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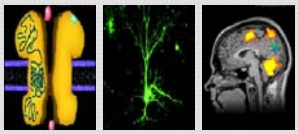

Sensory Processes: From Molecules to Cognition

April 12 - 13, 2016, Veranstaltungszentrum, Ruhr University Bochum

Wednesday April 13, afternoon (13:10 – 16:00)

Session 4 **Sensory Integration and Representation**

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Visual categories in the pigeon brain

Every day we are confronted with a bewildering variety of objects. In order to reduce the processing load, we deal with them at the category level. Categorization is the ability to generalize various stimuli into a single class and to discriminate between classes. Traditionally, the ability to categorize was seen as a cognitive feature that requires complex mental abilities incl. language. Then came the classic study of Richard Herrnstein in which he demonstrated that pigeons easily learned to discriminate between hundreds of photographic scenes that either contained or did not contain a human. Within a few sessions, the pigeons could not only reliably discriminate between the already depicted pictures but were also able to transfer discrimination to novel stimuli. Since then, a vast number of categories have been further demonstrated in pigeons like the ability to categorize flowers, fish, man-made vs. natural objects or impressionist vs. cubistic paintings. But how do pigeons achieve these amazing abilities? Since mammals and birds separated about 300 million years ago, a comparison of categorization abilities across vertebrate classes could shed light on variant and invariant mechanisms of categorization abilities and their evolutionary history.

We started this endeavor by proceeding in three steps. First, we aimed to find out how pigeons are able to categorize so many diverse sets of stimuli. We first conditioned pigeons to discriminate humans from non-humans by additionally tracking the location of their pecks as a proxy for their attentional focus. These studies revealed that pigeons especially looked out for faces. A “definition” of a human face in the eyes of a pigeon was to a good extent a skin-colored patch with a high density of contrast changes.

In addition, it was likely that the pigeons do not perceive photographs of people as 2D-representations of real persons. Then we taught pigeons to discriminate written English words from written no-words. Quickly, our pigeons learned the task and could extrapolate to novel words and non-words (yes: Pigeons can "read" English! ...at least at the tabloid newspaper level). By analyzing their strategy we detected that they exploited very simple but highly efficient strategies of perceptual input statistics.

In the next step we analyzed brain asymmetries of categorization. It turned out that each hemisphere is doing a different job. While the left hemisphere is categorizing visual stimuli by concentrating on tiny features, the right hemisphere seems to capitalize on the configuration of the visual object. In a third step we aimed to understand categorization at the structure and single cell level. It turned out that the nidopallium caudolaterale (NCL) – an avian analogue to the prefrontal cortex – seemed to be a critical structure to extract abstract category-relevant features from the visual input. Here we also discovered how lateralized cellular processes that possibly represent the stimulus interact with other groups of neurons that are part of the appropriate motor output.