Reg. No: 2015/18/E/NZ8/00477; Principal Investigator: dr hab. Paweł Ręk

Traditional approach to communication is based on the premise that animals transfer information with the use of discrete carriers, analogically to words in human speech. Signals designed in this way are easily identifiable by specific senses and are directed at a particular receiver. However, animals communicate with their whole bodies and perceive signals through all available sensory channels. Furthermore, many signals are produced as a result of cooperation between two or more senders. Such complex systems of communication, consisting of multiple components identified by different senses and produced by several individuals together, are relatively rare. However, they make a valuable research material for studying such phenomena as temporal coordination and integration of stimuli coming from multiple sources and through various transmission channels. For the same reason why not only the substance and dosage but also the time of taking are crucial for the effectiveness of medicines, the form, intensity, and temporal relationships among signals are important for the effectiveness of information transfer. Temporal relationships between signals can transfer information independently from the signals themselves, which can be easily verified by comparison of perfectly coordinated musicians with a group of practicing amateurs – even if the number of notes is the same, the impact is completely different. Temporal coordination is a characteristic describing the time-based relationship between discrete behaviours of a single individual, similar behaviours of several individuals, or different behaviours of several individuals. However the term is intuitively clear, we do not understand why animals coordinate their signals and how they do this, but most of all, usually we do not understand what they coordinate. In other words, even if we sense that some behaviours are coordinated with each other or not, we cannot justify it in detail.

The main goal of this project is to describe mechanisms and functions of temporal coordination in acoustic, visual, and audio-visual signals of animals. However, the project is limited only to acoustic and visual channels, it is not an indispensable requirement. In fact, it was thought of as a means of focussing on principles rather than exploration of possibilities. The first step will be to determine what is temporal coordination from perspective of the signal producer and perceiver, i.e., on what grounds both sides assess signals as coordinated, how they coordinate signals, and how they process information encoded in temporal associations between signals. The next step will be to determine the effect of physical constraints on the transmission of the sound and light on temporal coordination. Because the sound and light propagate with different speeds, temporal coordination in audio-visual signals gives rise to some fundamental difficulties. When a bird sings and moves its wings simultaneously, the perceiver will hear the sound as slightly delayed relative to the movement if only the distance to the sender is considerable. Similar problem takes place when two birds being spatially apart sing in a duet. For a bystander temporal coordination between senders' signals depends on its position relative to each sender. Nevertheless, senders can coordinate their songs using the movements of wings in a way the conductor uses its baton, and thus eliminate the effect of the sound delay. During the subsequent stages of the project the influence of sensory illusions that occur during the integration of acoustic and visual information will be evaluated. Sensory illusions arise when senses transfer information that does not represent reality, at least to a certain extent. However, most of such phenomena, as for example the ventriloquist effect, have been described only for humans, it may be necessary to recognise and control such perceptual effects in order to understand the mechanistic basis of temporal coordination in animals in general. Despite far reaching implications, the research on temporal coordination does not emerge in general scientific circulation as often as it might be expected. Instead of this, it appears as fragmented and channelled into separate disciplines, without a wider perspective and multidisciplinary approach. This project is an attempt of a more holistic approach to the role of temporal relationships in the production and functioning of signals. The project will be based on explorational and experimental analysis of the audio visual signalling in the European starling (Srurnus vulgaris) and audio-visual cooperative signalling in the Australian magpie lark (Grallina cyanoleuca). In order to imitate precisely the motion and singing of living bird during experiments biorobots will be used based on predicted configurations of parameters of coordination and birds' movements. This project is almost to "go back to the drawing board"; starting with description of the fine scale of temporal coordination within two distinct signalling systems, multimodal and cooperative, through modelling and prediction of natural processes, and finishing with the construction of biorobots and experimental verification of assumptions.