Target detection in coral sand by bottlenose dolphins

With their sophisticated sonar bottlenose dolphins are able to detect and classify targets buried 45cm into mud[1]. However, the use of echolocation in crater-feeding, a foraging activity observed in the Bahamas where wild dolphins detect and dig out fish buried in coral sand while echolocating, is not known[2,3]; e.g. if the dolphins can extract useful information from the sonar echoes from the buried fish or if they use other cues to detect the fish. Here I show how bottlenose dolphins, despite echolocating, did not seem to use sonar as a primary cue when trained to detect targets successively buried until invisible in coral sand during seven days. The results suggest that the dolphins were unable to use their sonar to detect buried targets; however, more training is needed to conclude whether or not these inexperienced dolphins can learn how to extract useful information from their sonar echoes.

To my knowledge it has never been investigated if bottlenose dolphins can detect targets buried in coral sand using their sonar. Although they are able to do so in sediment, the detection possibility depends partly on the substrate[4], and except for the dolphins sonar, they also have good vision and hearing[5] enabling prey detection. It is possible that crater-feeding dolphins only echolocate to enhance the detection of the fishes once detected by other cues such as visible breathing holes and/or faeces piles on the surface or audible sounds made by the fish. I therefore made a first attempt to investigate if bottlenose dolphins can be trained to detect targets buried in coral sand, using their sonar and if so, if they used any particular search strategy.

Three male dolphins were, one at a time, trained in a total of 57 trials to find and retrieve targets, successively buried until invisible in a coral sand arena in a semi-natural enclosure at Dolphin Encounters, Bahamas. The ELVIS system, including a hydrophone matrix mounted on a fabric, was placed under a layer of sand in the arena and custom made computer software recorded and visualized the sonar beam pattern of the dolphins searching for the targets.

The results suggest that sonar was not the primary cue to detect the targets. During the training process the dolphins seemed mostly to rely on the trainers' referential pointing to find the targets. They also started to plough in the sand with their rostrum in their attempts to find the targets. When one of the dolphins was given the task to detect the first target to be completely buried, he did not find it despite searching for ~3 min, possible passing over the target with the sonar and with the trainer pointing towards it repeatedly. When the trainer then made it visible and pointed at it the dolphin did retrieve it. The dolphins reached the point were they could find buried targets after watching the trainer bury them and pointing towards them, sometimes repeatedly, and sometimes by ploughing through the sand.

The sonar search strategy was often to echolocate in the direction where the trainer pointed, and if not detecting the target within a few seconds, they echolocated in a somewhat scattered way, often being redirected by the trainer until they did find it. When or right before picking up a target they often echolocated over the target area. However, since they could have echolocated on the visible tips of the partly buried targets and/or they had seen the target being placed and pointed at they may not have been able to extract information about the targets through the sand.

Whether or not dolphins have the ability to detect targets or fish buried in coral sand using their sonar can not be concluded from this study due to the little amount of training with dolphins new to this experience. Detecting buried targets can be a great challenge due to reverberation (unwanted echoes scattered back to the dolphin from the surroundings) and reflection and/or scattering of the sonar sound striking the seabed. The amount of energy penetrating and reflecting back to the dolphin from under the sand surface depends on the substrate, the angle of incidence-and the frequency of the sonar signal[4]. Dolphins can receive echoes from the sonar emitted by another dolphin and therefore get the same information as the echolocating dolphin[6]. It has been observed in the Bahamas that young calves position themselves under adults that scan the seabed giving them a good opportunity to learn just how to use their sonar in finding buried fish[3].

Further trials with these dolphins will explore the possibility that learning may enable them to extract useful information from their sonar echoes. This may shed some light on crater-feeding in the wild.

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