Individual Differences in α Rhythm

Organizer: Rasa Gulbinaite

Room: # 105

Date and Time: Thursday, October6 / 14:40-15:40

Signal or Noise: Individual Differences in Alpha Peak Frequency
Historically, individual alpha frequency (IAF) is one of the most commonly used markers of inter-individual variations in brain rhythms, and is often considered a stable neurophysiological trait. The purpose of this symposium is to present up-to-date views on the mechanisms underlying flexibility and variability of the alpha rhythm and its functional roles, based on large-sample EEG/MEG recordings and intracranial ECoG in humans, in combination with advanced data analysis methods, and non-invasive brain stimulation protocols. In this symposium, Haegens will highlight fundamental methodological considerations related to assessment of IAF, with the emphasis both on inter-individual variability, andon intra-individual variability across brain regions. Thereafter, Gulbinaite will focus on IAF variations in the context of modern theories on the role of alpha oscillations in perception and attention. Finally, Herrmann will elucidate the conditions under which the endogenous alpha rhythm can be “hijacked” using brain stimulation and the limits of such interventions in modulating cognition. In summary, this symposium will call into question traditional ideas on the stability notion of IAF and bring discussion on how inter- and intra-individual “noise” in alpha rhythm can be turned into “signal” for studying the functional role of alpha oscillations, and frequency-band specific brain networks more generally.

Speakers:

- **Saskia Haegens** (Columbia Univ., USA)
  "Variability of the alpha rhythm across individuals, cognitive tasks and brain regions"

  Converging evidence suggests that the alpha rhythm plays an important and active role in cognitive processing. Here, we systematically studied variability in alpha peak frequency both between and within subjects. We recorded brain activity using MEG in 51 healthy human subjects under three experimental conditions – rest, passive visual stimulation and an N-back working memory paradigm, using source reconstruction methods to separate alpha activity from parietal and occipital sources.
  In both regions we observed an increase of alpha peak frequency from resting state and passive visual stimulation conditions to the N-back paradigm, with a significantly higher alpha peak frequency in the 2-back compared to the 0-back condition. Thus, alpha peak frequency increases with increasing cognitive demands. Additionally, we acquired resting state intracranial ECoG data in human patients, which allowed us to further elucidate the differences between brain regions. We found substantial variability of alpha peak frequency across brain regions within subjects.

  We conclude that alpha peak frequency varies both within and between subjects, and that the alpha rhythm operates across a wider frequency range than the 8-12 Hz band often used. Therefore, using a fixed and limited alpha frequency band for analysis might be suboptimal and lead to biased outcomes.

- **Rasa Gulbinaite and Rufin VanRullen** (Universite Paul Sabatier, France)
  "What works for you, doesn't work for me: Individual alpha frequency in perceptual and attentional processes"

  Individual alpha peak frequency (IAF) is highly heritable (80%), and has a remarkable test-retest reliability (0.75-0.9). Early studies on variations in IAF aimed at testing whether "smarter brains run faster," with some evidence for a positive relationship. However, an established role of alpha oscillations in visual perception and attention raises a more fundamental question: "Is there a link between perceptual/attentional processes and IAF?" In the first study, we focused on IAF and illusory perception by using the triple-flash illusion (the occasional perception of three flashes when only two veridical ones are presented). We demonstrated that the probability of third-flash perception is correlated with task-related IAF at parietal but not occipital alpha sources, and that the inter-flash interval that maximizes illusory perception is strongly correlated with the period of subject-specific "perceptual echoes" [VanRullen & Macdonald, 2012]. In the second study, we used a causal approach and tested the interaction between exogenous and endogenous alpha rhythms. Here, we showed that visual stimulus flicker modulates the effectiveness of spatial attention in a frequency-dependent manner: The strength of modulation depends on the correspondence between the flicker frequency and IAF. These results indicate that individual alpha tempo is important, yet faster is not necessarily better.

- **Christoph S. Herrmann and Annika Notbohm** (Carl von Ossietzky Univ., Germany)
  "Entrainment of human alpha rhythm modulates cognition"

  Many aspects of human cognition depend upon parameters of the ongoing alpha activity such as amplitude, frequency, and phase. Here, we demonstrate how sensory driving with flickering light and transcranial stimulation with alternating currents can entrain the human alpha rhythm and thus modifythe above-mentioned parameters. We have used EEG and MEG to monitor how the alpha activity changes during such stimulation protocols. In turn, this results in a modulation of cognitive processes such as visual perception, mental rotation, and short term memory capacity. We will review the physical properties of brain entrainment which require an adaptation of the stimulation frequency to the individual alpha frequency.