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Timing is everything for sharks that smell in stereo

Sharks sniff out their prey using the timing of scents, not concentration.

By Janet Fang

To follow the scent trail left by their prey across the ocean, sharks swim in the direction of the nostril that sniffed the odor first, scientists have found. Their research challenges the classic notion that sharks orient themselves based on the differences between odor concentration received at each nostril.

Shark prey--whether living, injured or dead--leaves behind swirling odor plumes that break apart with distance. The latest work, published online June 10 in *Current Biology*, suggests that when a shark moves into a patch of odor, the smell hits one nostril before the other--and that tells the shark to turn either left or right. By moving from side to side from one patch to another, the animal maintains contact with the odor plume as it tracks its prey, says Jayne Gardiner at the University of South Florida in Tampa, co-author of the study.

Ocean odors mix chaotically, so for sharks to steer using odor concentration, they would need to compare the average concentration at the two nostrils over a period of several minutes to determine the prey's direction. They would then have to reposition themselves and start again--a slow process. But by using timing cues, says Gardiner, sharks receive directionality in under a second.

Squid marinade

The study centered around lab studies of eight smooth dogfish (*Mustelus canis*), a small gray-brown shark. To recreate prey odor, Gardiner marinated squid--what she calls "junk food for dogfish"--in 50 liters of seawater. She fitted the sharks with headgear consisting of two tubes delivering this squid marinade to one nostril and then the other. She found that for delays between 0.1 and 0.5 seconds, the sharks turned toward the side receiving the first stimulus. If there was no time lag or if the lag was a second or longer, the sharks were equally likely to turn in either direction.

In addition to timing delays, Gardiner delivered varying concentrations of squid sauce to the sharks' nostrils. This was Gardiner's update of a 25-year-old experiment involving similar headgear on bonnethead sharks (*Sphyrna tiburo*). Gardiner delivered diluted squid essence to one nostril 0.5 seconds before delivering the full-strength squid broth to the other nostril. The animals turned towards the side receiving the first, albeit weaker, stimulus. "It was timing every time," Gardiner says.

"The previous dogma has always been that sharks orient towards odor by detecting greater concentration on one side of the head over the other," says shark sensory biologist Stephen Kajiura from Florida Atlantic University in Boca Raton. "In this study, timing seems to trump concentration. It's an exciting alternative way of looking at how we understand shark processing."

Speedy hammerheads

The results of this study may also have implications for the evolution of other shark species. For example, according to anecdotal evidence, hammerhead sharks seem to swim faster towards their prey than many other sharks--suggesting that they might have a better sense of smell. The swimming speed of sharks as they track prey may be limited by the spacing of their nostrils. If they move into an odor patch at a given angle, a faster shark will experience a shorter interval between the odor hitting the two nostrils, and if they swim too fast, the brain may not detect a time difference at all. Because the nostrils on hammerheads are more widely spaced than on pointy-nosed sharks, if the two animals swim into an odor patch at the same angle, the hammerhead will experience a longer time delay, making it capable of receiving a directional cue while swimming faster and from a smaller angle of attack.

Gardiner admits that better olfaction can't explain all of a shark's characteristics. The winghead shark (*Eusphyra blochii*), which has one of the widest nostril separations, isn't the most recently evolved shark. Rather, sharks have regressed from wider heads to narrower ones.

According to Kajiura, shark olfaction has been overlooked for decades. His lab examined the legendary ability of sharks to smell a drop of blood from miles away. Their as yet unpublished results do not support the myth--sharks probably aren't any better at detecting odor than any other fish. "With these new batches of information, maybe we can finally lay some myths to rest after decades of misinformation," he says.

Name/Period/Date

Timing is Everything for Sharks that Smell in Stereo

1. How do sharks follow a scent trail?
2. How long does it take for a shark to receive directionality?
3. What shark was used for this study?
4. Compare and contrast this issue with hammerheads and other sharks.