5th edition

CogEvo

Rovereto Workshop
on Cognition and Evolution

6-9 July 2016
Palazzo Piomarta (Istruzione) corso Bettini, 84
Rovereto (Italy)

Program

Day 1 Wednesday, July 6th

18.00 Registration and Welcome Reception

Day 2 Thursday, July 7th

Morning Session
09.00 Registration
09.45 Introduction to the workshop: **Giorgio Vallortigara**
10.00 **Ghislaine Lambertz-Dehaene**, *100% of adults have been infants: Why studying infants is a necessary step to understand human cognition*
11.00 Coffee Break
11.30 **Martin Giurfa**, *Cognition with few neurons: higher-order learning in insects*

Afternoon Session
15.00 Poster Session 1 & Coffee Break
16.30 **Josh Tenenbaum**, *Reverse-engineering common sense in the human mind and brain*

Day 3 Friday, July 8th

Morning Session
10.00 **Stanislas Dehaene**, *Elementary mechanisms of sequence and syntax in human and non-human primates*
11.00 Coffee Break
11.30 **Lisa Feigenson**, *How Core Knowledge Drives Learning*

Afternoon Session
15.00 Poster Session 2 & Coffee Break
16.30 **Daniel Hanus**, *Probabilistic judgments in chimpanzees*

18.30 Social Dinner

Day 4 Saturday, July 9th

Morning Session
10.00 **Justin Halberda**, *How might our evolution-built systems of core cognition span the gap to our lexical semantics*
11.00 Coffee Break
11.30 **Tecumseh Fitch**, *A comparative approach to understanding neural computation*
12.30 Closing: **Elizabeth Spelke**

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ABSTRACTS

Ghislaine Dehaene-Lambertz

100% of adults have been infants: Why studying infants is a necessary step to understand human cognition

The human infant is the only known example of a neural machinery able to rapidly master a natural language and develop explicit, symbolic, and communicable systems of knowledge. The development of non-invasive brain imaging techniques has opened the possibilities of examining the characteristics of this cerebral architecture underlying these cognitive successes. Concerning language for example, we note that parallel and hierarchical processing pathways are observed before intense exposure to speech with an efficient temporal coding in the left hemisphere and that frontal regions are involved from start in infants' cognition. Although still sparse, these observations illustrate a new approach which relies on a better description of infants' structural and functional architecture in order to shed light on humans' cognitive functions.

Martin Giurfa

Cognition with few neurons: higher-order learning in insects

Insects possess miniature brains but exhibit a sophisticated behavioral repertoire. Recent works have reported the existence of unsuspected cognitive capabilities in various insect species, which go beyond the traditional studied framework of simple associative learning. I will focus on capabilities such as attentional modulation and concept learning, and discuss their mechanistic bases. I will analyze whether these behaviors, which appear particularly complex, can be explained on the basis of elemental associative learning and specific neural circuitries, or on the contrary, require an explanatory level that goes beyond simple associative links. In doing this, I will highlight experimental challenges and suggest future directions for investigating the neurobiology of higher-order learning in insects, with the goal of uncovering basic neural architectures underlying cognitive processing.

Josh Tenenbaum

Reverse-engineering common sense in the human mind and brain

Stanislas Dehaene

Elementary mechanisms of sequence and syntax in human and non-human primates

How do human representational capacities differ from those of other species? Language, music and mathematics are prime examples of domains that seem uniquely developed in humans. Hauser, Chomsky and Fitch hypothesized that they reflect a human-specific ability to represent recursive or nested structures. In this lecture, I will present recent fMRI data from my laboratory exploring the issue of human uniqueness for language and mathematics. In the first part, I will present human fMRI data suggesting that linguistic and mathematical structures involve parallel circuits passing through distinct sectors of inferior frontal cortex. In the second part, I will describe our efforts to reduce the complexity of these tasks by studying the encoding of abstract auditory patterns in human adults, infants, and macaque monkeys. fMRI studies in monkeys and humans suggest that both species possess dissociable dorsal and ventral circuitry for number and sequence patterns, but that only humans are assembling both sources of information into a single integrative representation in bilateral inferior frontal gyrus.

Lisa Feigenson

How Core Knowledge Drives Learning

Across species and across human development, core knowledge empowers expectations about the physical and social world. Many non-human creatures—as well as very young human infants—exhibit knowledge about how objects should behave, how quantities should transform, and how social agents should act. This core knowledge has often been thought of as an alternative to learning. In contrast to this “static knowledge” view, I will describe recent findings from infants and children that show that core knowledge shapes the acquisition of new information. Across a range of learning content and tasks, babies and children show enhanced learning for entities that violated their basic expectations, and test hypotheses for these violations. These findings suggest that foundational knowledge can drive new learning.

16.30 Daniel Hanus

Probabilistic judgments in chimpanzees

While several studies have demonstrated apes’ capability to discriminate between discrete quantities, less is known about their ability to operate on probabilities. Recent work suggests that basic forms of statistical inferences can be found in all four great apes species, which lead to the conclusion that intuitive statistics is not a uniquely human but rather an evolutionarily more ancient capacity. We investigated a very fundamental aspect of probabilistic reasoning by exploring how non-human subjects spontaneously respond when confronted with options of identical absolute values but different probabilities of succeeding. Do chimpanzees understand that the likelihood of finding hidden food does not only depend on the total number of food items hidden or the number of potential hiding locations but on the combination of these two pieces of information? Our data suggest that individuals reliably prefer to choose the more likely option when the relative difference between the probabilities is obvious. Interestingly however, subjects did not appreciate the special value of a truly safe option (P=1.0). While human adults have a strong preference for options that offer a reward without a risk (compared to other options of the same value) chimpanzees applied the calculation of the probability ratio quite rigidly, which in some cases became counterproductive. Broader implications of these findings remain to be discussed.

Tecumseh Fitch

A comparative approach to understanding neural computation

Understanding the process by which brains compute cognitive functions is a central scientific "grand challenge" of the 21stcentury. An immense flow of funding supports research on "standard" model species (*C. elegans, Drosophila*, and mouse) but it is unlikely that these species alone will provide an adequate basis to understand human cognition, especially advanced cognitive abilities like language or social cognition. An alternative, and I think more promising, approach uses comparison between carefully chosen non-model species that differ in circumscribed ways to attempt to pinpoint the neural machinery underlying specific cognitive functions. I will first provide an overview of two well known examples - the use of songbirds to understand vocal learning and speech, and the use of primates and birds to understand complex "syntactic" pattern processing - before discussing several promising new comparative systems. These include dog/wolf comparisons (for very specific social cognitive abilities) and use of extinct hominid genomes (e.g. Neanderthals) to understand the evolution of specifically human cognitive abilities. Finally, I will discuss the sophisticated cognitive abilities that advanced birds (especially corvids and parrots) manage to generate with much smaller brains than primates, involving large numbers of densely-packed neurons in a non-layered, non-cortical forebrain. Avian brains pose a deep challenge to models of cognition that rely upon details of cortex to underpin cognitive computation. For all of these pursuits, a multi-pronged approach combining computational theory, experimental data, and modeling will be crucial for success.

Justin Halberda

How might our evolution-built systems of core cognition span the gap to our lexical semantics

Our mind has both non-linguistic faculties (e.g., vision) and linguistic faculties (e.g., word meanings). Whereas limits of visual processing are interesting in their own right, these limits take on a deeper meaning where vision integrates with other cognitive systems. It is at this point that limits within vision become limits that can affect the whole of cognition. I present evidence for one such case: an interface between vision, numerical cognition and the semantics of quantifier terms. The goal is to highlight where linguistic cognition (lexical meanings) interfaces with non-linguistic cognition (enumerating visual sets) and to explore the links between these two faculties of mind.