The multidimensional scaling of large subjective differences between monochromatic colors of different intensities in psychophysical experiments with humans and behavioral trials on animals (monkey, fish) has shown that all color stimuli can be represented by points on a surface of a hypersphere in four-dimensional metric space (Izmailov and Sokolov, 2004). The spherical coordinates (three angles of the hypersphere) correspond to three subjective aspects of color perception: hue, lightness and saturation. It was assumed that the Cartesian coordinates of points representing colors on the hypersphere correspond to excitations of four types of neurons present in visual system of animals with developed color vision: red–green, blue–yellow, brightness and darkness cells. In this research the results of the verification of this hypothesis in neurophysiological experiments are declared and discussed.

To get information concerning neuronal basis of the four-dimensional color space found from psychophysical experiments in human and instrumental conditional reflexes in carp intracellular recordings from bipolar cells of an isolated carp retina were performed using equiquantum monochromatic light stimuli. It was found six types of bipolar cells: "red+green−" and "red−green+" were depolarized on "either — or" basis, the same refers to "yellow+blue−" and "yellow−blue+" cells. Depolarized responses of "brightness" and "darkness" neurons were guided by increase and decrease of color brightness, respectively. Thus, color stimuli are represented at the level of bipolar cells with excitation vectors having four coordinates. The sum of squared amplitudes of their depolarization for any wavelength of the input stimulus was equal to a constant value demonstrating constant lengths of color excitation vectors. It means that colors are encoded at the level of bipolar cells by excitation vectors of a constant length.

Intracellular research of land snail *Helix lucorum* L. eye demonstrates two types of visual cells responding to flashes of white light by slow sustained depolarization (D-type) and by slow sustained hyperpolarization (H-type) respectively. The responses of D- and H-cells constitute two-dimensional 'excitation vector' of constant length, the direction of which is the code of light intensity (Chernorizov et al., 2007). Thus, the achromatic colors are coded by two-dimensional excitation vectors composed of excitations of brightness and darkness neurons.

The data of intracellular research of carp and snail retinas linked together are evidence of principle of vector encoding of information in color-coded neuronal networks.

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SYMPOSIUM 22: Perception of Emotional Faces and Psychopathology
Symposium Chair: Joelle Martineau (France); Co-Chair: Henrique Sequeira (France)

The current symposium will seek to extend knowledge about the perception of emotional faces across different psychopathologies. The first presentation will characterize at behavioral and neural levels the impact of emotional faces presented in peripheral vision in healthy adults. Using reaction times and event-related potentials (ERPs), this study suggests that human brain is able to disentangle emotional from neutral facial information in low acuity vision and open new perspectives to optimize peripheral visual abilities in subjects having problems to integrate their central and peripheral visual resources. The second presentation will show how ERPs, associated with emotional oddball designs, may help to enhance understanding of psychopathological conditions such as generalized anxiety disorder, alcohol abuse or schizophrenia. The third presentation, studying a large sample of inpatients suffering from major depression by means of functional magnetic resonance imaging (fMRI) at 3 T, will examine the effect of amygdala reactivity to emotion faces on severity and course of illness as well as on automatic negative judgmental bias. The fourth presentation will focus on visual scanning (eye-tracking) and brain activations (fMRI) used to evidence an abnormality of emotional faces perception in autistic pathology.

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Neural processing of peripherally presented emotional faces: An ERP study

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Findings from a recent study (Rigoulot et al., 2008) suggest that, for far peripheral eccentricities as for central vision, the brain engages specific resources to process emotional content of scenes. Considering that emotional facial expressions are salient stimulus for conveying nonverbal information to regulate social interactions, emotional faces appear particularly adapted to optimize the exploration of peripheral vision, well known to have low spatial resolution capacities. Consequently, the aim of the present study was to characterize at behavioral and neural levels the impact of emotional faces presented in peripheral vision. Happy, fearful or neutral faces were presented in near (−15°, +15 °) and far (−30°, +30 °) eccentricities and subjects had to categorize them according to their emotional content (explicit task) or their gender (implicit task). As compared to neutral faces, emotional faces induced longer reaction times in the implicit task and shorter ones in explicit task, whatever the emotional content of the face (happy or fearful). In order to investigate electrophysiological correlates of eccentric presentations, event-related potentials (ERPs) were recorded from 63 electrodes and analyzed by a classical baseline-to-peak followed by a spatio-temporal principal component analysis (PCA). Results evidenced an early P100 component modulation by far eccentricities (−30 and +30°) with greater and earlier contralateral activation in parieto-occipital areas, without influence of the task or emotional content. The N170 component varied according to the task and the emotional content. In the implicit task, the N170 evoked by happy faces was more negative when presented in the left visual field and less when presented in right visual field. In the explicit task, these modulations of N170 were reversed. For fearful faces, the N170 component was more negative in explicit task only. Spatio-temporal PCA evidenced differences at late components suggesting interactions between eccentricity, emotional content and nature of the task. These findings suggest that human brain is able to disentangle emotional from neutral facial information in low acuity vision. They also open new perspectives to optimize peripheral visual abilities in subjects having problems to integrate their central and peripheral visual resources.

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Using emotional faces may contribute to de fine emotional disorders thanks to ERPS

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Affective neuroscience disposes of complementary imaging tools, some identifying which neural regions are involved in a specific cognitive function, others defining the temporal sequences of these activations with an optimal temporal resolution. The aim of the present presentation is to show how event-related potentials (ERPs) may help us to enhance our understanding of psychopathological conditions. To do so, some experiments from our laboratory will be presented. Emotional oddball design was used, in which participants are confronted with frequent stimuli (neutral faces) and deviant stimuli (emotional faces) which they have to detect as quickly as possible. Our main purpose is to show that, if previous studies have shown for generalized anxiety disorder, as well as for alcohol abuse or schizophrenia, P3b alterations, the impaired processes leading to such an identical disturbance are different from one population to the other.

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Automatic neural response to emotion faces in major depression

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