SYMPOSIUM #1
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EINSTEIN ROOM

Where, when and how? Targeting the neural mechanisms and cortical network dynamics underlying multisensory perception

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***Main organiser**

Neuroimaging studies in the last decades have provided compelling evidence that multisensory interactions can occur in virtually all areas of the brain. More recently, studies have extended this question by asking not only where in the brain multisensory interactions occur, but also when and how. In this proposal, we will present recent electrophysiological and functional neuroimaging studies that have explicitly addressed this question by using advanced computational modelling approaches to combine psychophysical and neuroimaging data in multisensory paradigms (talks by Uta Noppeney; Virgine van Wassenhove; Tim Rohe).
Our understanding of the spatio-temporal network dynamics underlying multisensory communication has already improved with these innovative analysis approaches. Specifically, the data presented in this symposium provide evidence suggesting that the perception of multisensory objects is shaped by hierarchically organized cascades of neural computations that, in turn, rely on the dynamic interplay of lower and higher cortical areas. In addition, we hypothesize that ongoing and stimulus-driven neural oscillations in different frequency bands, and thus with different temporal resolutions, play a central role in initiating and sustaining multisensory processes (talks by Salvador Soto-Faraco and Daniel Senkowski). Collectively, this symposium will provide a state-of-the-art overview on research addressing how cortical network dynamics shape multisensory perception.

Talk 1 - Attentional control of multisensory causal inference and perception

Uta Noppeney 1
1 Donders Institute for Brain

To form a coherent percept the brain needs to solve the causal inference or binding problem deciding whether signals come from common sources and should hence be integrated or else be segregated. First, I discuss our recent research at the behavioral, computational, and neural systems level that investigates how the brain solves the causal inference problem. Next, I will show that attention can influence causal inference via two distinct computational mechanisms in early sensory (V1-3) and later audiovisual (PT, IPS) cortices.

Talk 2 - Temporal comodulation in multisensory causal inference

Virginie van Wassenhove 1
1 INSERM Cognitive Neuroimaging Unit

Perception relies on inferences about the causal structure of the world provided by multiple sensory inputs. In ecological settings, multisensory events that cohere in time and space benefit inferential processes, e.g. hearing and seeing a speaker enhances speech comprehension. Using psychophysics and functional connectivity characterization of human brain activity measured with magnetoencephalography (MEG), I will discuss how temporal comodulation may contribute to the analysis and synthesis of incoming speech and non-speech signals.

Talk 3 - The role of alpha oscillations for causal inference in multisensory perception

Tim Rohe 1
1 Friedrich-Alexander-University of Erlangen-Nürnberg

Humans integrate signals across the sensory modalities to obtain a multisensory perception of their environment if they infer that the signals arose from a common cause, but they segregate signals from independent causes. To infer the causal structure of multisensory signals, humans combine causal evidence from the signals' spatiotemporal relations with a priori causal assumptions (i.e., a causal prior). On the one hand, the causal prior adapts to the multisensory statistical regularities of the recent stimulus history. On the other hand, the causal prior may also capture at a computational level that the neural communication between (multi-) sensory regions fluctuates intrinsically as indicated by neural oscillations. Thus, the brain's tendendy to integrate or segregate incoming multisensory signals (i.e., the causal prior) may depend on the brain's a priori oscillatory state. A recent study showed that the causal prior was indeed correlated with the power and phase of prestimulus alpha oscillations. In this talk, I will present EEG and psychophysical studies that investigate wether prestimulus alpha-phase has a causal effect on the causal prior by manipulating alpha phase using visual entrainment. Our results support the notion that alpha phase indicates a transient prestimulus time-window for optimal multisensory interactions between sensory and/or higher association regions as captured by a causal prior at the computational level.

Talk 4 - The role of conflict in multisensory perception

Salvador Soto-Faraco 1
1 Universitat Pompeu Fabra

Multisensory perception is often studied through the consequences of inter-sensory conflict in illusions, such as the McGurk effect, ventriloquism, and the rubber hand. Moreover, Bayesian accounts of cue fusion and causal inference also draw on inter- sensory conflict to measure and to model the outcomes of multisensory integration. Given the prevalence of conflict in this field of research, it is remarkable that accounts of multisensory perception have paid little attention to the cognitive processes of conflict monitoring and resolution. Here, we present EEG and fMRI data showing that audio- visual conflict in speech triggers neural mechanisms of conflict processing in fronto- medial brain areas. Additional experiments measuring behavioural and EEG in a cross- modal spatial perception protocol support the hypothesis that frontal conflict mechanisms are involved, more generally, during multisensory perception. Collectively, these results are indicative of the putative interplay between higher level control mechanisms and lower-level perceptual processes. In particular, we suggest that the role of conflict detection and resolution mechanisms would be the regulation of competition between alternative perceptual representations during causal inference.

Talk 5 - Multisensory perception utilizes neural oscillations: Evidence from EEG and EcOG recordings

Daniel Senkowski 1
1 Universitätsmedizin Berlin

The processing of multisensory information in our environment relies on the rapid integration and segregation of stimuli from different sensory modalities. In particular, stimuli enter our sensory systems with different temporal and spatial properties, and thus highly adaptable and flexible neural mechanisms are required for the vast amount of multisensory processing that our brains seem to perform effortlessly in everyday life. In this talk I will present evidence from EEG and EcOG studies in human participants that ongoing and stimulus-driven neural oscillations, in particular power modulation, phase resetting/locking and functional coupling, may provide important neural mechanisms underlying multisensory integration. Specifically, the different frequency bands of neural oscillations, with their different temporal resolutions and functions, appear to be well suited for integrating and segregating stimuli with different temporal and spatial properties across sensory modalities.