

## Fish Behaviors in Electromagnetic Fields

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### Abstract

Electromagnetic Fields (ELFs) may change biological organisms' behaviors and brain mechanisms. There are some findings about laboratory animal's behaviors after exposure to electromagnetic fields but the findings about changes in marine especially fish are limited. In this mini review after presentation of brain structure in teleost fish, the effects of ELFs on behaviors of fish are expressed.

**Keywords:** Electromagnetic field; Fish

**Abbreviations:** EMFs: Electro-Magnetic Fields

### Introduction

Electromagnetic Fields (ELFs) may change brain mechanisms [1] that lead varieties in organism behaviors [2]. In recent years some studies were focused on behavior changes in laboratory animals such as mice [3,4] and rats [5-7] after exposure to ELFs. Some kinds of learning and memory functions for example avoidance learning and spatial memory [8] are the cognitive functions that change negatively after exposure to ELFs.

One of the animal models that is considered in experimental research because of its simple neural system is fish. In this mini review, after a brief view on brain system of fish, the effects of ELFs on fish behaviors is explained.

In a general glance the parts of simple nervous system of fish are forebrain, midbrain hindbrain and other smaller parts that are shown in a schematic form in Figure 1. Olfactory bulbs and telencephalon play a crucial role in learning and conditioning specially avoidance learning and spatial awareness. Forebrain damages may result failure to memorize a maze. According to Salas et al. [9] after telencephalic ablation in goldfish ability to learning of complex place will be impaired.

The effects of ELFs on each of the parts of nervous system of fish is not clear but in the Teleost Fish these findings are reported:

1. Heart rate elevated in eels in 7 to 70  $\mu\text{V}/\text{cm}$  electrical field and in 25  $\mu\text{V}/\text{m}$  (0.025 V/m) to 15 V/m Swam towards an electrically charged anode [10].
2. Exposure to 12,663 nT to 192,473 nT field exhibited significant conditioned response in Japanese eel (*Anguilla japonica*) [11].
3. Sensitivity to electromagnetic field was detected in European eel [12].

As Ohman et al. [13] mentioned in their study the contradictory

results in behavioral response of fishes to magnetic fields may related to different experiments and species that used in studies. Sense of magneto-reception is different in fish species and the basic abilities in spatial orientation; vision, hearing, and olfaction lead to different behaviors in electromagnetic fields.

In a study entitled "Melatonin activates brain dopaminergic systems in the eel with an inhibitory impact on reproductive function" it is stated that melatonin treatment had negative effect on reproductive function. Reproductive function of the eel needs immigration [14]. On the other hand, power frequency magnetic fields induced a marginally statistically significant increase in melatonin levels in exposed rats compared to control [15]. Based on these findings it is a hypothesis that ELFs may increase melatonin and increased level of melatonin causes delay or stop in immigration of the eel and its reproductive functions. This hypothesis and the others in the field of effects of ELFs on fish behaviors and brain parts need more experimental researches.

### Results and Discussion

Because of simple neural system of fish, especially Teleost fish, it can be used in experimental research in the field of toxic effects of ELFs on different parts of brain and the behaviors that derive from each part. For instance, in fish, pituitary-gonad axis has a crucial role in sexual steroid and reproduction of fish and melatonin can disturb reproduction process. Melatonin and some of the other biological components is suggested that change after exposure to ELFs. So, it can be imagined that ELFs may change biological processes but approving these hypotheses will be after experimental research.

### Conclusion

Changes in heart rate, conditioned response and immigration of some species of fish after exposure to ELFs are the recent findings about fish behaviors in ELFs. A plenty of inquiries about alteration in particular neural ways in fish brain after exposure to ELFs are for more research and certain conclusions.

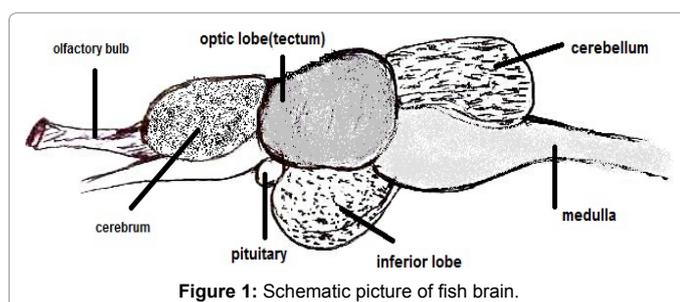


Figure 1: Schematic picture of fish brain.

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