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A deeper understanding of noise effects on cetaceans

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OUTLOOK

A deeper understanding of noise effects on cetaceans

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Summary

Recent research with cetaceans under human care is illuminating just how dolphins are affected by human-made noise both in terms of their ability to cooperate as well as their ability to habituate to such noise. This research is providing granular detail to regulators assessing the problems associated with anthropogenic effects and is highlighting a role for behavior/cognition research in conservation.

A great deal of work has been done to assess wild cetacean responses to both simulated and real human-made ocean sounds. Usually, this work is done by assessing how wild animals withdraw from or approach sound stimuli presented in their environment. However, recently there has been a call to consider data collected from animals under managed care to get more fine scale assessments of how noise affects cetaceans' behavior as well as consider cognition in response mitigation (Southall et al., 2021; Stevens et al., 2021). As such, we are starting to see researchers incorporate experiments with animals in managed care to give more detailed granular assessments of cetaceans under the effects of noise. One example of particular interest comes out of work done at the Dolphin Research Center investigating how noise impairs cooperation in dolphins trained on a tandem task (Sørensen et al., 2023).

An elegant study, what Sørensen et al. (2023) does is model cooperative scenarios that get to the very nature of adaptive sociality in bottlenose dolphins. Social association and coordination are key to survival in cetaceans because cooperative hunting, group defense against sharks, and mating are vital to maintaining fitness in these highly social mammals. Sørensen et al. (2023) captures cooperation using a clever methodology that involves two dolphins, their respective trainers, and two buttons located 22 meters away on the opposite sides of the lagoon. The dolphins are sent simultaneously by each of their trainers to each press their buttons within 1 s of each other (see Jaakkola et al., 2018, for original methodology). When the dolphin dyad successfully performed tandem button presses, they were rewarded with a success sound (and a fish), whereas when the dolphin dyad delayed the second press by more than a second after the first press, they were greeted with a failure sound (and no fish). Making this study more challenging than the preceding one (Jaakkola et al., 2018) is the presence of an underwater speaker or power washer—emitting various levels of sound—in the middle of the lagoon positioned directly in the midpoint between the buttons.

As one might predict, success on this cooperation task for the dolphin dyad was inversely proportional to the amount of noise generated by the speaker. Under very high noise levels (150 ± 4 dB re 1 mPa, rms), success on the tandem button-press task dropped by 22.5% versus ambient levels (mean ± *SD* = 115 ± 6 dB re 1 mPa, rms). Whistle communication from one member of the dyad also dropped from 41 whistles in the quietest category (ambient noise) to only 15 whistles in the presence of very high noise. The other member of the dyad produced the most whistles in the low-noise category (33) but still relatively few in the very high-noise category (16). The nature of the sounds produced under very high noise is also of note, as both dolphins increased their whistle duration to accommodate the noise (although only one of the two did so significantly). The authors also report a positive relationship between the increase in dolphin acoustic output and the amplitude of sound presented to the animals. I will point out that while the sound levels of the playback stimuli (at the dolphins) varied from ambient to very high by as much as 20 dB 1 μPa, rms, dolphin vocalizations only varied between 2 and 4 dB 1 μPa, rms, which shows the limits of the high amplitude responses to loud noises in dolphin vocal systems.

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In context, this paper is one of the first to highlight the direct effects of noise on potential survival critical cooperative behaviors in a social mammal. While pressing buttons is not something typically thought of as life or death, eating or defense of young is. One can easily see this artificial button-pressing cooperation task as a model for behaviors like cooperative hunting where, in dolphins, coordination is required to corral fish into a bait ball or coordinating positioning of adults around young to protect them from shark predation. As such, Sørensen et al. (2023) highlights a look into a behavioral response to noise likely very difficult to observe under naturalistic conditions and allows us to even quantify a direct relationship between noise and task failure.

We are left with at least two potential reasons for task failures in the wild in the presence of noise. As an explanation for their results, Sørensen et al. (2023) lean heavily on noise and its role in masking dolphin communication. No doubt that acoustic masking plays a predominant role in disrupting communication and therefore behavioral cooperation which likely impeded success in this task. Previous research has clearly demonstrated the role communication plays in the tandem button-press task (Jaakkola et al., 2018). However, for those of us interested in cognitive mechanisms noise as a distractor is an attractive thought in the broader question about how noise affects animal success in the wild. Perhaps noise not only inhibits communication between partners but also disrupts an animals' focus , hijacking attention, perception and behavior, especially in the presence of noises to which the animals are not habituated. One could evaluate this idea by looking at success over the course of a study like this one to see if the dolphins' performance improves posthabituation and then falls off when novel sounds are presented. Or, more simply, future researchers could remove the tandem aspect of the behavior and see if and how noise affects generalized performance on other associative/operant tasks. That could help get at the question of how cognitive load affects operant performance without the communication component, removing the possibility that masking explains the poorer performance.

Recent research has demonstrated that dolphin habituation and sensitization occur to different types of anthropogenic sound stimuli based on the nature of the sound itself. Furthermore, dolphins can readily lose their habituation to sound sources following periods of quiet, as was shown when dolphins resumed responding to cruise ship playbacks during the COVID-19 anthropause after they had shown habituated responses pre-pandemic (Stevens et al., 2023). Stevens et al. (2023) highlights the ability of sounds to distract dolphins differentially based on type and exposure history. What will be interesting for cognitive ecologists moving forward will be separating, where possible, the role of cognitive processes related to attention from perceptual processes resulting from acoustic masking effects. What is clear, however, is that animals under managed care have a role to play in helping elucidate more clearly just what effects human noise is having on cetaceans as they try to survive in an increasingly noisy ocean.

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