The Effects of Mask Coloration on the Swimming Patterns of Carcharhinus perezi

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Introduction

Shark attacks: incidents involving a shark inflicting harm upon a person, whether the attack is purposeful or unintentional (7)

Unprovoked attacks: incidents where an attack on a live human occurs in the shark's natural habitat with no human provocation of the shark

Provoked Attacks: occur when a human initiates physical contact with a shark

In 2017, **88 unprovoked attacks** were recorded
Only 5 of these incidents resulted in human fatality (1)

Over 100 million sharks are slaughtered annually by fisheries = decline on shark population and the projected marine environment (6, 7, 8)

Great white, hammerhead and bull sharks hold the top numbers for recorded shark attacks (7)

Other recorded shark attacks involve members of the Carcharhinus genus

Caribbean Reef Sharks (Carcharhinus perezi)

***Carcharhinus Genus*:** larger, pelagic sharks, with mostly warm water habitats and several distinguishing characteristics according to species

***Perezi Species*:**

- Extra rear tip on the second dorsal fin (2)
- Slightly angled first dorsal fin (2)
- Longer gill slits (2)
- Tropical water habitat (1)
- Predator of reef fish (2)
- Keeps ecosystem in check (2)
- Listed as "threatened" - human impact on ocean is lowering net population (2)

- Sharks of the *Carcharhinus* genus, including *Carcharhinus perezi* are able to sense electromagnetic fields using ampullae of Lorenzini and a lateral line system (9)
- Allows sharks to detect changes in water movements and detect the presence of prey in the water (9)
- Shark eyesight is currently being explored through a variety of retinal analyses (9)

While Caribbean reef sharks are considered dangerous to humans due to size and physiology, they do not have a significant attack history on humans (4)

Research Goals

This study investigates the **approach patterns** Caribbean reef sharks will exercise in relation to **the mask color of a diver**

- Will the mask color influence the shark's swimming pattern?
- Will sharks be more attracted to one mask color than another?

Literature Review

- Previous studies have investigated the **biology and physiology of *Carcharhinus perezi*** - Compagno et al. (n.d.) & Randall et al. (4 &5)
- Ritter et al. (2012) indicated **that bull sharks** (*Carcharhinus leucas*) **can determine human body position,** and show an aversion to approaching humans when vertical in the water, as opposed to horizontal closer to the ocean floor (1)

Table 1. 95% Confidence Intervals and Tests for the Mean Absolute and Relative Distance between Sharks and the Test Subject

Body position	N	$D_{abs} \pm SD$ (L, U)	$D_{rel} \pm SD$ (L, U)
vertical	21	2.33 ± 0.37 (2.17, 2.50)	1.21 ± 0.25 (1.09, 1.32)
horizontal	75	1.72 ± 0.47 (1.61, 1.82)	0.93 ± 0.33 (0.86, 1.00)
Test		t = 5.48	t = 3.82
p-value		< .05	< .05

Note: N = Number of measurements; D_{abs} = Absolute distance (in m); D_{rel} = Relative distance (D_{abs}/BL, whereas BL = Shark body length); SD = Standard deviation; (L, U) = Lower and upper limit of the 95% confidence interval. Test = t-test for independent samples.

Table 1: confidence of Carcharhinus leucas when approaching a person in the water, vertically or horizontally (1)

- Ritter et al. (2013) suggested that **Caribbean reef sharks (*Carcharhinus perezi*) are able to perceive human body orientation**, and prefer to approach humans from the blind spot (2)
- Ritter et al. (2015) showed that ***C. perezi* approached divers from the blind spot**, often lying low to the ground, likely in an attempt to remain camouflaged with the sand (3)

https://www.scubadiving.com/sites/scubadiving.com/files/styles/hero_1x_landscape/public/2019/03/Carcharhinus%20perezi_Caribbean%20reef%20shark.jpg?itok=0fcOmeOY

- Nelson et al. (1977) focused on summarizing shark behavioral studies, and the limitations associated (6)
  - Baited scenarios disrupt natural behavior (6)
  - Sharks are not likely to approach without bait (6)
  - Divers and humans involved disrupt natural behavior (6)

Gap in Research

- Previous studies focus on analyzing shark bite wounds on humans (8)
- Few studies revolve around human/ shark interaction because of ethical dilemmas
- This ethical barrier leaves a large gap in scientific knowledge of shark behavior

Hypothesis

Caribbean Reef Sharks (*Carcharhinus perezi*) are more likely to approach divers when their vision is unimpaired by a clear mask.

Purpose
- Spread awareness about shark conservation
- Educate the public about Caribbean reef shark behavior

Goals
- Observe the approach patterns of sharks on divers
- Analyze how a shark views a diver (predator, prey or unimportant object)

Potential Problems
- Studying sharks without changing natural behavior
- Ethical dilemmas involving humans in the water with sharks

Methods

Test conducted in Grand Cay Bahamas

- The same underwater location is used
  - 11m deep
  - Sandy bottom surrounded by coral reef
  - Meteorological conditions are kept constant to ensure validity

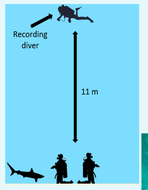
Around 200 different reactions are recorded throughout the 2 week study (mid-August for 2-3 hours)

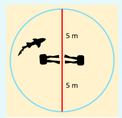
- A pattern for mask switches was arranged beforehand
- Each mask type is repeated twice during the hour long period
- 5 switches in total for six, 10-minute periods

Clear Mask: completely unobstructed visual field (control group)

Mirrored Mask: reflective, altered visual field

Black Mask: fully obstructed visual field





Two divers are positioned back to back, kneeling on the ocean floor

A recording diver hovers 11m above the set up

1 meter long poles are positioned 5 meters way from the radius of the study circle to mark the radius for later analysis

Each diver's head positioned in the 0˚ line
- Visual field: 90˚ sector to the left and right of the 0˚ line

Eliminates a blind spot

Statistical Analysis

All statistical analyses were performed with Pixelstick 2.7 software package
- Only sharks swimming along the bottom are tallied

Three factors are measured using the meter long poles as reference lengths (shark body length, closest approach to diver & shark speed)

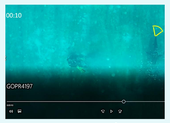
Body length

measured from nose to tip of the tail using pole markers

Approach distance

is measured from the closest part of the diver to the side of the shark's head closest to diver

Speed of the shark



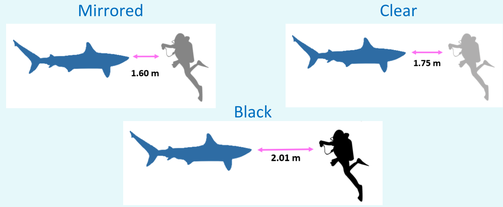
is measured in tailbeats per second, and is the amount of time for the tail to flick in a complete cycle

One-tailed Fisher's Exact to compare approach patterns between the mask colors

Results

The mean approach distances were used to judge which mask the sharks preferred to approach the closest

Approach Distances

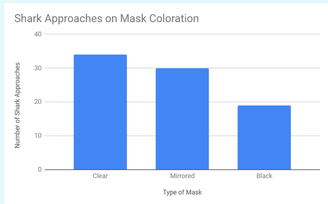


The approach frequencies (# of sharks entering study radius) were also used to interpret which masks were preferred

Clear: 40.5%

Mirrored: 35.7%

Black: 22.6%



Discussion

Sharks interpret any organism's field of view in the oceanic environment

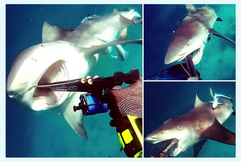
- These sharks approach fish and other natural food in the same pattern, which offer the sharks the advantage of surprise and security
- The coloring of sharks also benefit a lower-lying rear approach so as to camouflage with the sand

Tendency to approach divers wearing clear goggles → Ability to view the diver's eyes → More natural for oceanic species

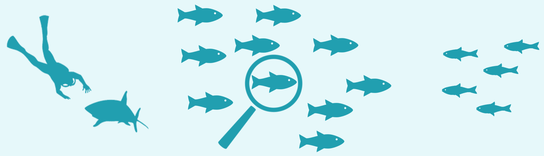
Less likely to approach divers wearing the black lenses → Inability to interpret the diver's field of view → Absence of anything resembling eyes, or light

Attraction to mirrored masked divers → Shiny nature of mask and reflective quality invokes curiosity

- The aversion to approaching black masks could be used to prevent negative shark/human interactions
- Significant for spearfisherman who are most often approached by C. perezi



Study Limitations



Differing exposure to humans

Sample size

Uncontrollable environmental factors

Significance

This test will be the first to analyze the behavioral shifts in Caribbean reef sharks in relation to the mask coloration of scuba divers
- The results of this study can contribute to
  - Shark attack prevention
  - Better understanding of the behavior and physiology of Caribbean reef sharks
  - Education for the general public

Conclusion

Hypothesis
Caribbean Reef Sharks (*Carcharhinus perezi*) are more likely to approach divers wearing a clear mask with an unobstructed visual field in the water

Purpose
Gain insight regarding shark behavior and thought process, while providing insight into the prevention of shark attacks

Results
Sharks are more likely to enter the recording radius when a clear mask is worn, and will approach the diver at a closer average distance when compared to the black mask

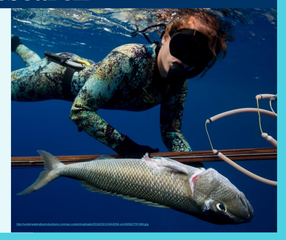
Significance
Allow people to understand the way sharks view humans
Play a role in preventing negative shark/human interactions from occurring, allowing for the engineering of shark attack mitigation devices

Future Research

Investigate the **approach patterns of different species** of sharks on divers

Impact of previous human interaction on shark approach patterns in the specific investigation

Color and reflective quality of dive equipment and fins



Acknowledgements

I would like to thank…
-Dr. Erich Ritter for allowing me to participate in the design and execution of this experiment & gain field research experience for two weeks in the Bahamas
-My science research teacher, Ms. Gillian Rinaldo, who has assisted me for countless hours
-The endless encouragement and support from my family and peers

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