and consensus, to developments that take place in language change over historical time. I will argue that both misunderstanding and the emergence of consensus have central roles to play in language change, particularly in the development of grammatical constructions. To start with the idea of consensus, speakers' knowledge of language can be modelled as an inventory of form-meaning pairings that are conventionalized, such that the members of a speech community entertain an implicit consensus about what a given linguistic unit means and how it can be used. Importantly, this consensus is negotiable and open to change. In such processes of change, misunderstanding is a key component. Misunderstanding can affect both meaning and form of linguistic units. Hearers may misunderstand the meaning of an utterance and read more than the intended meaning into it. They may also misunderstand the form of an utterance and analyze its structure in a way that was not intended by the speaker. In subsequent events of language use, misunderstandings of this kind may propagate and eventually become conventionalized linguistic units in their own right. These processes of misunderstanding, which linguists call 'invited inferencing' and 'syntactic reanalysis', have been extensively studied. What is less well-studied is how these processes unfold in real time. I will present data from historical

corpora that visualize how misunderstanding and the emergence of consensus dynamically shape linguistic conventions.

- **Bruno Galantucci**, Yeshiva University, Psychology

The development of sophisticated forms of communication in humans

One of the hallmarks of our species is that we develop sophisticated forms of communication. However, there is growing evidence that we exhibit important limitations when we are asked to perform tasks that require communicative sophistication. I will illustrate some of this evidence, which comes in part from research on the emergence of novel communication systems in the laboratory and in part from research on the use of natural language. Then I will focus on the question of how individuals who have limited communicative skills manage to develop sophisticated forms of communication. I propose three non-mutually exclusive hypotheses to address the question. The first hypothesis is that communicative sophistication does not originate from sophisticated individuals but emerges in the public arena, as the result of a cultural ratchet effect. The second is that there may be great variability in communicative skills within the human population and that the development of sophisticated forms of communication may be driven by a minority of exceptional communicators. The third hypothesis turns the question on its head, suggesting that human communication may often be much less sophisticated than we think. I will present various kinds of evidence supporting the second and the third hypotheses and argue that one can help us understand how humans avoid misunderstandings (or resolve them when they arise) and the other can help us reduce the conceptual gap between the study of human communication and the study of other forms of coordination in humans and animals.

d) **Assessment of the results and impact of the event on the EUROCORES programme.**

It should describe what was gained from the meeting. Concrete or follow-up actions to be taken as a result (i.e. dissemination plan) should appear in this section.

Slides of the presentations delivered at the workshop have been made publicly available on the workshop website <http://emergcons.wordpress.com/presentations/>.

What was gained from the meeting

The meeting gave the opportunity to discuss different points of view concerning:

- Modelling schemes for consensus and misunderstanding. In particular the role and the interplay of the different time-scales (cultural vs. evolutionary);
- The role that big-data could play in studies concerning consensus and misunderstanding;
- The possibility to run web-based experiments to assess the determinants of consensus and misunderstanding in complex societies;
- The role of misunderstanding as opportunity for change and a source of innovation more than merely a communication accident;

On all the above-mentioned subjects new collaborations have been established and old ones have been strengthened.

Other results/impact

The whole workshop and the round-table in particular gave the opportunity to make a point about where the scientific community interested in the workshop's themes stands. The participants, though very positive about the outcomes of the workshop, expressed their worries about the lack of an official status for studies in this area, despite the relevance of studies on consensus and misunderstanding in many different areas. For instance the participants complained about e.g. the lack of suitable scientific journals open to these themes, the lack of specific curricula to train young students and scholars and the lack of specific funding schemes in this area. The participants acknowledged that the EUROCORES programme represented a very positive note since it concretely helped in gathering an otherwise dispersed community. From this perspective everybody urged the possibility for having more of these programmes. All in all, the workshop has been a great success and we expect now to see this still small, though growing, community work together progress, without losing the knowledge acquired so far.

List of speakers and participants

Lars Bach (University of Aarhus)

Andrea Baronchelli (City University London)

Emilia Garcia Casademont (Institut de Biologia Evolutiva, Barcelona)

Claudio Castellano (ISC-CNR, Rome)

Francesca Colaiori (ISC-CNR, Rome)

Christine Cuskley (ISC-CNR, Rome)

Zhou Feifei (University of Hong Kong)

Piera Filippi (University of Vienna)

Bruno Galantucci (Yeshiva University, New York)

Pietro Gravino (Sapienza University, Rome)

Martin Hilpert (University of Neuchâtel)

Gerhard Jäger (University of Tübingen)

Simon Kirby (University of Edinburgh)

Vittorio Loreto (Sapienza University, Rome)

Bernardo Monechi (Sapienza University, Rome)

Martina Pugliese (Sapienza University, Rome)

Andrea Ravignani (University of Vienna)

Sean Roberts (Max Planck Institute for Psycholinguistics, Nijmegen)

Andreas Roepstorff (University of Aarhus)

Vito Servedio (Sapienza University, Rome)

Luc Steels (Vrije Universiteit Brussel)

Francesca Tria (Institute for Scientific Interchange, Torino)

Peter Turchin (University of Connecticut)