**EUROCORES Programme**
European Collaborative Research

**OMLL**
**The Origin of Man, Language and Languages**

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# Abstracts OMLL Final Conference

## 12-14 December, Rome, Italy

### Session 1 - Language Evolution and Computer Modeling

**The emergence of grammatical constructions: Neural Network simulation, Neurophysiology and Robotics**

Peter Ford Dominey, CNRS / Université Lyon 2, Laboratoire d'Etude des Mécanismes Cognitifs

Our simulation work has now addressed aspects of the problem of language emergence and acquisition, from theoretical simulation results to human fMRI studies and to implemented robotic systems that demonstrate language acquisition. These results demonstrate how a model of grammatical construction processing, based on the known neurophysiology, can learn reduced versions of English, French and Japanese and how this learning can take place in a physical, robotic system. Furthermore, we are now investigating how this framework can lead to the next generation of human-robot interaction systems.

**When doing is saying: Implicit communication before and without language and gestures**

Cristiano Castelfranchi, Institute of Cognitive Sciences and Technologies, CNR, Rome
Luca Tummolini, Institute of Cognitive Sciences and Technologies, CNR, Rome

Observation and more specifically 'signification' (the capability to interpret and ascribe meaning to observed facts) is the basis of a very basic, natural and crucial form of communication without words or special symbols. Efficient coordination in humans exploits not just 'observation' but more precisely this form of silent communication: when Agent X relies on the fact that Agent Y is observing her in order to let Y understand that p, i.e. for communicating to Y that p. The general theory of behavioural implicit communication (BIC) (not to be mixed up with the so called "non-verbal", "expressive" communication) is presented: practical behaviour can be communication without any modification or any additional signal or mark. This use of the term 'implicit' is explained. The relationship with the ill-defined but important notion of stigmergy is analyzed: stigmergy results to be a sub-case of BIC.

We will illustrate the spontaneous and necessary steps to arrive from mere observation and exposure to observation to Behavioral Communication. We will stress both the cognitive steps (for example the role of 'recognition' and 'interpretation' of X's action (and the possible role of mirror neurons in this)), and the teleonomic steps - intentional BIC vs. functional BIC - and also how BIC evolves towards conventional, specialized and decontestualized signs via ritualization or via simulation.

We will also suggest why BIC is really ubiquitous and crucial for social interaction; from mutual understanding and commitment, to social conventions, norms keeping, imitation and learning, etc.

In particular we will argue about:
- the relevance of BIC in the evolution of communication;
- how this can define cognitive and interactive prerequisites usually considered only for the evolution of language;
- how BIC allows the negotiation of meaning and of linguistic rules;
- how reasonably BIC is recursively responsible for the gricean, meta-communicative nature of specialized communication systems like language;
- how BIC is fundamental for the establishment of human cooperation, institutions, norms.

### Modelling aspects of grammaticalization

Pieter Wellens, Free University of Brussels

Grammaticalization is the process whereby a lexical language progressively incorporates grammatical constraints in order to express additional aspects of meaning and in particular how the meanings of individual lexical items need to be combined. Grammatical constraints take the form of syntactic constraints (e.g., word order or intonation patterns) as well as the exaptation of lexical items for grammatical functions, as in the English "will" (original lexical meaning 'want') which evolved into an auxiliary for future, or the English preposition "by" (original meaning spatial proximity) which evolved into a marker of passive. The main topic of our OMLL project was to see how the mechanisms underlying these grammaticalization processes can be operationalised and this requires in turn that we have a solid operational theory of lexicalization processes.

We have investigated lexicalization and grammaticalization dynamics with grounded multi-agent experiments using Sony QRIO humanoid robots. These robots engage in a series of description games, without enforcing any restrictions on word meaning and providing no constraints (biases) that could help prune the hypothesis space. As a result, the agents have to deal with an uncertainty that scales exponential in the number of sensory channels. Previous models, like those based on cross-situational learning, rely on an explicit enumeration of competing hypothesis, using co-occurrences between form and meaning to choose. Such an enumeration approach is no longer feasible in the vast hypothesis spaces encountered in our experimental setup. Instead, agents associate form and meaning by scoring separately any part of meaning playing a role in the uncertainty, resulting in a representation comparable to fuzzy set theory. This avoids any need to explicitly enumerate competing hypotheses and allows for much greater scaling.

We define a weighted similarity measure between such representations that drives language use. The most important corollary is the flexibility in which the words can be used. This flexibility enables the use of a linguistic item beyond its specification. In high dimensional spaces you need such flexibility to get a balance between coverage and the inventory size. At the end of each game the agents increment those scores that were beneficial for the similarity and decrease those that were not. This can be interpreted as phenomena of entrenchment and erosion. It is the repeated combination of flexible language use with entrenchment and erosion that makes it possible for the agents to gradually home in on and align their linguistic inventory.

Entrenchment and erosion effects over multiple words lead to abstract constructions to emerge out of lexical ones. These can contain extra information (such as markers of agent and patient) not available in the individual lexical items. When scenes become more complex, the need for search increases when such grammatical relations are not marked in form. This can be taken as a functional pressure to add additional constraints (e.g., word order) to these abstract constructions.

This presentation gives some concrete results of our experiments, both for flexible word meaning and for the exaptation of lexical items for grammatical functions.

### The role of talking to oneself in the evolution of language

Marco Mirolli, Institute of Cognitive Sciences and Technologies, CNR, Rome

What kind of selective advantage did language conferred to those that possessed them during language evolution? Notwithstanding the importance of this question there is not much debate on this topic. The reason is that it is commonly assumed that the function of language is communication. But language, in modern humans, has not only a communicative function but also an individual function: it is used for talking to oneself, as a cognitive aid. There is indeed a growing body of empirical evidence demonstrating the importance of language for a number of cognitive functions including, for example, learning, memory, analogy making, and problem solving.

Given the importance of talking to oneself for current human cognitive capacities, if we want to understand language evolution we must understand the possible role that talking to oneself might have played in language evolution. Beside classical questions like 'when, where and how did language evolve?', we must also address questions like: when did the use of language as a cognitive tool begin? And what role did it play in language evolution itself?'.

A possible answer is that only when language reached, at the end of its evolutionary history, its current mature and rather complex form, it was used not only to talk with others but also to talk to oneself. If this is the case, then talking to oneself didn't play any role in the evolutionary emergence of language.

But in this contribution we explore an alternative hypothesis. Since its very early evolutionary stages, when language was just beginning to have some properties that made it different from animal communication systems but was very different from today's human languages, the use of language for talking to oneself has been a pressure for the emergence and evolutionary transformation of language itself.

Several recent artificial life simulations have demonstrated that even very simple, non syntactic forms of 'language', can indeed improve basic cognitive capacities like learning and categorization. Furthermore, other simulations have shown how talking to oneself might have played a role in language evolution itself, either as an aid to memory or as a way to self-monitor one's own linguistic production. These simulations point to the fact that language does not need to be complex to aid cognition.

Hence, it seems not only reasonable but also very important to explore the possible role that the use of language as a cognitive aid might have played in the evolution of language. We will conclude our contribution by providing some preliminary ideas on this topic. In particular, we will explore the possibile role that talking to oneself might have played with respect to the transition from a visuo-gestural to a vocal-acoustic language, to the transition from context-based to displaced signals, and to the transition from a-syntactic proto-language to syntactic language.

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### Session 2 - Language and Archaeology

#### From symbols to language. The archaeology of the origin of language and early diversification of languages

Francesco d'Errico, CNRS, Institut de la Préhistoire et de la Géologie du Quaternaire, Talence
Marian Vanhaeren, ArScAn, Ethnologie Préhistorique

In recent years, there has been a tendency to correlate the origin of language and modern culture with that of anatomically modern humans. According to this view, the process that produced our species in Africa must have granted it a number of advantages – syntactical language, advanced cognition, symbolic thinking – that favored its spread throughout the world, determined its eventual evolutionary success, and led to the extinction of pre-modern human populations with little or no biological and, if any, unbalanced cultural interaction. Here, we discuss this correlation in the light of results provided by our first hand analysis of previously excavated and recently discovered relevant archaeological and paleontological materials from Africa and Europe. Our joint effort has involved examination of all categories of potentially symbolic material culture produced by Neandertals and early AMH (personal ornaments, decorated tools, utilized pigments, engraved bones and stones, burials, grave goods, systems of notation, musical instruments, complex bone technologies) from Europe, Africa, and the Near East.

Our analyses have confirmed an early appearance of symbolic practices, possibly associated to modern humans, at sites from Africa and the Near East dated to ca. 100 ky. They have also revealed the presence of modern traits at times and places incompatible with the Out of Africa model as well as a discontinuous pattern with innovations appearing and disappearing or being associated in a way that does not match the expected trend. Multidisciplinary archaeological research has the potential to increase our understanding of the origin of modernity. Language does not fossilize but its origin and the diversification of languages are closely linked to behavioral innovations and spatial patterns in material culture preserved in the archaeological record. We believe that continued research along these lines will provide important keys necessary for unlocking our understanding of the origins of language.

#### The prehistory of Amazonian languages: Ecological and cultural processes underlying linguistic differentiation

Alf Hornborg, Lund University

Attempts to explain the distribution of indigenous languages in Amazonia since the time of European contact, whether by linguists or archaeologists, have generally been founded on an essentialist conception of ethno-linguistic groups as more or less bounded, genetically distinct populations that

have reached their recent territories through migration. This perception of ethno-linguistic diversity is a phenomenon that itself deserves explanation, as it appears to draw on a Eurocentric experience of nation-building that historically has struggled to integrate territory, language, identity, and biology. On closer examination, however, the evidence in Amazonia suggests a much more fluid relation between geography, language use, ethnicity, and genetics. Correlations of data on the physical geography, linguistics, archaeology, and ethnohistory of Amazonia indicate that ethno-linguistic identities and boundaries have been continuously generated and transformed by shifting conditions such as economic specialization, trade routes, warfare, political alliances, and demography. In order to understand the emergence, expansion, and decline of cultural identities over the centuries, we thus need to consider the roles of diverse conditioning factors such as ecological diversity, migration, trade, epidemics, conquest, language shifts, marriage patterns, and cultural creativity. If ethnicity is understood as a means of communicating distinctness, we need to explore criteria for recognizing expressions of identity in the use of language, material culture, and other ethnic markers, acknowledging also that such use may be context-specific, and to trace the specific ways in which Amazonian experiences of distinctness and difference have been shaped by spatially distributed circumstances largely defined by the macro-scale logic of economic and political structures. The main objective of the present project is to build a G.I.S. database for correlating geography, linguistics, material culture (e.g., ceramic styles, rock art styles, horticultural systems, etc.), trade routes, and political projects over time. Correlations thus established can then be used to test or at least illuminate various hypotheses on the emergence and history of specific ethno-linguistic groups. One such hypothesis, offered here as an example, is that the wide distribution of Arawakan languages in greater Amazonia (from the Antilles to Bolivia) is the imprint not so much of ancient migrations as of a network of trade routes spanning much of the continent several centuries before European contact. A corollary hypothesis is that the demarcation and diversification of several other linguistic divisions, such as the separation of Tupí, Carib, and Gê, may have been brought about by wedges of Arawak-speakers along major rivers. Rather than treat human history in the area as explicable in terms of biogeography, such approaches to the linguistics of ancient Amazonia seek explanations in social and cultural processes.

### *Rock art, trade routes, and languages in prehistoric Amazonia: Exploring correlations through GIS*

Love Eriksen, Lund University

The aim of this paper is to investigate how Geographical Information System (GIS) mapping of materialized aspects of human culture in pre-conquest Amazonia can increase our understanding of the distribution of indigenous languages and ethno-linguistic entities. The main objective of the project is to build a GIS database for correlating geography, linguistics, material culture (e.g., ceramic styles, rock art styles, horticultural systems, etc.), trade routes, and political projects over time, in order to gain further understanding of the forces behind the extraordinary linguistic diversity in Amazonia. This presentation will exemplify this methodology, focusing on the relationship between symbolism (as expressed in the frog motive in rock art and green stone amulets), trade routes, and language families. By correlating the distribution of symbolic expressions, such as the frog motive, with known trade routes and the distribution of language families at the time of contact, it is possible to test or at least illuminate various hypotheses on the emergence and history of specific ethno-linguistic groups. One such hypothesis, offered here as an example, is that the wide distribution of Arawakan languages in greater Amazonia (from the Antilles to Bolivia) is the imprint not so much of ancient migrations as of a network of trade routes spanning much of the continent several centuries before European contact.

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### **Session 3 - Language and Brain**

### *The link between human language and action representation*

Luciano Fadiga, Biomedical Sciences, Università degli Studi di Ferrara

In the last decade new evidence is growing in favour of an additional, more cognitive, role played by motor and premotor centers. Clear motor activation is evident when one simply imagines a motor act and it has been shown that during other's action observation, a temporo-parietal-frontal circuit, becomes active in the observer's brain. What is the function of this 'high-level' motor involvement? Why is it that – in order to understand how other individuals act - our brain looks inside its own motor

representations? Is this motor involvement functional to perception or it represents a mere epiphenomenon? In the first part of my talk I will review the neurophysiology of action representation in monkey premotor cortex, then I will describe some TMS experiments on action perception in humans. In the second part of my talk I will show some recent results demonstrating that not only observing actions but also 'listening to actions' enhances the excitability of the motor cortex. During passive listening of speech, normal subjects motorically resonate' by internally re-acting the listened words. If on one side these data give support to Liberman's motor theory of speech perception, on the other side they suggest that "visuo-motor" and "acoustic-motor" matching systems may represent two particular aspects of a more general mechanism, used by the brain to map sensory information on its own motor repertoire. Finally, in my contribution, I will present data and theoretical framework supporting a new interpretation of the role played by Broca's area. Recent brain imaging studies report that, in addition to speech-related tasks, Broca's area is significantly involved also during tasks devoid of verbal content, such as arithmetic calculation and listening to music. Taking into account the large variety of experimental paradigms inducing such activation, I will present neurophysiological and brain imaging data trying to integrate, on a common ground, these apparently different competences.


### The mismatch negativity as an index of the different levels of speech processing

Risto Näätänen, University of Helsinki


### The beginnings of word segmentation in French-learning infants

Thierry Nazzi & Josiane Bertoncini, Laboratoire Psychologie de la Perception, CNRS - Université Paris Descartes

We will present behavioral data tracing the developmental trajectory of word form segmentation in French-learning 8-, 12-, and 16-month-olds. As predicted from our rhythmic-based segmentation hypothesis, these results show that French-learning infants initially parse fluent speech using the syllabic unit, before being able to extract coherent bisyllabic word forms. Taken together with data on stress-based English, Dutch and German showing that infants learning these languages extract trochaic units, the present data on syllable-based French support the claim that rhythmic units play a driving role when segmentation abilities emerge during the second half-year of life.

We will also present data from an ongoing study reassessing the issue of syllable-based segmentation in French using a high-density ERP procedure. So far, we were able to find a word-initial segmentation effect at 12 months of age. Further ERP studies are being conducted to directly assess syllabic segmentation.


### Linguistics universals and language acquisition

Itziar Laka, Universidad del Pais Vasco, Vitoria-Gasteiz
Marina Nespor, Università degli studi di Ferrara

The talk will be divided into two parts, the first by Itziar Laka on Linguistic Universals, the second by Marina Nespor on Mechanisms of Language acquisition.

1. A growing body of experimental studies using neuroimaging techniques explores syntactic processing of natural language. The vast majority of studies focus on Indo-European languages that share central design properties; thus it cannot be determined which findings reflect universal or language-type dependent processing strategies and mechanisms. Expanding the language pool investigated is crucial to achieve this goal. We present and discuss results from studies on complexity, ambiguity resolution and certain grammatical phenomena undertaken on Basque, a non Indo-European language, also considering aspects such as native versus non-native language representation.

2. When humans come into the world and start acquiring language, they have at their disposal their genetic endowment and the speech sounds uttered in the surrounds. It is to those sounds that an infant gets attuned and on the basis of those sounds that it must build the first steps into its linguistic competence.

Recent experiments established that infants are very sensitive to prosody, both to rhythm and intonation. In my talk, I will address the issue of how, in the acquisition of language in the first year of life, some learning mechanisms, at least partly of general nature, and thus possibly shared with other species, are governed by the sound pattern of language.

Two themes will be addressed:
   a. the computation of transition probabilities in the segmentation of continuous speech, and the privileged role consonants play in this only for humans (Bonatti et al. 2007; Newport et al. 2004). A general learning mechanisms is thus modulated by linguistic representations.
   b. The grouping of words within phrases on the basis of the realization of prominence. Since a similar grouping is known to take place in music, a general perception mechanism might be responsible for the acquisition of a purely linguistic notion, i.e. whether heads precede or follow their complements (Nespor et al. submitted).

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### Session 4 - Language Acquisition and Language Universals

#### Shiftability: a key feature of language and thought

François Recanati, CNRS/EHESS, Institut Jean Nicod, Paris

Pre-human thought is arguably egocentric: it only concerns the present situation. In contrast, human language and human thought alike are characterized by the freedom we have to 'shift' the situation which our discourse/thought concerns: that situation need not coincide with the context in which the utterance is made or the thought tokened. How did that crucial feature emerge? Two possible accounts will be considered.

#### The role of intentions in reference

Manuel García-Carpintero, Universitat de Barcelona

Proper understanding of referential expressions such as indexicals ('here', 'I', 'he') and proper names appears to require integrating extra-linguistic information from context - including information about the referential intentions of speakers, perceptual information and memory - with whatever comes from linguistic competence itself. Since the already classic work on the topic by "direct reference" theorists such as David Kaplan, Saul Kripke and Hillary Putnam in the seventies, researchers have debated whether the existence of "informational links" with the referents provided through these cognitive mechanisms is all that it takes to determine the referents, even in the absence of any capacity by speakers to correctly describe or conceptualize them. On the view we subscribe to, the interpreter must integrate pragmatic information about the specific referential intentions of the speaker, with purely semantic information given by his grammatical competence. We propose to make room for the data supporting Millian views by counting the relevant descriptive information not as constituting the truth-conditional content, but rather a grammatically driven presuppositional content. In our presentation, we will introduce the view, and we will discuss whether it is at odds with data concerning the ontogenesis and phylogenesis of language.

#### Cultural embodiment, social practice and space-time analogies in language evolution: evidence from an Amazonian language

Chris Sinha, University of Portsmouth

With Vera da Silva Sinha, Jörg Zinken (University of Portsmouth) and Wany Sampaio (Federal University of Rondônia, Brazil)

The recruitment of spatial lexicon and grammar to linguistically conceptualize time intervals and temporal relations is widespread in the world's languages. It has therefore been proposed that there is a natural, universal cognitive of domain of time, whose linguistic organization is universally derived via metaphoric mapping from the lexicon and grammar of space and motion. We challenge this account on the basis of our research on the linguistic conceptualization of space, motion and time in the Amondawa language and culture of Amazonia. Amondawa is a Tupi Kawahib language with a complex, distributed spatial relational lexicon and verb framed / equipollent motion typology. Like other Tupi languages, Amondawa lacks verbal tense but has a rich nominal aspectual system. It does not employ cardinal chronologies such as ages of individuals, or ordinal chronologies such as yearly or monthly calendars. An abstract term for time

does not exist in Amondawa. The word *kuara* ("sun") is preferentially used to denote time intervals in general, since it is the movement of the sun which governs the passage of both the time of day and the seasons. The system is based not on countable units (the Amondawa number system has only two numerals with a maximum combinatorial value of four, but on social activity, kinship and ecological regularity. The system therefore does not permit conventional "time-reckoning". This does not mean that Amondawa speakers have no time awareness, or that they are unable to talk about temporal relations between events and activities, and between such events and activities and the time of speaking. But they do not talk *about* time, or frame relations between events in terms of a notion of time separate from the events and activities being talked about. This abstracted (or reified) notion of a separate time plane or domain we call the notion of "time as such".

We advance three conclusions. First, time-based time interval systems are constituted by the use of linguistically organized, materially-anchored symbolic cognitive artefacts. Second, the conceptual domain of "time as such" is not a human cognitive universal, but a cultural evolutionary construction constituted by schematic time-based time interval systems, reflection upon which is language and culture dependent. Third, because the cognitive domain of "time as such" is a cultural, historical and linguistic construction, the hypothesis that it is universally constructed by metaphoric mapping from the conceptual domain of space is false. Rather, it is the cultural, historical and linguistic construction of the domain of "time as such" that potentiates the linguistically widespread recruitment of spatial linguistic resources for the structuration of the temporal domain, and perhaps the grammaticalization of temporal relations.

### *Phonetic continuity in babbling and first words? A crosslinguistic answer.*

Barbara Davis, University of Texas, Austin
Sophie Kern, CNRS, Laboratoire Dynamique du Langage, Lyon
Inge Zink, University of Leuven, Leuven

The aim of this study was to compare the developmental trajectory of speech production capacities in children acquiring different languages from the babbling period to the emergence of early grammar. A large number of crosslinguistic studies on early acquisition have shown that children produce largely the same sound patterns in early developmental stages, independent of the characteristics of their ambient language. Studies (Oller, 1980; Stark, 1980) of prelinguistic vocalizations indicate that perceptually rhythmic canonical babbling occurs between 6 and 10 months. Around 12 months of age, the child begins to elaborate his productive vocabulary at a very slow rate before increasing the rate of development at the 50-word mark (termed the 'lexical spurt'). Strong similarities in sound types (i.e., segments), sound combinations and utterance type preferences across different communities have been frequently documented across the babbling and early word periods. Longitudinal investigations of the transition from babble to speech have also shown continuity between phonetic features of an infant's pre-linguistic vocalizations and early speech forms (Oller et al. 1976, 1980; Stark, 1980; Stoel-Gammon & Cooper, 1984; Vihman, Ferguson & Elbert, 1986).

These preferred trends in the babbling and first word periods have been explained by biomechanical models of language acquisition focussed on production system characteristics of young children (e.g., "Frame-content" theory, MacNeilage & Davis, 1990). But language acquisition is also linked to perceptual learning from input. It is generally acknowledged that input from the ambient language plays a role in children's very early perception as early as 8-10 months (Werker & Lalonde, 1988). It has also been proposed that input from the ambient language may also influence the shaping of children's production preferences at some point in the late babbling and first word period, influencing common production system tendencies by the child's learning of precise ambient language regularities.

We have collected and imposed a uniform analysis profile on large corpora for five diverse languages: Turkish, French, Romanian, Dutch and Tunisian Arabic. Twenty children (4 children per language) developing normally were observed in their typical daily environment. One hour of spontaneous vocalization data was audio and video recorded every two weeks from 8 through 25 months in the children's homes. For comparison with the child data for each language, 1,000 dictionary entries from that language employed were transcribed and analyzed.

We will focus on the question of phonetic continuity between babbling and the early lexicon: Do all children follow the above described universal trends? Are the phonetic features used in babbling the same as those used in first words across language environment? Are differences across languages due to the influence of ambient language characteristics or due to child-related individual differences?

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**Session 5 - Gesture, communication and language in Human and Nonhuman primates**

*Gestures, signs and words in the acquisition and development of language*

Virginia Volterra, Institute of Cognitive Sciences and Technologies, CNR, Rome

The present talk focuses on early stages of development exploring the emergence of the gesture anguage system in infancy and his evolution toward the adult system. Old and recent studies carried on within the OMLL project will be described.

Interesting parallels and links between action, gestures  and first words will be presented. The function of gesture in the transition from the one-word to the two-word stage will be briefly discussed. These findings, which illustrate the tight relationship between language and gesture, are compatible with recent work carried out in the study of adult language, as well as with recent neurophysiological discoveries regarding the "mirror neuron system"and language evolution. More recent studies on the relationship between spoken and gestural modalities in children with atypical development (Down syndrome) will be reported and discussed. All of these studies provide evidence on the continuity between prelinguistic and linguistic development and on the interplay between gestural and vocal modalities, both in children with typical development as well as in children whose development proceeds in an atypical fashion.

*Orofacial control in communication in human and non human primates*

### Introduction. A quest: Grounding language in orofacial control

Jean-Luc Schwartz, CNRS, Institut de la Communication Parlée, Grenoble

This project has been conceived as an integrated multi-disciplinary approach to a unique and focussed question, which is: how did human oral language evolve from pre-existing cognitive abilities in primates? This involves a dialectic exploration of both **continuities** – searching the sensory, motor and cognitive pre-human ingredients that could have been "parasited" by speech and language – and **evolutions** – searching the evolutionary steps that could have filled some existing gap to provide a lacking solution to the phylogeny of oral language. A view common to all the partners of this project is that a possible link can be attempted between language and general sensori-motor abilities. This project follows a line of research opened at the beginning of the 70s by the phonetician Bjorn Lindblom, who proposed to "derive language from non-language". The line that could be drawn from pre-linguistic sensori-motor abilities to human language would not only enable to better decipher the origins of language, but also to better explain the language structure, some of its phonological or syntactical universals, provide a framework for grounding language into sensori-motor cognition.

Whatever the emphasis that could be made on the brachiomanual gestures (signs) as a possible step in language origin, it is uncontroversial that *speech* is a crucial viapoint between perceptuo-motor communication and language. The project aims at better understanding the passage *from orofacial control to speech*, around three questions. Firstly, what are the possible continuities and evolutions in the peripheral orofacial equipment from pre-human species including monkeys and fossil humans, to Homo Sapiens? Secondly, what are the cortical circuits available for perceptuo-motor communication in the monkey's brain and possibly used by speech in the human's brain? Thirdly, what computational framework can enable to model orofacial control in speech, and provide an integrating system in which the results of the first two questions could be introduced?

### Reconstitution of fossil vocal tracts: Speech potentialities
Louis-Jean Boë, CNRS, Institut de la Communication Parlée, Grenoble

In the present state of knowledge it is not possible to infer when our ancestors acquired the Faculty of Speech and Language in the Narrow sense [1]: control of speech articulators,

coordination larynx and vocal tract, phonology, syntax, semantic and recursivity. It is not possible to infer which language or languages were acquired by our ancestors and if the languages spoken today derive from a common source. Among old unsolved questions [2]: Why is our species alone in having speech and language? Why is language the way it is? How and when did language come to be this way? Some of these questions are ill posed problems: we do not have sufficiently data to answer. Perhaps these questions will remain unsolved. But we think that the following question can be solved: If we suppose that our ancestors (and distant cousins) controlled their larynx and vocal tract in the same way as present-day humans, did the geometry of their vocal tract allow them to produce the universal sound structures of the languages spoken today?

From classical bony landmarks of the head and jaw used in anthropology, and using a generic model of the vocal tract we attempted to apply the prediction of geometric limits of the vocal tract for modern man to fossils covering a period from 10 ka until 2 Ma (Paleolithic period). We can infer that all the reconstructed vocal tracts could produce the same variety of speech sounds as we can today. But we do not know to what extent they mastered the control skills needed to produce speech.

### *The control of fundamental frequency in human and non-human primates*
Didier Demolin, Université Libre de Bruxelles

One key feature in the evolution of speech is that it requires the evolutionary specialization of vocal fold control in order to modulate the fundamental frequency independently of intensity, a feature that is hardly present in most primates. It is difficult to know when this feature appeared in the evolution but it is likely linked with the descent of the larynx and with the reorganization of the vocal tract in modern humans. One of the main consequences of having the larynx in a low position is that the intrinsic and extrinsic musculature of the larynx is oriented and organized differently in modern humans. In speech, this allows finer adjustments of the vocal folds' tension and a greater control of muscles like the cricotyhroid and the sternohyoid in raising or lowering the fundamental frequency. Another important consequence of the larynx's lowering that has rarely been discussed is the fact that it allows a greater control and a more stable fundamental frequency to produce vocalizations. Hauser (1996) and Fitch (2002) emphasized many times that primate vocalizations are characterized by an instable and more variable source. This has been observed in many different species by Fitch & Hauser (1995), Riede et al. (2004), Demolin et al. (2007), where non linear phenomena such as biphonation, deterministic chaos, frequency jumps and subharmonics have been observed. Even if non linear phenomena can be described in human speech, it is not comparable with non linear phenomena in primate vocalizations. Therefore it is very important to understand the differences between the voice source in non human primates and in human primates.

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### *A left-lateralized communicatory gestural system in non human primates*
Jacques Vauclair, Université de Provence, Aix-en-Provence (to be presented by Jean-Luc Schwartz)

### *A neural substrate for voluntary vocalization in the lateral part of monkey ventral premotor cortex*
Gino Coude, Università degli Studi di Parma

The ventral premotor cortex (PMv) has been subdivided into a caudal area F4 and a rostral area F5. While the medialmost part of these areas has been the object of many investigations, only a few functional studies concentrated on the lateralmost part of these areas, which is mostly

involved in the control of mouth movements. Since anatomo-functional data support a homology between area F5 of macaques and part of human Broca's area, a detailed functional analysis of the ventral premotor sector is particularly important for assessing the differential sensorimotor properties of F4 and F5 and for understanding which of these properties could have played a role in language evolution. This research had two parts: a mapping study aimed to explore the general functional properties of the lateral part of PMv, and a functional study intended to verify whether neurons of lateral area F5 are involved in vocal production. The results of the mapping study suggest a functional subdivision of the lateral part of ventral motor cortex that seems to reflect different roles for the three areas. We hypothetize that lateral area F4 has a role in sensorimotor transformation for mouth actions, while lateral area F5 is more involved in action programming and recognition. This is in agreement with the sensorimotor and cognitive roles of the medialmost part of these areas. The results of the study of vocal production showed that in 20% of the recorded penetrations in F5 there are neurons discharging before or during vocalization. All neurons having a discharge related to vocalization were found within two spatially limited locations in lateral F5. These data suggest that this sector of area F5 contains a population of neurons involved in the voluntary control of vocal production. However, their limited number indicates that this control is an emerging property in the monkey, subsequently exploited in evolution of speech. Altogether, our results give further support to the proposed homology between Broca's area and F5.

### The main project achievements, conclusions and perspectives
Jean-Luc Schwartz

### The origins of primate semantic and syntactic abilities

#### Proto-syntax in Campbell loud Call?
Karim Ouattara, Centre Suisse de Recherche Scientifique, Ivory Coast

There is an increasing consensus that questions about the evolutionary origins of human language can be successfully targeted by studying animal behaviour, and particularly primate communication. Some primates, such as Diana monkeys, produce acoustically different alarm calls that function as referential labels for different predator classes. Others, such as putty-nosed monkeys or Campbell's monkeys, also produce different alarm call types, but combine them into different sequences that are meaningful to other monkeys. We conducted a two-year field study with wild Campbell's monkeys in Taï Forest, Ivory Coast, to investigate the acoustic features and combinatorial properties of male loud call sequences. We recorded 200 loud calls from the males of four habituated groups. We found that call sequences were composed of between 1 to 15 successive calls from a repertoire of seven acoustically different call types. We identified eight sequence types, which were given in highly context-specific ways. While some sequences were given in response to different predators, such as eagles, leopards, or humans, others were given to non-predatory animals, hetero-specific alarm calls, and falling branches and males sometimes produce specific sequences to the presence of stranger males. Our results suggest that Campbell's monkey call sequences have the potential to inform each other about a range of external events, including predator presence, intra-specific competitors, and spatial issues. To what degree these different call sequences are perceived as meaningful signals by other group members is the topic of ongoing research.

#### Meaningful call combinations in free-ranging putty-nosed monkeys: population differences between Nigeria and the Ivory Coast
Anderson Bitty, Centre Suisse de Recherches Scientifiques Abidjan, Ivory Coast

Some non-human primates produce acoustically distinct alarm calls to different predators, such as eagles or leopards. Recipients typically respond to such calls as if they have seen the actual predators. Adult male putty-nosed monkeys produce two basic loud calls when threatened by predators. "pyows" are mainly used against leopards (Panthera pardus) while "hacks" are primarily used against eagles (Stephanoaetus coronatus). Interestingly, however, these monkeys also regularly combine these two alarm call types into a structurally more complex sequence, the "pyow-hack" unit. In Nigeria, we found that the pyow-hack unit functions to initiate group travel, regardless of context. Putty-nosed monkeys occur throughout the West African rainforest belt, which prompted us to test whether the "pyow-hack" unit is a species-specific combinatorial signal, which functions to initiate group movement in all putty-nosed monkeys. We conducted playback experiments with nine non-habituated putty-nosed groups in the Tai Forest, Ivory Coast. In addition, we followed one habituated putty-nosed group to monitor all the distances

travelled in relation to the male's calling behaviour. Results from the Ivorian and Nigerian populations revealed strikingly different patterns. Unlike what we found in the Nigerian population, the Ivorian putty-nosed monkeys did not travel further after producing call series that contained a pyow-hack unit. We discuss these results in light of more general cognitive skills underlying primate communication, and suggest that the observed population differences might be a rare example of cultural divergence in non-human primate communication.

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## Session 6 - Language and Genes

### Pioneers of Island Melanesia: a joint project between British, Dutch, German and Swedish teams

Michael Dunn, Max-Planck-Institute for Psycholinguistics, Nijmegen
Eva Lindström, Stockholm University, Stockholm

The project "Pioneers of Island Melanesia" has sought to integrate genetic, archaeological, bio-anthropological and linguistic sources of evidence to shed light on the human history of island Melanesia prior to the Austronesian expansion into the Pacific. This history is complex: diversity in each domain is a product of phylogenetic (tree-like) and reticular (network-like) processes. In the case of linguistic and biological/genetic diversity, the project has developed innovative quantitative, computational methods to render the patterns of diversity commensurable and has produced novel and in some cases counter-intuitive results.

### Linguistic, cultural and genetic perspectives on human diversity in west-central Africa

David Comas, Unitat de Biologia Evolutiva, Universitat Pompeu Fabra, Barcelona
Lluis Quintana-Murci, UP Human Evolutionary Genetics, CNRS URA 3012, Institut Pasteur, Paris
Lolke J. van der Veen, UMR 5596 — CNRS / Université Lumière - Lyon 2

The present project is focused on west-central Africa and, among others, addresses issues related to the so-called 'Bantu expansion' and the peopling of the Gabon area. Human diversity was examined from linguistic, cultural and population genetic perspectives. Until very recently this part of the African continent was only very poorly represented from the genetic point of view (Salas et al. 2002; Cruciani et al., 2002) but currently more than 1400 samples are available for this region, most of which have been carefully studied in the context of our project.

First, it was found that there is a lack of clear correlations between languages and genetic markers, in particular for the Bantu-speaking agriculturalists. The analysis of mitochondrial DNA (mtDNA) variation in Gabon revealed only one clear grouping, viz., the MYENE-TSOGO cluster. The analyses of both mtDNA and Y-chromosome variation, reveal that the homogeneity within Bantu-speaking villagers is high, maybe due to the recent Bantu expansion (from 4,000 YPB on) and/or to the extent of admixture. However, there are clear genetic differences between the agriculturalist ('Bantu') populations and the (semi-)nomadic hunter-gatherer populations (the so-called 'Pygmies'). Taking into account 29 populations (20 'Bantu' populations and 9 hunter-gatherer groups), the study of the mtDNA variation strongly suggests the shared (ancient) maternal ancestry of modern (currently Bantu-speaking) agriculturalists and western hunter-gatherer populations. More generally, our mtDNA data suggest

  (i)   an initial divergence of the ancestors of contemporary Pygmies from an ancestral Central African population starting not earlier than ~70,000 years ago,
  (ii)  a period of isolation between the two groups needed to explain their phenotypic differences, and
  (iii) long-standing and asymmetrical maternal gene flow from Pygmies to (proto) agriculturalists, starting not earlier than ~40,000 years ago and persisting until the last few thousands of years.

As for the study of the Y-chromosome variation, based on 22 populations (19 'Bantu' populations and 3 hunter-gatherer groups), some typical agriculturalist male lineages have been found in the hunter-gatherer populations, but not the other way around. This finding can be accounted for by paternal gene flow from Bantu-speaking villagers to hunter-gatherers. A small amount of (non-African) lineages

present in agriculturalist populations have been found. These could be the result of expansions in Central Africa coming from northern parts of the continent, and prior to the Bantu expansion.

Most obviously, the extent of language replacement has been underestimated. The extremely complex and probably frequent interactions between the different Bantu-speaking populations will most certainly have caused language shift, language merger and language death. Marriage strategies (mating patterns) must have played a considerable role.

Another important conclusion is that the ethnic (i.e., ethnolinguistic) groups are very much socially and culturally determined. The lineages (as sub-parts of the ethnic groups) probably form more relevant entities for the type of investigation we were (and still are) interested in.

The presence of a non-African haplogroup (R1b) in some 'Bantu' populations such as Fang, Punu and Teke, sheds new light on the migration movements and contacts of these groups. Although the origin and the distribution of this particular haplogroup still remains to be examined more closely, it might conceal a valuable contribution to the study of the history of the populations of sub-Saharan Africa.


### The berber and the Berber: genetic and linguistic diversity

#### The chronology and the homeland of Berber
Maarten Kossmann, Leiden University

One of the elements which are necessary for the understanding of the possible links between genetics and linguistics is the linguistic analysis of the time depth and geographical spread of the language. In this presentation, I will discuss some of the problems encountered in this respect in the specific case of Berber in Northern Africa, and give some approximate indications on chronology and geography.


#### Autosomal genetic data on Berber populations
Pedro Moral Castrillo, Universitat de Barcelona

Findings from different mutation rate autosomal markers on the differentiation and history of Berber populations


#### Mitochondrial diversity in Berber populations
Clotilde Coudray, Université Paul Sabatier, Toulouse III

See abstract of Dugoujon below.


#### The berber and the Berber: genetic and linguistic diversity
Jean-Michel Dugoujon, Laboratoire d'Anthropobiologie, CNRS and Université Paul Sabatier, Toulouse III

Our objectives are to correlate linguistic, historical and genetic studies. In our project - which associates genetic and linguistic expertise - we are in a uniquely favorable position to address these problems, since we are able to control the precise language affiliation of the donors, thus enhancing the reliability of the results. In the following the term "Berber" is defined on linguistic grounds. A Berber is someone who speaks a Berber language as his native tongue.

Genetic data show that oriental Berbers from Siwa differ strikingly from North African Berbers. Results on mitochondrial DNA (mtDNA), Y chromosome and Alu insetions are presented. For understanding the peopling in North Africa, we compare the mtDNA diversity of Berber populations with geographically related populations (in particular from south-western Europe, the Middle East and sub-Saharan areas). Our results show that North Africans have, in the total mitochondrial diversity, an intermediate position between European and sub-Saharan populations. More precisely, we see a genetic differentiation between North-Western and North-Eastern African groups: populations from the Maghreb are related to European and Middle Eastern populations whereas High Egyptians share more affinities with sub-Saharans and East Africans. Actually, the Berber mitochondrial pool is composed of 44 to 84% of H, HV, J, T, and U* haplogroups (frequents in European populations), of 13 to 47% of L sub-Saharan haplogroups, of 0 to 16% of M1 haplogroups (frequents in East-Africa) and of 0 to 28% of the predominantly North-African U6

haplogroup. Our data also reveal a clear and significant genetic difference between Berbers from the Maghreb and Egyptian Berbers. The first are related to European populations (24 to 38% of H haplogroup in Moroccans vs. 1% in Egyptians) while the latter share more affinities with East-African populations (16% of M1 haplogroups in Egyptians vs. around 0% in Moroccans, and L3i and L4g East-African haplogroups only observed in the Siwa oasis). Finally, the U6 North-African haplogroup is observed only in Berbers from the Maghreb.

We analyzed the Y chromosome diversity of seven Berber-speaking populations (N = 400) from Morocco and Algeria (northwestern Africa), Egypt (northeastern Africa) and Niger (central Africa) by analyzing biallelic (both new and previously described) and microsatellite markers. For comparison, we also analyzed other Afroasiatic-speaking populations from northern (N = 235), eastern (N = 318) and central Africa (N = 70). Y chromosomal haplogroups were also unevenly distributed among Berbers from northwestern, northeastern and central Africa, with a reduced degree of haplogroup sharing among regions. Conversely, a consistent portion of the gene pool of the Berbers from northeastern and central Africa was shared with some sub-Saharan populations suggesting possibly ancient contacts with these populations. Finally, when Afroasiatic speaking populations here analyzed were grouped following their linguistic affiliation (Berber, Semitic, Cushitic, Omotic and Chadic), we observed a low level of apportionment of the Y chromosome diversity among groups, suggesting that the Afroasiatic linguistic branches spread independently with respect to genes.

The case of Berber shows this very clearly. One of the elements necessary for the understanding of the possible links between genetics and linguistics is the linguistic analysis of the time depth and geographical spread of the language. In our presentation, we will discuss some of the problems encountered in this respect in the specific case of Berber in Northern Africa, and give some approximate indications on chronology and geography (homeland of Berber). It proves to be very difficult to correlate the actual and reconstructable spread of the Berber languages with archaeological and genetic evidence. This lack of correlation may provide us with indications of the type of linguistic expansion we are dealing with.

### Emergence and flow of gene lineages and languages along the steppe belt and beyond

Richard Villems, Estonian Biocenter, Tartu

In my presentation I will discuss some general problems of the temporal and spatial variation of haploid genetic systems alongside the steppe belt, extending from Manchuria to Europe and to discuss the results in the context of the mayor language phyla in the same region as they exist at present.

### Genetic and linguistic diversity in Central Asia

Evelyne Heyer, Museum National d'Histoire Naturelle, Paris
François Jacquesson, Laboratoire des Langues et Civilisations de Tradition Orale, CNRS, Villejuif
Svetlana Jacquesson, Max-Planck-Institute for Social Anthropology, Halle

The OMLL project "East meets West" will be represented by three speakers: François Jacquesson and Svetlana Jacquesson for social anthropology and linguistics of Central Asia and Evelyne Heyer for human genetics in Central Asia.

François Jacquesson (coordinator) will describe what was done in North-East India. NE India consists of a main valley, created by the Brahmaputra river, and the mountains around. It is a land of mixed influences: India from the west, and South-East Asia from the east and south. The question was: how populations from different regions got mixed or separated in the area and how to reconcile the old idea of "migrations" with the regional dynamics, which provide good examples of both local merging and local splitting.

Svetlana Jacquesson will describe how the human groups that have been studied were selected and identified in Central Asia. She will also dwell on « social structures »: what do interviewing people in the field tells us about social structure and what is the place of a concept such as « social structure » in current social anthropology.

The subproject of Evelyne Heyer highlights the differences in genetic diversity between ethnic groups belonging to the Turkish language family and those belonging to Indo-European language family. In

particular, we focused on the impact on social organization on the genetic diversity of these populations since Turkish populations are organized in patrilineal descent groups (lineages, clans and tribes), with rules of exogamy, whereas Indo-European populations are organized in families, with rules of endogamy. We have shown that Turkish populations, but not Indo-European populations, exhibited a significant loss of intra population genetic diversity for their Y chromosome (inherited from father to son), as a result of the dynamics of their patrilineal descent groups and significant genetic differences among populations regardless of their ethnic group considered. We have also shown that Indo-European populations are differentiated for their mitochondrial DNA (transmitted from mother to daughter), whereas Turkish populations are not differentiated even at the ethnic groups level. This observation is likely to result from the different ways of exchanging spouses among populations, with fewer exchanges between Tajik populations than between Turkish populations.

Using autosomal neutral markers, we further observe the differences between Turkish groups and Indo-European groups, with the Turkish group being more closely related to eastern Eurasia, and the Indo-European being closely related to Europe and Pakistan. These autosomal markers also enable us to identify several populations who have gone through a language shift.

Regarding linguistic data, we have been able to design a field study and methodology that enable the computation of linguistic distances. The correlation between linguistic and genetic distances is in process.

These linguistic groups also have differences in life style that have had an impact on the evolution of their genes involved in the detoxication (NAT2) and genes involved in alimentation (Lactase persistency).


### *Language and genes of the Greater Himalayan Region*

Mark Jobling, University of Leicester

The greater Himalayan region contains the highest geographic barrier on Earth and is home to the most ethnically and linguistically diverse human populations in Eurasia. Most language communities belong to one of two language families: Tibeto-Burman (T-B), thought to have moved out of China into the Himalayan region several thousands of years ago, and Indo-European (I-E), thought to have come from Northern India more recently. Did languages and genes codisperse? What genetic pattern is found at the boundary between the two dispersals? Can we determine whether geography or language had the greater impact on the distribution of genes? How has the microgeographical mosaic of valleys and mountain ridges affected genetic diversity in the region? We present data on a wide range of genetic markers in >2,000 individuals from distinct ethno-linguistic groups of both Nepal and Bhutan. Our studies of HVS1 and coding region SNPs of mitochondrial DNA, plus SNPs and STRs on the Y chromosome and autosomes, show that the I-E speaking Himalayans are more closely related to I-E speakers in other regions of the world, while the T-B speakers in Nepal and Bhutan are closer to T-B speakers in China. These results point to a movement of genes along with the T-B and I-E speakers to the Himalayas, creating a genetic boundary that almost perfectly corresponds with the linguistic boundary. Surprisingly, Nepal and Bhutan contain much greater genetic diversity than their larger neighbouring countries, probably reflecting more subdivision and genetic drift in smaller populations. A detailed analysis of Bhutan shows that the extreme geography of the region patterns genetic diversity, with the number of walking days between populations explaining a greater proportion of diversity than map distances.