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Multimodal perception of aquatic vibrations and airborne sound in crocodiles

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ABSTRACT

In order to locate their prey precisely, crocodiles have to use all available sensory modalities, in particular the numerous mechano-sensory receptors on their skin. Although crocodiles are known to communicate acoustically, we do not yet know to what extent they are able to integrate the two communicative channels. The aim of the study was to reproduce and play back to a crocodile the presence of a younger conspecific by using speakers and vibratory devices, and to observe the behavioral responses. All these responses were captured by video analysis that allowed to compute some parameters to assess crocodiles' interest for the stimuli (like the minimum distance to stimulation reach by the crocodile during the observation period). This experiment was aimed: first, at determining to what extent crocodiles are able to use auditory and vibratory stimuli simultaneously in different spatial and temporal patterns; second, at studying the possible dominance of one perceptual modality over the other. Lastly, at determining if these stimuli can be perceptually related to each other.

Keywords: *Crocodiles, Sound, Vibration, Perception*

1. INTRODUCTION

Crocodilians are fascinating animals, many new researches have been conducted, but their behavior is not yet well studied. Crocodilians, being both amphibious and carnivorous, primarily hunt at the interface between water and land. They can be found in tropical and subtropical rivers, lakes, and coastlines, and tend to spend the majority of their time in or near the water. [1] Crocodilians rely on their hearing to detect potential prey and engage in social interactions. The auditory communication channel plays a vital role during their formative years, as young individuals use calls to communicate with one another and with their parents [2]. Crocodiles have the remarkable ability to precisely locate the source of a sound, which allows them to overcome background noise and identify relevant sounds with great accuracy [3-6]. Moreover, crocodiles are also often found in the position at the interface between water and air to stay on the lookout of any possible prey that might arrive. In this position, they have a lot of sensory channels allowing them to detect the water disturbances named integumentary sense organs (ISOs) [1]. These ISOs are well described by Leitch and Catania [7] and allow for example alligators to localize the source of single water droplets [8]. The aim of the study is to deepen the knowledge on crocodilians by determining how they integrate information provided by two different sensory channels.

2. MATERIALS AND METHODS

Two experiments were carried out in the framework of this study at the Crocoparc zoo in Agadir. The animals tested were young naive crocodiles (N=9 for the first experiment and N=10 for the second experiment). The experiments were performed at night and a different crocodile was tested each night. Two types of signals were used: sound signals and vibratory signals. The sound stimuli used was crocodile contact calls. The vibratory stimuli used was surface waves

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generated on the water surface. The experiments took place in a tank filled with water with two pairs of loudspeakers/vibratory device (see Fig. 1). For the first experiment, 4 different conditions were tested: sound and vibration at the same place, sound and vibration at two different places, sound only or vibration only. For the second experiment, 3 temporal conditions were tested: sound and vibration arriving at the same time at the crocodile, sound arriving before vibration with a fixed delay and vibration arriving before sound with also a fixed delay. Circles traced on the floor of the tank allowed us to know the crocodile's initial distance from the stimulation, and therefore to send the stimuli with the right delay, knowing the propagation speeds of the sound and the surface wave. Filming and analyzing all tests allowed to have access to crocodiles' position across time and to calculate parameters to quantify the approach of the crocodile towards one or the other stimulation.

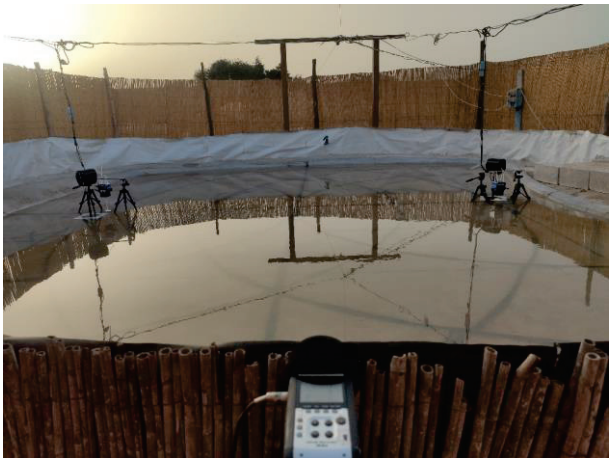

Figure 1. Experimental set-up: pond filled with water with two pairs of loudspeakers and vibratory devices.

3. RESULTS

In the field of multimodal perception, it is often questioned whether information from different sensory channels is additive or redundant for the receiver. It can be hypothesized that sound and vibration are two additive pieces of information that can enhance the receiver's ability to localize a source. As for the temporality of these two pieces of information, it can be hypothesized that the receiver tends to trust the last piece of information it perceives.

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