

[Judit Gervain](#)

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*Why is speech special: An efficient neural coding perspective*

Recent advances in the understanding of the neural encoding and information processing properties of the mammalian auditory system make the time ripe for a rethinking of the logical problem of language acquisition. Indeed, the speech signal encoded by the auditory system serves as the input for language learning. Importantly, auditory processing transforms this signal by organizing it into different representational patterns. The talk will present a series of near-infrared spectroscopy and behavioral studies with newborns and young infants investigating the general hypothesis that these transformations have a direct impact on early language learning. In particular, I will show that certain properties of the speech signal are responded to and encoded by the developing brain in an information theoretically optimal way. For instance, newborns process time-compressed speech in ways that are adult-like, adapting to speech compressed to 60%, but not to 30% of its original duration. The newborn brain also selectively recognizes environmental and speech sounds that show scale-invariance, a hallmark of neural encoding in several perceptual systems including hearing, in their spectro-temporal properties. The implications of these results for why speech is a special signal and how its auditory processing facilitates language acquisition will be discussed.

[Jean-Rémy Hochmann](#)

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*Same but not Different?*

The concepts same and different have been the topic of many studies as the paradigmatic example of abstract relations, which are necessary to the development of language and logical reasoning. They are also interesting for another reason: they are linked by negation: SAME IS NOT DIFFERENT, and DIFFERENT IS NOT SAME. Do infants represent these two relations? Do they represent the logical link between them? In a series of anticipatory looking and pupillometry experiments, I investigate infants' ability to represent these abstract relations. In 4- to 14-month-olds, we find strong evidence in favor of a representation of the relation

SAME. Evidence for a representation of DIFFERENT are much weaker. I will suggest that this pattern of success and failure tells us something about the limitations of infants' language of thought and the format of their representations.

### Bahia Guellai

Laboratoire Ethologie, Cognition, Développement (LECD) – Université Paris Ouest Nanterre La Défense (UPOND), France.

#### *The multimodal aspects of prosody*

Speech is a multimodal experience: it is perceived both by the ears and the eyes. While studies evidenced that seeing someone talking influences adults' and infants' perception of speech, it is not clear which aspects of the speech signal are conveyed visually. Here, we explored the possibility that prosody can be perceived both auditory and visually from the earliest stages of development. In a first study, we examined this possibility in infants from birth. Using a movement capture system, we recorded female faces talking in an infant-directed speech (IDS) style and presented audiovisual displays to infants. IDS provides specific auditory and visual prosodic cues such that facial movements are exaggerated. Here, we investigated if infants were sensitive to the match between the auditory and visual correlates of ID speech prosody from birth, and how this capacity develops during the first year of post-natal life. In a second study, we explored the possibility that prosody can be perceived not only in the facial movements of the speaker but also in his/her gestures. Two experiments tested this possibility in adults. Experiment 1 shows that gestures provide prosodic information, as adults are able to perceive the congruency between a low-pass filtered – thus unintelligible – speech and the gestures of the speaker. Experiment 2 shows that participants can use the prosodic information contained in gestures to disambiguate sentences with two alternative meanings. Overall, the results suggest that the prosodic structure of speech from voice and head/gestures kinematics are highly connected. Perspectives of this work will focus on detailing this connection using EMG techniques.

[Silvia Benavides](#)

Università degli Studi di Padova

*The foundations of word order*

Silvia Benavides-Varela (1), Judit Gervain (2)

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The ability to remember sequential order information is critical for the mastery of grammar. We carried out two near-infrared spectroscopy studies aiming at investigating whether the ability to detect violations of word order in linguistic sequences is already present at birth. Newborns were presented with repetitions of ungrammatical sequences consisting of four French words (e.g. de appel et aller ‘from call and go’). For one group of infants, the sequences were recorded as intonational phrases, with well-formed prosody. For another group of infants, the words were recorded separately with list intonation and concatenated, so the sequences had no well-formed intonational phrase prosody. In each condition, sequences were presented six times, five times in an identical fashion (e.g. “de aller et appel”) and the sixth and last time with a violation of the order of words (e.g. “de et aller appel”). We found that newborns could detect the violation of the word order in the list intonation condition, but not in the well-formed prosodic unit condition. These results suggest that while newborns are already sensitive to word order in linguistic sequences, prosody appears to be a stronger cue than word order for the identification of linguistic units at birth.

[Juan Manuel Toro](#)

ICREA - Universitat Pompeu Fabra

*Perceptual biases and linguistic representations: exploring what we share and what we do not share with other animals during language processing*

Here I will briefly review three lines of experiments suggesting humans share with other animals some basic perceptual mechanisms we use for language processing, but also use specialized representations that are uniquely human. Research on the Iambic-Trochaic Law and on the ability to track relative frequency of elements in a sequence has shown that we share with other species perceptual biases that we apply to linguistic stimuli. On the contrary, research on processing differences between

consonants and vowels suggests humans, but not other animals, benefit from a “division of labor” across phonological representations. The studies I will present provide support to the idea that perceptual biases combined with language-specific representations guide the discovery of linguistic structures.

[Ansgar Endress](#)

City University London

*Working memory capacity and interference*

Working memory (WM) is used to temporarily retain items that are manipulated by ongoing cognitive operations, and is thought to have a capacity of 3 or 4 items, and that these capacity limitations reflect the limitations of active maintenance mechanisms. However, the evidence for such severely capacity-limited memory stores mostly comes from experiments with substantial interference among items. Here, I show that such capacity limitations are removed once interference among items is reduced. Further, I prove mathematically that, under general conditions, the presence of interference among items guarantees fixed and limited capacity limitations. I also present experiments suggesting that the forms of attention that supposedly yield capacity limitations of 3 or 4 items have fundamentally different properties from memory, suggesting that they cannot be the reason for WM limitations. Based on these and other experiments, I propose a unitary view of STM, LTM and WM. With brief presentation durations, memory has a large capacity but is fleeting. When memory items are presented repeatedly or for longer durations, they become gradually stabilized into LTM representations. If proactive interference is added, memory capacity becomes compatible with past WM capacity estimates.

[Hanna Marno](#)

Central European University

*The role of language in social cognition: Beyond the social groupism effect*

In the past many studies investigated the effect of language perception on social cognition. These studies showed that already newborns prefer to listen to a person who speaks their native language (Nazzi et al., 1998; Mehler et al., 1988). By the age of six months infants look longer to a person, who previously spoke in their native language, and at the age of ten months they tend to reach more for a toy that is offered by a person with whom they share the same language (Kinzler et al., 2007). At twelve months they are more influenced by the attitudes of speakers of their native language (Shutts et al., 2009) and by the age of five years they would choose friends based on which language they speak (Kinzler et al., 2009). Thus, from a very early age, perceiving language has a strong effect on social cognition. As many researchers claim, this preference for native language is the basis of dividing the world into social groups and establishing ingroup-outgroup dispositions (Kinzler, 2007). However, it is that possible sharing the same language does not only influence social cognition, but also attention and memory processes. We propose that infants prefer speakers of their native language also because the probability that they could acquire some new and relevant knowledge from them is higher, compared to when the source of information is a foreign speaker. Thus, we predict that when infants are exposed to some new information, presented by either a native or a foreign speaker, they will pay more attention to the information they receive from a speaker of their language, which can have an impact on later learning processes. To test this prediction, we made an experiment with forty, 12-month-old monolingual Italian infants, who were first familiarized with two Italian and a Slovenian bilingual speakers, one of them talking in Italian and the other talking in Slovenian to them. After the familiarization, in the Teaching Phase infants saw a sequence of movies, where each of the two speakers silently gazed towards two unfamiliar objects. At the Test Phase infants saw only the objects in pair, without the speakers being present, to eliminate that infants' looking would be biased by their preferences towards the speakers. Results revealed that they preferred to look at the object that was presented by the Italian speaker, compared to the object that was presented by the Slovenian speaker, even though at the teaching

phase they spent equally long time by looking at both object. Recent results with 5-month-old infants indicate that this effect is also present at much younger age. These findings provide evidence that infants both at the age of twelve and five months tend to pay more attention to an unfamiliar object presented by a person with whom they share the same language. We believe that this selectivity can serve as a basis for establishing social learning processes by influencing infants' choices between potential sources of information in their environment.

### [Ernő Téglás](#)

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#### *Disjunctive inferences in a visual search task: an eye tracking study with 10-month old infants*

Rational action requires that agents adequately represent the available choice alternatives. Studies exploring search strategies in preschoolers suggested that in the process of eliminating possible locations they proceed deductively representing the available choice alternatives in terms of disjunctions (A or B, not A, therefore B). These experimental protocols required participants to represent the alternative hypotheses and update the representation of possible outcomes after the alternatives are verified. In a comparative study involving preschool-aged children and dogs, Watson et al. (2001) proposed that these abilities are present only in children: when a target item was hidden in one of three possible locations the searching time decreased as alternatives were eliminated, specially it was the shortest when children could infer the location of a target with certainty. In contrast, however, dogs displayed a prolonged searching time as they progressed from one alternative to the other. Logical operators, such as disjunctions allow for representing different hypotheses and determine the valid inferences that can be performed when alternatives are eliminated. Thus, the search-time pattern observed in preschool-aged children (specifically, that the more choice alternative were eliminated the faster the search became) could be considered as a marker of disjunctive inferences.

It is not yet known, however, whether logical connectives are available early in development. According to one possibility, in order to reason deductively children need first to master the verbal representation of

logical connectives. According to another possibility such abilities might not depend on language and might be present already in pre-linguistic thought. In order to disentangle between these scenarios we tested pre-linguistic infants and explored whether they possess the representational resources to reason using disjunctive syllogisms. To address this question, in our main experiment we developed an interactive eye-tracking paradigm involving 10-month-old infants. We measured whether their searching behavior (as reflected by their eye movements) would reflect similar patterns as the manual search observed in preschoolers. The participants saw three cups on a computer screen positioned at equal distance from each other. Infants could verify the content of a cup by looking at the corresponding region of interest (i.e. cup A, B and C). In each trial one of the cups contained an interesting object while the others were empty. The study was designed in such a way that at each stage of verification they had equal chance to find the rewarding object. Infants could verify the cups one by one and a trial ended if the target object was found. Of special interest were those trials where infants needed to verify all three possibilities in order to identify the final location of the object. We collected the temporal parameters of this search process, specifically we measured the speed of the gaze-shift from one location to the other. In contrast to preschool-aged children, 10-month-old infants were slower in verifying a third possibility in comparison to the time needed to check the preceding locations (even though the third location contained the object with 100% certainty). Ongoing experiments explore the factors responsible for this pattern.

[Ágnes M. Kovács](#)

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*Belief Files and further ToM subcomponents in infants and adults*

Everyday social interactions require efficient mechanisms to infer others' goals and beliefs. Despite extensive research, the development and the underlying mechanisms of such Theory of Mind (ToM) abilities remain poorly understood. It is still unclear what exact processes implicit and explicit ToM reasoning requires, how these develop, and how attributed and regular representations differ. To answer these questions ToM abilities should be divided into separable underlying component mechanisms. I will analyse three potential components: i) opening a

'Belief File'; ii) computing the belief content; and iii) sustaining two belief representations concurrently. First, I will present a series of behavioural and eye tracking studies suggesting that two components (i,ii) are already present in young infants. Next, I will describe fMRI and behavioural evidence suggesting that implicit ToM favors specific belief contents (i.e., beliefs about the presence, but not the absence of objects). Finally, I will discuss neurophysiological data from infants suggesting that they can deal with two belief representations concurrently, and that attributed and regular representations seem to be encoded in a similar format. A separate investigation of ToM subcomponents will lead to a better understanding of how ToM operates in typical and atypical development, generating new perspectives for understanding social interactions crucial to human societies.

[Mohinish Shukla](#)

University of Massachusetts, Boston

*Do certain concepts need grammar for their development? The case of two-place predicates*

A fundamental challenge in cognitive development is understanding precisely which concepts are innate, what are the learning mechanisms, and what is the data over which these mechanisms and innate concepts are deployed in order to develop adult cognitive competences. Within this broad framework, a subset of theories have suggested that the acquisition of grammatical, structural forms might be causally necessary for the development of certain classes of concepts. One example of this is simple predication that takes two arguments, as in "Judith pushes Agnes." In order to correctly assign the meaning of such a phrase, not just the three words, but their precise relation is important if one is to distinguish an event of Judith pushing Agnes from one in which Agnes pushes Judith. In this study, we compare infants and adults in their ability to discriminate and classify videos (without accompanying language) of such reversible, two-argument predicates. Notably, we use an identical anticipatory looking task with both infants and adults. The adult data replicates previous studies – anticipatory looks towards videos matching the primed structure (e.g., dog pushing car) were greater than towards their reversed counterparts (car pushing dog), but only when adults were not

simultaneously engaged in a linguistic task. The aggregate infant data does not show clear evidence for learning to anticipate the primed structure.

### [Albert Costa](#)

ICREA Research Professor, Universitat Pompeu Fabra

*“If you talk to a man in a language he understands, that goes to his head.  
If you talk to him in his language, that goes to his heart.”*

We are constantly making decisions of many different sorts. From more mundane decisions such as which clothes to wear every morning or where to go for lunch, to more relevant ones, such as whether we can afford the price of a nice holiday on a Pacific island, or whether an investment plan is too risky; decision making is an everyday life activity. It is well known that frequently our decisions often depart from a purely rational cost-benefit economical analysis, and that indeed they are biased by several factors that prompt intuitive responses that often drive the decision made. In this talk, I will describe several studies in which there is a pervasive effect of the language in which problems are presented on decision making. These studies cover economic, moral and intellectual decisions. Together the evidence suggests that a reduction in the emotional resonance prompted by the problem leads to a reduction in the impact of intuitive processes on decision making. This evidence not only helps to understand the forces driving decision making, but it also has important implications for a world in which people are commonly faced with problems in a foreign language.

### [Luca Bonatti](#)

ICREA and Universitat Pompeu Fabra

#### *Behavioral markers of inference making in infants and adults*

Infants possess several mechanisms to solve domain-specific problems. However, little is known about infants' abilities to reason beyond these limited domains. I will present evidence that when they witness a scene not previously experienced, infants reason about it by applying basic

logical principles. I will argue that such inferences are used to build strategies to inspect the scenes and make inferences to enrich knowledge. I will argue that specific behavioral correlates of this inferential processes can be identified and studied.

### [Marcela Peña](#)

Laboratorio de Neurociencias Cognitivas, Pontificia Universidad Católica d Chile.

#### *Rhythm, resonance and language acquisition*

Speech and human brain are rhythmic by nature. Do these rhythmic activities couple? Whether and how this coupling does supports language acquisition? We explored these questions here. We present a series of studies showing that the infant brain resonates with speech units such as syllables and words during language learning. Indeed, exposed to a 3 minutes long monotonous continuous artificial speech stream composed by 9 tri- syllabic nonsense words, the brain of 8 months old infants initially resonates to the frequency of the syllable but after 20 to 30 seconds starts to resonates at the frequency of the words, suggesting that have being able to discovering the words. Additionally, infants who showed that switching from syllables to words, show higher success recognizing words after listening the speech stream. We also show that synchrony not only involves speech, but other rhythmic communicative behaviours such interpersonal interactions between mother and infants, during situations such as turn taking. Taken together the data suggest that brain activity can synchronize with external stimulation during learning, that the synchrony between the brain and the external rhythmic stimulation may reflect an efficient mechanism for language and communicative learning in young infants, and that brain synchrony may be a new tool to estimate on-going learning.