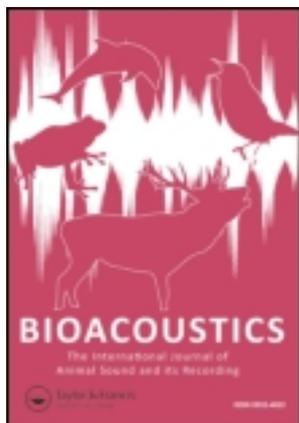


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EFFECTS OF INTENSE ULTRASOUND ON ATLANTIC COD, GADUS MORHUA

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EFFECTS OF INTENSE ULTRASOUND ON ATLANTIC COD, *GADUS MORHUA*

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INTRODUCTION

Astrup & Møhl (1993) showed that Atlantic cod could be conditioned to detect ultrasound. They hypothesized that this ability could have evolved to avoid echolocating toothed whales. Ultrasound may therefore be perceived as a threat by cod, and it can be hypothesized that the extensive use of echo sounders in modern fisheries could represent a possible stress factor for exposed cod. Furthermore, in 1983, Norris & Møhl suggested that very high intensities of ultrasound may have a debilitating effect on fish. This was initially proposed as a feeding mechanism in odontocetes, but it may also have implications for echo sounders that employ similar source levels.

Here we investigate (1) the effect of intense ultrasound on unconditioned Atlantic cod using heart rate as a measure of short-term stress and (2) the possible debilitating effects of very intense ultrasound.

METHODS

For heart rate measurements, steel electrodes were inserted on either side of the heart in 10 cod that were left to recover for 15-24 h. The fish were exposed to 50-kHz 10-ms sound pulses with sound pressure levels of 214 ± 2 dB re 1 μ Pa (peak) and a repetition rate of 10 pulses/s generated using a Simrad EK-38/22E echo sounder.

Another 10 Atlantic cod were placed, one at a time, in a flow chamber with a flow of 0.4 m/s and exposed to sound pressures of 214 ± 3 dB re 1 μ Pa (peak) and tracked with a 2-D video system.

RESULTS

The maximum heart rate interval from 30 s preexposure and the 30-s exposure periods is compared for all 10 fish, with no significant difference between periods (Wilcoxon test, $P = 1$, $df = 10$).

Figure 1 shows the mean swimming speed of 10 cod in a 180-s window around the exposure from $t = 0$ s to $t = 5$ s. In the case that

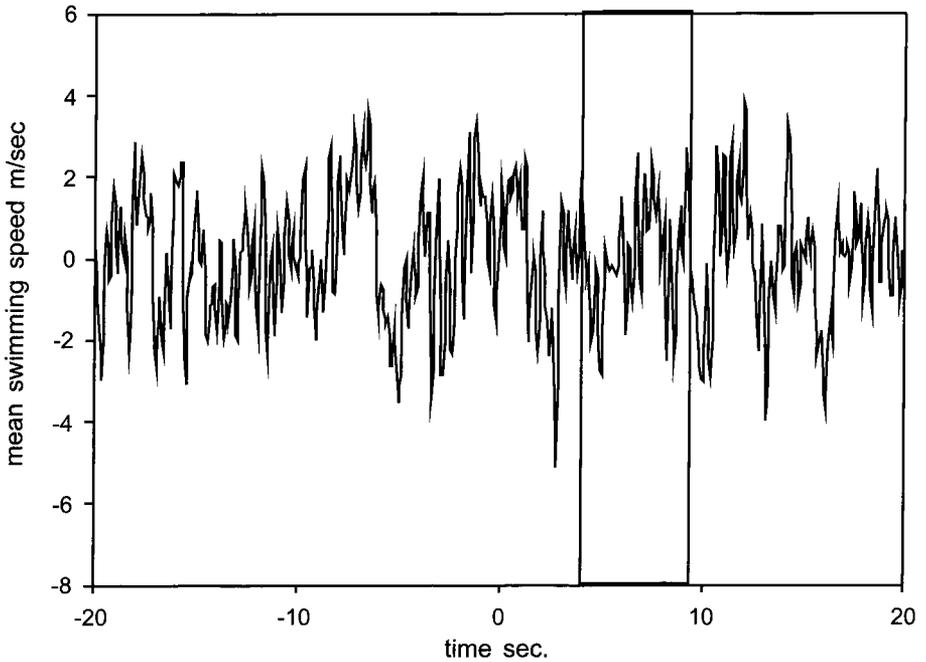


Figure 1. Mean swimming speed for the 10 cod. The marked area is the exposure period.

debilitation occurs, a sudden change in swim speed is expected but such a change does not occur (Figure 1).

DISCUSSION

The results show no reaction in heart rate in unconditioned Atlantic cod when exposed to ultrasound, implying that ultrasound does not elicit antipredator responses nor is it perceived as a predatory threat in unconditioned fish. Cod must therefore rely on other sensory cues for detection of echolocating predators. In addition, we did not find any signs of debilitating effect on cod from very high intensities of ultrasound. This is in agreement with the findings of Benoit-Bird et al. (2006), suggesting that debilitation may not be a feeding mechanism in odontocetes after all.

Echo sounders do not, therefore, pose a source of stress to cod populations, but low-frequency noise from the fishing vessels themselves could induce stress and thereby present a challenge to conservation.

ACKNOWLEDGMENTS

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BIG BANG? INTENSE ULTRASOUND DOES NOT HAVE ANY DETECTABLE EFFECTS ON THE SQUID *LOLIGO PEALEII*

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INTRODUCTION

There are two important sources of ultrasound in the aquatic environment. One is the anthropogenic source in the form of echosounders and the other is the biosonar system of toothed whales. Both systems are very powerful, with source sound pressure levels of more than 220 dB re 1 μ Pa (peak to peak) (Au 1993). Their widespread use means that many fish and cephalopods often are exposed to intense ultrasound, but only a few studies have been conducted on the effects of these exposures. In this experiment (Wilson et al. 2007), we exposed the squid, *Loligo pealeii*, to intense ultrasonic signals to test for behavioural responses and to test if toothed whales may use intense echolocation signals to debilitate their prey.

METHODS

Twelve squid were exposed to ultrasonic click types at two repetition rates (16 and 125 clicks/s) with received sound pressure levels of 199-