Human eyes are frequently considered to be one of the most remarkable achievements of evolution. They are connected to the organ which might be the most complex entity in the universe – our brain. These two constitute the visual system which enables us to explore and understand the environment around us. Attempts to build artificial systems which mimic its capabilities quickly revealed that the tasks it performs are extremely difficult. Further investigations revealed that one of the 'tricks' used by the visual system is constantly making predictions about the state of the environment, instead of just passively observing it. This idea inspired the development of a set of theories known under the umbrella term 'predictive coding'. The predictive coding is currently the most influential approach to studying the human brain and a matter of intense scientific debate.

In this project, one specific prediction derived from the predictive coding approach will be tested. It is related to a phenomenon called a binocular rivalry. The binocular rivalry arises when two different images are presented to each eye. A person subjected to such conditions perceives one image for some time, and after a couple of seconds – the other one, with periods of two images perceived as 'mixed' in between. According to the predictive coding, when two images are highly similar, more 'mixing' between them should be experienced by the participants. However, the notion of similarity is unclear here. The recent findings on how the brain processes the information received from the eyes indicate that this information is represented in many different ways simultaneously. Some brain regions 'see' the world as composed of only contours and edges, while some others – as composed of meaningful objects. For each region, therefore, the similarity between stimuli would mean something very different. In this project, I will test how these two different kinds of similarity influence the binocular rivalry.

The first stage of the project will involve preparing the appropriate visual stimuli: pairs of photographs which differ with respect to both kinds of similarity systematically. To achieve this, I will use the state-of-the-art measures of both kinds of similarity adopted from the studies on machine learning and linguistics.

The second stage of the project will involve conducting an experiment with human participants. They will be experiencing binocular rivalry between the prepared stimuli and constantly reporting which one they currently see by means of pressing buttons. Additionally, their eye movements will be recorded. This will allow for tracking subtle aspects of the binocular rivalry, which cannot be captured by reports of the participants.

Obtained results will be an important contribution to the current scientific discussion about the predictive processing. Moreover, they will shed a new light on the mechanisms of the visual perception and their relations to the different ways of representing information used by the brain.