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Influence of social media on fear of sharks, perceptions of intentionality associated with shark bites, and shark management preferences

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Sharks, a critical component of marine ecosystems, represent one of the most threatened taxa globally. Shark conservation efforts are constrained by public fear and misperceptions. Positive social media-based outreach may provide one cost effective means to reduce fear of sharks and change misperceptions about shark bite intentionality. Using framing theory, which suggests that the ways in which information is presented influences how it is processed and the changes in perceptions that result from it, we experimentally evaluated impacts of positively and negatively framed YouTube videos on fear of sharks and perceptions of shark bite intentionality among participants from the coastal state of North Carolina (NC), USA in Spring 2020. Respondents took a pre-test, followed by a randomly assigned positive or negative video treatment consisting of ~15 min of shark week videos. Pre/post-test comparisons suggest positive YouTube content decreased fright by 24%, perceived danger by 27%, and perception of shark bite intentionality by 29%, whereas negatively framed media did the opposite. Positively framed media resulted in fewer respondents blaming shark bites on sharks, and resulted in more respondents blaming swimmers or no one. Positively framed media decreased support for lethal responses to shark bites, such as shark nets, hunting down sharks that bite people, and drum lines. The positive treatment increased support for responding with research, leaving the shark alone, and education. Negatively framed media decreased support for responding by leaving the shark alone or doing nothing and increased support for some lethal responses to shark bites (i.e., drum lines and hunting down sharks). When positive and negative treatments had different effect sizes, the positive treatments tended to be more impactful. Collectively these results suggest social media may be a valuable tool for leveraging the power of communication to promote shark conservation.

KEYWORDS

shark bite, intentionality, social media, message framing, policy, conservation, management preferences, *Selachimorpha*

Introduction

Sharks are an important focus of conservation efforts, as they provide several benefits to marine ecosystems and humans alike (Ferretti et al., 2010; Cisneros-Montemayor et al., 2013). Sharks help regulate oceanic food webs through both direct predation and modification of prey behavior, and their removal can reshape the structure of coastal ecosystems (Ferretti et al., 2010). Captive sharks are utilized in aquariums for educational purposes and as a means of inspiring advocacy for conservation (Gendron, 2004). Tourism involving sharks generates millions of dollars each year for local communities around the world (Gallagher and Hammerschlag, 2011; Cisneros-Montemayor et al., 2013) and can also support conservation efforts (Vianna et al., 2018; Zimmerhackel et al., 2019). Additionally, sharks have intrinsic, or existence, value. This value stems from multiple factors, including their aesthetic appeal, contribution to global biodiversity, connection to human culture, and evolutionarily important lineage (McCauley et al., 2013). However, sharks and the many benefits associated with them are threatened as a result of human activity, especially commercial fishing (Pacoureau et al., 2021). One study estimates that shark populations in the ocean have declined by about 70% since 1970 (Pacoureau et al., 2021) in large part due to the shark fin trade and other fishing related pressures (Clarke, 2008; Cardeñosa et al., 2018). The slow growth rate of many shark species and limitations associated with their fecundity render them more susceptible to overharvest and slow population recovery (Camhi et al., 2008). Collectively, these issues demonstrate the pressing need to elicit more support for shark conservation among the general public (Acuña-Marrero et al., 2018).

However, building the requisite support for shark conservation requires helping the public overcome fear of sharks and misconceptions about them (Acuña-Marrero et al., 2018; Lucrezi et al., 2019). Although attitudes toward sharks worldwide tend to be positive, fear of sharks is persistent, even in nations where attitudes are generally positive (Giovos et al., 2021). Higher risk perception of sharks predicts support for killing sharks and less concern about negative portrayals of sharks in the media (Lucrezi et al., 2019). Fear, coupled with misconceptions about sharks, exacerbates conservation challenges. Many people perceive sharks as human predators (Neves et al., 2021). Similarly, the public sometimes erroneously assumes shark bites are intentional. In response the public may want lethal management responses to shark bite incidents that eliminate the suspected shark (Pepin-Neff and Wynter, 2018a,b).

Popular media may promote fear and misconceptions about sharks in multiple ways. Common portrayals of sharks treat them as violent killers who intentionally attack humans (Kellert et al., 1996; Muter et al., 2013; Friedrich et al., 2014; Sabatier and Huveneers, 2018; le Busque et al., 2021; le Busque and Litchfield, 2022). Most US and Australian news articles about sharks from 2000 to 2010 referenced shark attacks whereas only 11% addressed shark conservation (Muter et al., 2013). News stories released after shark attacks can enhance perceived risk from sharks and increase anxiety about sharks among the public (Sabatier and Huveneers, 2018). Even reading a news headline about how a majority of shark bites are unintentional may increase perceived risk of the species (le Busque et al., 2021). Messages conveying risk from shark diving promoted negative attitudes and reduced interest in future shark diving (Lapinski et al., 2020) and almost all shark-related films depict sharks as threats to humans (le Busque and Litchfield, 2022). Conversely, direct interactions with sharks (e.g., encounters while diving or visiting an aquarium) often promote support for sharks (Friedrich et al., 2014; Acuña-Marrero et al., 2018). Direct exposure to sharks may reduce risk perceptions associated with them (Pepin-Neff and Wynter, 2018b). This reduced fear after controlled exposure was also identified for bears (Johansson et al., 2019) and alligators (Skupien et al., 2016). However, authentic experiences with sharks in the wild are inaccessible to the vast majority of people, demonstrating the need to find different methods to increase public support for shark conservation.

Additionally, popular media may also influence the public's perceptions of shark bite intentionality and societal preferences for responding to shark bites. Understanding intentionality is critical as it has been demonstrated to be an important component influencing public policy responses (Stone, 1989). Both fear and perceptions of intentionality are critical components influencing support for lethal policy responses (Pepin-Neff and Wynter, 2018a,b, 2019). For example, a fearful and misinformed public may view shark bites as intentional acts (i.e., sharks specifically targeting humans for attack) and thus have preferences to respond to shark bites with lethal measures (e.g., hunt and kill sharks that bite people). With the recent small uptick in shark bites in North America and throughout the world (Florida Museum, 2021), public messaging that propagates fear and perceptions of intentionality is inherently troublesome for global shark conservation efforts.

Social media may help reduce fear and misconceptions about sharks and promote public support for their conservation. Social media represents a ubiquitous outreach tool, with more than 4.6 billion people using the internet worldwide (Dixon, 2022), and more than two-thirds of those people using social media in 2020 (Statista, 2022). YouTube alone had more than 2 billion monthly logged in viewers in 2019, 27% of whom accessed content daily (Clement, 2019). Additionally, shark related content is prevalent on social media platforms. News outlets in the US and Australia cover hundreds of shark related stories each year, with many of these stories resulting in content and engagements (e.g., comments) for their respective social media accounts (le Busque et al., 2019). For example, Australian news agencies made over 2,600 shark related social media posts in 2016, resulting in over 40,000 engagements. However, many of these stories emphasize

risks from sharks rather than benefits of conserving sharks or other scientific information (le Busque et al., 2019). Previous studies have demonstrated social media's positive effect in building tolerance for feared or maligned species (Casola et al., 2020), even in the context of shark conservation (Beall et al., 2022); however, we are not aware of research addressing social media's impact on fear and misconceptions of intentionality associated with shark bites. This gap in knowledge must be addressed to understand public support for shark conservation policy. Public perceptions, not just objective evidence, influence the acceptability of wildlife management decisions (Bennett, 2016). Perceptions formed as a result of shark related messaging may have a direct impact on which types of management policies people support (Friedrich et al., 2014). Negative messaging which increases fear and perceptions of intentionality, may lead to support for lethal shark management policies that undermine conservation efforts.

In combination, the ubiquity of social media users, presence of shark related social media content, and the demonstrated impact of social media on attitudes and perceptions suggest social media may be an underutilized avenue for reducing fear and misconceptions about sharks (Beall et al., 2022). Very few people have firsthand interaction with sharks in the wild, thus making shark related media content a primary source for shark related information for many (Gallagher and Hammerschlag, 2011; Gallagher and Huveneers, 2018). It is therefore critically important to understand the framing of this content and the impacts this content may be having on public perceptions. Framing theory posits that the way messages are processed and resulting behaviors are a consequence of the way a message is presented to the audience (Chong and Druckman, 2007; Kusmanoff et al., 2020). Previous experimental studies have demonstrated the impact of message framing on wildlife communications (Casola et al., 2020; le Busque et al., 2021; Beall et al., 2022), showing that both positive and negative message framing impact human tolerance. However, the impact of social media and, specifically, social media message framing, on fear and perceptions of intentionality related to shark bites has not been explored.

We used Casola's et al. (2020) experimental approach to test the degree to which popular YouTube videos influenced fear of sharks, perceptions of shark bite intentionality, and corresponding support for shark management and conservation. We hypothesized that: (H1) positive YouTube messaging would decrease fear of sharks, as measured by perceived fright and danger, and (H2) decrease perceptions of intentionality associated with shark bites. We hypothesized that (H3) negative YouTube messaging would increase fear of sharks and (H4) increase perceptions of intentionality associated with shark bites. Because Casola et al. (2020) found that positive framing of wolves on social media had a larger influence on changes in tolerance than negative framing, we further hypothesized that (H5) positively framed videos would have greater influence on changes in fear and perceptions of intentionality than negatively framed videos. Additionally, we hypothesized that (H6) positive YouTube messaging would shift shark bite blame away from sharks, whereas (H7) negative YouTube messaging would shift shark bite blame onto sharks. Lastly, we hypothesized that positive YouTube messaging would (H8) decrease support for lethal post shark bite response strategies and (H9) increase support for non-lethal post shark bite response strategies, and that negative messaging would have the opposite effect (H10 & H11).

Methods

Sample

The study sample was composed of residents of North Carolina, USA and neighboring states who were in social networks of students in the North Carolina State University Fisheries, Wildlife and Conservation Biology Program (FWCB), excluding immediate family members and other students ($N = 340$). North Carolina is a coastal state where shark bites regularly occur, and access to a wide network of family and friends of students at a large public university enabled us to develop a geographically and demographically diverse sample. This sampling strategy resulted in a small number of respondents from neighboring states (n = 4; Georgia and South Carolina).

Video treatment selection

Videos included in the two treatments (positive or pro-shark and negative or anti-shark framing) were identified using keyword searches on YouTube. Keywords were "shark," "shark week," and "Discovery Channel." Official Shark Week footage and videos with high view counts were prioritized (Figure 1). Results from the keyword searches were refined based on clarity of the positive or negative message framing and total view count (minimum of 3,000 views). Additionally, we excluded videos containing celebrities, compilation videos, and videos over 4 min long. Positive-framed videos showed non-aggressive human-shark interactions (e.g., being pet by divers) and/or the portrayal of sharks through a scientific lens (e.g., the process of giving birth). Negative-framed videos showed sharks behaving violently or aggressively toward humans (e.g., shark attacks). This initial screening process identified 16 videos for potential inclusion in the two video treatments.

This initial list of 16 videos was refined to 10 videos based on the results of a systematic classification process completed by 73 undergraduate students within the FWCB program at NC State University. The 73 students watched each of the 16 videos and responded to four prompts asking how the video portrayed sharks on −3 to +3 value scales of "worthless

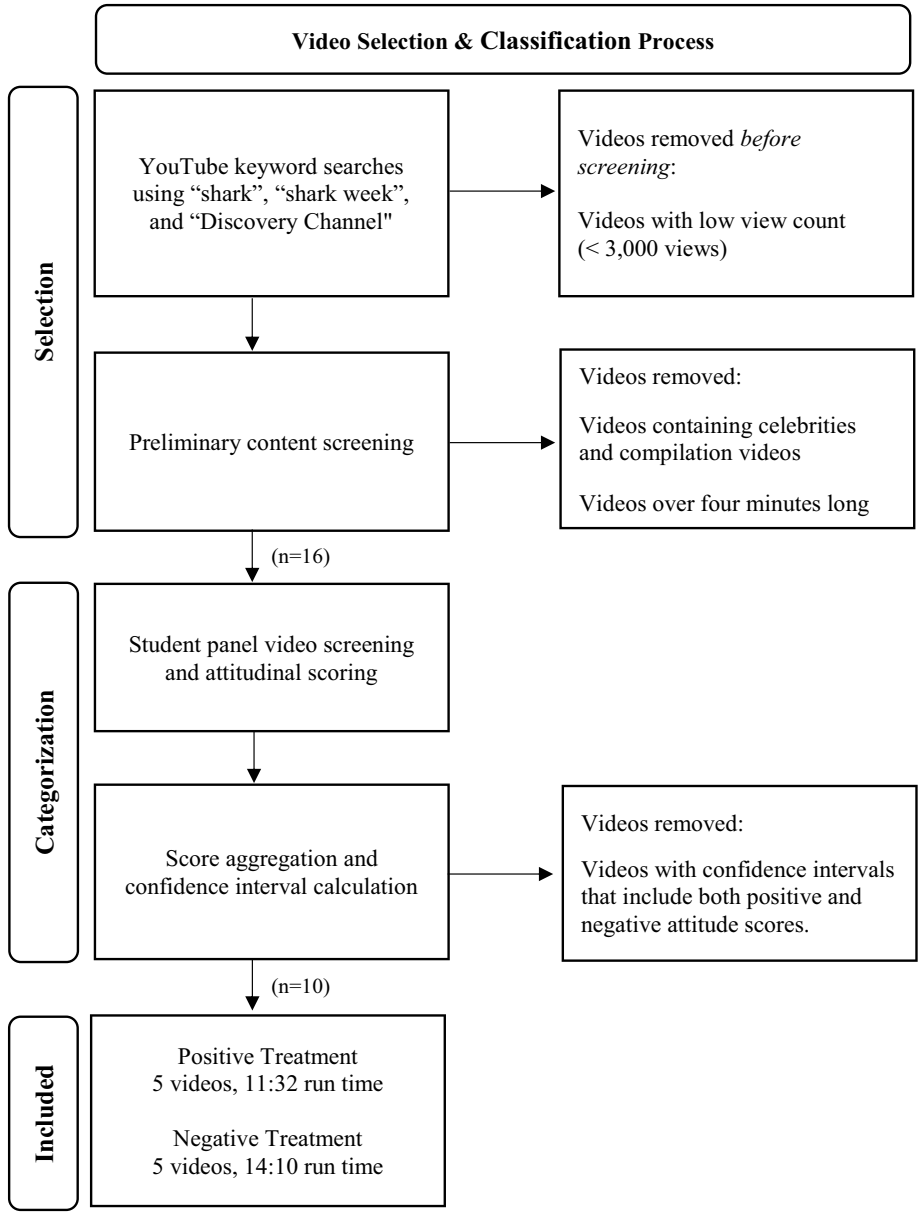

FIGURE 1
Video selection process for the positive and negative video treatments.

to valuable," "unpleasant to pleasant," "harmful to beneficial," and "bad to good." We aggregated scores, calculated summary statistics and 95% confidence intervals. The final 10 videos (5 most positive and 5 most negative, Table 1) were based on the positive/negative ranking which emerged from this classification scheme and selected to maximize or minimize average rankings and remove any overlap in CIs between positive and negative videos. The chosen 5 most positive videos had an average attitude score of 1.92 (SD = 0.38), a combined run time of 11:32 min, and a median view count of 316,334 views. The chosen 5 most negative videos had an average attitude score of −2.04 (SD = 0.32), a combined run time of 14:10 min, and a median view count of 4,650,532 views. One video ("Sharks Love to be Petted, They're Like Dogs") included in the final positive treatment was from National Geographic's SharkFest, not from Discovery Shark Week; however, it was returned via the above keyword search criteria and may reflect the relative scarcity of positively framed Shark Week content on YouTube that fulfilled our search criteria. Treatment playlists were shuffled and viewed in a random order. Respondents were randomly assigned to each treatment based on their association with the FWCB member who asked them to

TABLE 1 Video names, URLs, duration, and view counts for videos included in the positive and negative treatments.

Video name and URL	Duration (min:sec)	Views (June 24, 2022)
Positive treatment		
Lemon shark gives birth | shark week	1:28	598,642
URL: https://www.youtube.com/watch?v=LfQgRCg1bNA		
Reef shark nods off after nose rub	2:05	46,491
URL: https://www.youtube.com/watch?v=7UMrDC3jpUU		
Shark week 2011: sand tiger sharks deceive with toothy look	3:10	73,488
URL: https://www.youtube.com/watch?v=e-PpG3fcBJc		
Understanding sharks | shark week (360 video)	2:57	316,334
URL: https://www.youtube.com/watch?v=XYrrlbItfPg		
Sharks love to be petted—they're like dogs[a]	1:52	19,185,889[b]
Negative treatment		
18-Foot shark attacks cage | great white serial killer	2:37	16,751,333
URL: https://www.youtube.com/watch?v=73PW56YHvXs		
Man loses arm to shark | shark bites	3:56	3,001,089
URL: https://www.youtube.com/watch?v=psftY9DV9iE		
Meet "Slash" the shark | shark week	2:59	4,650,532
URL: https://www.youtube.com/watch?v=w5A2FmNQv8g		
Oceanic whitetip shark bites diver	1:51	5,530,441
URL: https://www.youtube.com/watch?v=WkF7yW4oaDU		
Giant great white attacks the WASP | AIR JAWS: FINS OF FURY	2:47	202,492
URL: https://www.youtube.com/watch?v=Sh_aWElP5F0		

[a]Not a Shark Week video, from National Geographic's SharkFest.
[b]URL not available, video removed from YouTube, view count reflects April 24, 2021.
Table adapted from Beall et al. (2022).

participate (Lawson et al., 2019; Casola et al., 2020; Beall et al., 2022).

Questionnaire

The final pre-test and post-test questionnaires were broken into three parts. First respondents answered a set of Likert-type questions measuring their fear and perceptions of intentionality associated with shark bites. Fear consisted of two measures, fright, and danger. Fright was assessed by asking "On a scale of 1-10, how frightened are you of sharks? With 1 being not frightened at all and 10 being extremely frightened." Danger was assessed by asking "On a scale of 1-10, how dangerous do you think sharks are? With 1 being not dangerous at all and 10 being extremely dangerous." Intentionality was assessed by asking "On a scale of 1-10, how intentional do you think most shark bites are? With 1 being completely accidental and 10 being completely intentional." Second respondents were asked to indicate "Who do you think is most to blame when sharks bite people? Choose one." Options were sharks, swimmers, no one, the government, and other. Third, respondents were asked to what extent they agreed or disagreed with various ways a local government could respond when a shark bite occurs. Response options are listed in Table 5. All scales were adapted from Pepin-Neff and Wynter (2018b). All respondents answered all three sections in both their pre-test questionnaire and post-test questionnaire.

The post-test questionnaire contained additional questions related to past experience with sharks. Past experiences included seeing a shark in the wild, seeing a shark at an aquarium or catching a shark while fishing. Additionally, we asked respondents if they had swam in the ocean, fished in the ocean, or surfed in the ocean within the last year. Lastly, in the post-test questionnaire respondents reported sociodemographic attributes including gender, age, education, residency, and income.

Survey administration

Survey administration followed four main steps. First participants were asked to review the Informed Consent for Participation in Research. Consenting respondents were then asked to complete the pre-treatment questionnaire. Following completion, respondents were asked to watch the YouTube videos contained within their assigned treatment.

Videos were displayed in a random order using YouTube's shuffle option. Participants then completed the post-treatment questionnaire. Both the pre-treatment and post-treatment questionnaires were administered using *Qualtrics* between March and April 2021. Completed responses were cleaned by removing straight-lined responses and those with abnormally fast completion times.

Analysis

Treatment effects were measured through the comparison of pre-treatment and post-treatment survey responses. We began by calculating summary statistics (means and standard deviations) for pre and post treatment scores for fright, danger, and intentionality (Table 2) and agreement scores for the various ways a local government could respond when a shark bite occurs (Table 5). To test hypotheses H1 to H5, we compared mean pre and post test scores using paired t-tests to determine if significant changes occurred after treatment administration. We also used ordinary least squares regression to model the change in score for fright, danger and intentionality as a function of video treatment (binary, reference level = negative treatment), pre-treatment score (continuous; to control for a ceiling effect; Theobald and Freeman, 2014), demographic variables, past experience with sharks, and coastal recreational activities. Demographic attributes included age (continuous), college education (binary; 0 = no college and 1 = college), race (binary; 0 = white and 1 = non-white), sex (binary; 0 = male and 1 = female), political affiliation (continuous; 1 = very conservative, 3 = moderate, 5 = very liberal; Rhemtulla et al., 2012; Harpe, 2015), and residency in a coastal county (binary; 1 = coastal and 0 = inland). Coastal counties were identified by the classification outlined within the NC Coastal Area Management Act (NC Department of Environmental Quality, 1974). Past experiences were either seeing a shark in the wild, seeing a shark at an aquarium, or catching a shark while fishing (all binary). Coastal recreational activities were frequency of swimming in the ocean, fishing in the ocean, or surfing in the ocean within the last year (continuous; frequency). Changes in scores were calculated as the post-treatment value minus the pre-treatment value, with a positive change indicating increase in either fear or perceived intentionality and a negative change indicating a decrease in fear or perceived intentionality. To evaluate effect size, we also calculated standardized beta values for all regression models. To test hypotheses H6 and H7 we used chi-squared tests to measure the two treatment's effects on who respondents blamed for shark bites. Lastly, to test hypotheses H8 to H11, we compared mean pre and post test scores using paired *t*-tests to determine if significant changes occurred after treatment administration. All analyses were completed using R Version 4.2.1. The NC State University Institutional Review Board (IRB #23605) approved this study.

Results

We received 340 usable responses after data cleaning. Mean age of the respondents in our sample was 32 (SD = 15.5) and median age was 25. The sample was 50.6% male and 49.4% female. For comparison, North Carolina's population was ∼51% female with a median age of 39 years old in 2020 (US Census Bureau, 2020). 61% of our sample had completed at least an associate's degree, 13% identified as non-white and 9% resided in a coastal county. The average respondent identified as moderate, with a mean political identification score of 3.18 (range: 1 = very conservative, 3 = moderate, 5 = very liberal). 73% of respondents reported swimming in the ocean in the past year, 34% reported fishing in the ocean in the past year, and 19% reported surfing in the ocean in the past year. 98% of respondents reported seeing a shark at an aquarium, 60% reported seeing a shark in the wild, and 30% reported catching a shark while fishing.

Fear and intentionality

Pre-test scores for fright (M = 5.74, SD = 2.53) and danger (M = 5.61, SD = 2.34) were above 5.5 suggesting respondents had minor levels of fright and danger before receiving any of the treatments. Perceived intentionality (M = 4.24, SD = 2.35) was below 5.5 suggesting respondents perceived shark bites to be more accidental, rather than intentional, before receiving either treatment.

Hypotheses H1 to H5 were supported by both regression and *t*-test results, indicating positive YouTube messaging decreased measures of fright, danger, and intentionality associated with shark bites. Respondents who received the positive treatment reported a 24% decrease in fright (pre M = 5.95, post M = 4.55, $\beta = -0.45$, $p < 0.001$), a 27% decrease in danger (pre M = 5.69, post M = 4.17, $\beta = -0.52$, $p < 0.001$), and a 29% decrease in intentionality associated with shark bites (pre M = 4.34, post M = 3.10, $\beta = -0.50$; $p < 0.001$) post treatment (Tables 2, 3). Additionally, results indicated negative YouTube messaging increased measures of fright, danger, and intentionality associated with shark bites; however, the magnitudes of these changes were less than those elicited by the positive treatment. Respondents who received the negative treatment reported a 6% increase in fright (pre M = 5.53, post M = 5.85, $p < 0.01$), a 11% increase in danger (pre M = 5.54, post M = 6.17, $p < 0.001$), and a 24% increase in intentionality associated with shark bites (pre M = 4.13, post M = 5.11; $p < 0.001$) post treatment (Tables 2, 3). Coefficients for pre-test scores within the fright ($\beta = -0.31$, $p < 0.001$), danger

TABLE 2 Individual measures of fright, danger, and shark bite intentionality, and associated pre and post treatment mean and standard deviation response values, and paired *t*-test results.

Measures[a]	Mean response (positive treatment)		Mean response (negative treatment)	
	Pre	Post	Pre	Post
Fright: Not frightened at all—Extremely frightened	5.95 (2.62)	4.55*** (2.39)	5.53 (2.43)	5.85** (2.63)
Danger: Not dangerous at all—Extremely dangerous	5.69 (2.28)	4.17*** (1.90)	5.54 (2.40)	6.17*** (2.51)
Intentionality: Completely accidental—Completely intentional	4.34 (2.34)	3.10*** (2.04)	4.13 (2.38)	5.11*** (2.57)

Significance levels: *p < 0.05, **p < 0.01, ***p < 0.001 for paired t-test.
[a]Measured using 10-point scales (1–10).

($\beta = -0.45, p < 0.001$), and intentionality ($\beta = -0.38, p < 0.001$) models indicate that respondents with very low or very high pre-test scores for all three measures were correlated with larger post treatment changes than respondents who reported moderate pre-test scores, likely a result of the ceiling effect (Theobald and Freeman, 2014; Tables 2, 3).

Regression results also indicate that in addition to treatment, demographic/behavior attributes also predict the pre-post changes observed. Political affiliation was significant in all three models, indicating larger decreases in fright ($\beta = -0.17$, $p < 0.05$), danger ($\beta = -0.22$, $p < 0.01$), and intentionality ($\beta = -0.16, p < 0.10$) for liberals compared to their conservative counterparts (Table 3). In the Change in Danger model, sex, and frequency of swimming in the ocean were also significant. Female respondents reported higher danger scores than male respondents ($\beta = 0.47$, $p < 0.05$), and frequent swimmers had lower danger scores compared to those for rarely or never swim in the ocean ($\beta = -0.29$, $p < 0.05$; Table 3). In the Change in Intentionality model, sex was also significant, indicating female respondents considered shark bites to be more intentional acts than male respondents ($\beta = 0.42$, $p < 0.05$; Table 3).

Results indicate support for H6 but not H7. Chi-square results indicate a significant change in blame pre-post positive treatment [X^2 (4, $N = 172$) = 17.91, $p = 0.001$]. As a result of the positive treatment, respondents tended to shift blame from sharks (15% pre-test, 5% post-test) to swimmers (38% pre-test, 42% post-test) or no one (42% pre-test, 48% post-test). Chi-square results indicate no changes in blame pre-post negative treatment [X^2 (4, $N = 168$) = 2.31, $p = 0.679$; Table 4].

Shark management preferences

Baseline preferences indicated an initial preference for non-lethal shark management strategies. The top four preferred strategies were non-lethal and were education (M = 4.66; Scale: 1 = Strongly Disagree to 5 = Strongly Agree), research (M = 4.29), technology (M = 4.00), and leave the shark alone (M = 3.61). Shark nets was the most preferred lethal option, ranking 5th overall, behind four non-lethal methods, with a pre-test mean approval score of 2.65. The bottom three strategies based on pre-test baseline scores were do nothing (M = 2.62), drum lines (M = 1.90), and hunt the shark that bit someone (M = 1.85).

Results indicate support for H8 and mixed support for H9, H10, and H11. Positive YouTube messaging decreased support for all three lethal post bite response measures. Support for shark nets decreased by 11% (pre M = 2.73, post M = 2.44, $p < 0.001$), support for hunting the shark that bit someone decreased by 11% (pre M = 1.93, post M = 1.71, $p < 0.001$), and support for baited drum lines decreased by 10% (pre M = 1.94, post M = 1.75, $p < 0.01$; Table 5). Negative YouTube messaging increased support for two of the three lethal measures, increasing support for hunting the shark the bit someone by 10% (pre M = 1.77, post M = 1.95, $p < 0.001$), and support for baited drum lines by 13% (pre M = 1.87, post M = 2.11, $p < 0.01$; Table 5). For the five non-lethal post bite response strategies, positive YouTube messaging increased support for three measures, increasing support for education by 3% (pre M = 4.61, post M = 4.73, $p < 0.01$), research by 4% (pre M = 4.24, post M = 4.40, $p < 0.01$), and leave the shark alone by 7% (pre M = 3.51, post M = 3.77, $p < 0.001$; Table 5). Negative YouTube messaging decreased support for two non-lethal measures, decreasing support for leave the shark alone by 8% (pre M = 3.72, post M = 3.42, $p < 0.001$) and do nothing by 8% (pre M = 2.66, post M = 2.45, $p < 0.01$; Table 5).

Discussion

This study suggests YouTube videos may be an effective tool to decrease fear of sharks, perceptions of intentionality associated with shark bites, and support for lethal forms of shark management. These results align with prior literature indicating carefully framed communication about sharks has the potential to shape public perceptions of the species, including risk from sharks (Lapinski et al., 2020; le Busque et al., 2021), fear of sharks, and perceived intentionality of shark attacks (Pepin-Neff and Wynter, 2018b). These findings also contribute to prior literature that suggests social media videos can influence

TABLE 3 Model parameters for three ordinary least squares regression models predicting change in perception of fright, danger, and shark bite intentionality.

Variable name	B	SE	Standardized beta
Change in fright ($n = 324$) Adj. $R^2 = 0.29$			
Constant	4.10****	1.22	0.0
Pre-test fright	−0.22****	0.04	−0.31
Treatment (positive)	−1.64****	0.17	−0.45
Political ID	−0.17**	0.07	−0.12
Change in danger ($n = 325$) Adj. $R^2 = 0.44$			
Constant	3.79***	1.29	0.0
Pre-test danger	−0.41****	0.04	−0.45
Treatment (positive)	−2.18****	0.18	−0.52
Sex (female)	0.47**	0.18	0.11
Political ID	−0.22***	0.08	−0.13
Swimming in the ocean	−0.29**	0.11	−0.16
Change in intentionality ($n = 325$) Adj. $R^2 = 0.40$			
Constant	5.21****	1.38	0.0
Pre-test intentionality	−0.36****	0.04	−0.38
Treatment (Positive)	−2.24****	0.19	−0.50
Sex (Female)	0.42**	0.20	0.10
Political ID	−0.16*	0.08	−0.09

Significance levels: *p < 0.10, **p < 0.05, ***p < 0.01, ****p < 0.001.
Insignificant variables are not displayed in the table. Political identification is measured on a 5-point scale from 1 (very conservative) to 5 (very liberal).

TABLE 4 Who is to blame when sharks bite people, broken down by treatment.

Who do you think is most to blame when sharks bite people?	Positive treatment ($n = 172$)[a]		Negative treatment ($n = 168$)[b]	
	Pre	Post	Pre	Post
Sharks	15% (26)	5% (9)	8% (13)	10% (17)
Swimmers	38% (66)	42% (72)	38% (63)	39% (65)
No One	42% (72)	48% (83)	46% (77)	44% (74)
The Government	1% (1)	2% (3)	3% (5)	2% (3)
Other	4% (7)	3% (5)	6% (10)	5% (9)

Percentages shown with counts in parentheses.
[a]X^2 (4, N = 172) = 17.91, p = 0.001.
[b]X^2 (4, N = 168) = 2.31, p = 0.679.

public perceptions of carnivore species, including tolerance of sharks (Beall et al., 2022) and wolves (Casola et al., 2020). More broadly, our results add to a growing body of literature that suggests public perceptions of a variety of environmental topics are shaped by how issues are framed on social media (Hilverda et al., 2017; Jacobson et al., 2019; Lewandowsky et al., 2020).

Positive YouTube messaging about sharks may elicit larger changes in fear, intentionality, blame and preferred management response by increasing perceived control among participants. Negatively framed videos within this study displayed sharks behaving violently or aggressively toward humans, and previous studies exploring negatively framed social media content about wildlife suggest portrayals of violent and aggressive animal behavior (which were typical in the negative shark videos) may result in a reduced sense of personal control (Kusmanoff et al., 2020). A reduced sense of control in turn often leads to inaction and apathy (Bandura, 1990). Conversely, positive message framing surrounding sharks may increase perceived control, making treatments intended to change behavior and attitudes more effective (Ajzen, 1991; Kusmanoff et al., 2020). The impact of positive and negative framing has been explored across a wide range of disciplines, demonstrating that the impact of message frames are highly context-dependent and vary based on the types of changes (e.g., behaviors, attitudes) the messages seek to

TABLE 5 Individual measures of post shark bite response strategies and associated pre and post treatment mean and standard deviation response values, and paired *t*-test results.

	Response strategy[a]	Mean response (positive treatment)		Mean response (negative treatment)	
		Pre	Post	Pre	Post
Lethal	Put shark nets at popular beaches	2.73 (1.19)	2.44*** (1.18)	2.57 (1.11)	2.60 (1.26)
	Hunt the shark that bit someone	1.93 (1.03)	1.71*** (0.89)	1.77 (0.93)	1.95*** (1.05)
	Put in baited drum lines to catch sharks near popular beaches	1.94 (1.01)	1.75** (0.94)	1.87 (0.99)	2.11** (1.17)
Non-lethal	Educate the public	4.61 (0.70)	4.73** (0.58)	4.71 (0.51)	4.68 (0.67)
	Leave the specific shark that bit someone alone	3.51 (1.06)	3.77*** (1.04)	3.72 (1.08)	3.42*** (1.15)
	Do nothing	2.58 (1.10)	2.64 (1.13)	2.66 (1.10)	2.45** (1.05)
	Conduct more research to investigate human-shark interactions	4.24 (0.82)	4.40** (0.75)	4.35 (0.76)	4.43 (0.80)
	Pay for new technologies to prevent shark bites without killing sharks	3.96 (0.96)	4.06 (0.94)	4.04 (0.99)	4.14 (1.00)

Significance levels: *p < 0.05, **p < 0.01, ***p < 0.001 for paired t-test.
[a]Measured using 5-point scales (1 = Strongly Disagree – 5 = Strongly Agree).

influence (McCagh et al., 2015; Kidd et al., 2019). However, some consistent patterns are emerging. A growing body of framing studies within conservation communication suggest positive frames are more effective than negative frames for building tolerance and reducing fear and perceptions of intentionality. This study of shark-related communication supports those findings (Casola et al., 2020; Beall et al., 2022).

Historical narratives surrounding sharks and identity politics among the US electorate may help explain why changes in fear and perceptions of intentionality were smaller among conservative respondents. In the US, the prevailing narrative around sharks was arguably set following the release of the film *Jaws* in 1975. Previous studies have described the impact of the film as the *Jaws effect*—"the way in which political actors use fictional representations in film as the basis for explaining real-life events" (Neff, 2015). The film was effective at planting the idea that shark bites are intentional acts, that human-shark interactions always lead to fatal outcomes, and that sharks must be controlled with lethal measures to neutralize the threat (Neff, 2015). Unsurprisingly, this thought pattern aligns well with the plot of the film, which solidified public perceptions of sharks in the US for decades (Neff, 2015). Although openness to change has been well-documented among the US electorate, people who identify as politically conservative tend to be less open and willing to change compared to those who identify as liberal (Mooney, 2012; Eriksson, 2018). These differences in openness to change emerge from differing in-group norms, and accepted beliefs and behaviors that dictate how members of a group should behave (Wellen et al., 1998). These differences are often expressed as part of group ideologies. Ideologies that value resistance to change may experience dissonance if presented with video content that does not conform with their interpretation of the prevailing narrative (Coffee, 2015). Thus, the negative public narrative regarding sharks (*via Jaws* and other factors), combined with an ideological resistance to change, may help explain why conservative respondents experienced smaller pre-post changes compared to liberal respondents.

The tendency for females to report greater negative changes in perceptions of danger of sharks and intentionality of shark bites may be explained by stronger negative attitudes toward sharks making women more sensitive to the video treatments. Previous research suggests that, compared to men, women express more fear (Røskaft et al., 2003) and display more negative attitudes toward large carnivores (e.g., bears, wolves, lynx, and wolverines; Kaczensky et al., 2004; Røskaft et al., 2007). Starting with more negative predispositions toward sharks, or any attitude object, can make people more susceptible to negative messaging about them (Acuña-Marrero et al., 2018; Prokop and Randler, 2018). This phenomenon may also help explain why swimming in the ocean was associated with lower perceptions of danger of sharks. Specifically, those who visit the coast more often tend to have more positive attitudes toward sharks (Friedrich et al., 2014), perceive less danger from sharks (this study; Acuña-Marrero et al., 2018), and thus be less vulnerable to negative messaging about them. Collectively, these patterns illustrate the significant influence of emotions in wildlife conservation, and the power of positive personal experiences—*via* both direct and indirect encounters with wildlife—to shape public perceptions (Castillo-Huitrón et al., 2020).

Implications and future research

This study provides insights about shark-related social media that may be leveraged to promote shark conservation. Results support other studies showing that positive message frames about wildlife are consistently more impactful than negative frames and may help reduce fear, correct misguided perceptions, and promote pro-conservation attitudes and behaviors (Casola et al., 2020; Beall et al., 2022). Thus, popular shark-related media (e.g., Shark Week, SharkFest) would generate greater benefits for shark conservation by presenting positively framed messages about sharks. These findings highlight the importance of responsible media design by content creators and journalists. We realize these suggestions may be difficult to implement since negatively framed messaging has driven one of the most watched, most lucrative, and longest running cable television programming events in history (i.e., Discovery's Shark Week; Fetters, 2012) with related content on social media (e.g., Facebook and Instagram) engaging 48 million users in 2018 (Feldman, 2019). However, Discovery Channel has acknowledged some of the issues with Shark Week content under its former CEO (de Moraes, 2015), and other popular nature shows such as Planet Earth and Blue Planet have demonstrated how the drama and excitement that draws in viewers can be generated without negative framing.

Future studies should build upon this work by addressing several limitations of this study. Although respondents were shown multiple videos, this study is representative of a single virtual exposure to sharks. Additional research is needed to evaluate the long-term impacts of exposure to popular shark content specials such as Shark Week. Such evaluations are especially important because this type of content is created within the context of a larger set of programming, not as single standalone videos. Additionally, previous studies suggest single exposures are unlikely to produce long-term effects without future exposures to similar content (Bode, 2016). Future studies may include "filler tasks" which simulate the realistic scenario of combining different types of information presented in sequence (e.g., commercial breaks interspersed within a television show). Future studies could also strive for a simple random sample to reduce the potential for a pre-existing knowledge bias. Our sample was limited in geographic scope and may have included respondents overly aware of environmental issues (due to their network ties to college students in a wildlife-related major, and proximity to and high frequency of recreating in the ocean) compared to a random sample of the general public, potentially dampening treatment effects observed (Theobald and Freeman, 2014; Bode, 2016). Coastal residents are physically closer to the ocean and their behaviors and policy preferences are more likely to directly impact coastal ecosystems. Additionally, major coastal cities in the US lean politically liberal, which this and previous studies have indicated is likely to further increase the efficacy of positively framed content (Tausanovitch and Warshaw, 2014). Future studies should explore these possible geographic effects and how they may be leveraged to help reduce fear, correct misguided perceptions, and promote pro-conservation attitudes and behaviors. Measures of key outcome variables could also be expanded. Future research should consider the impacts to explaining post shark bite management options in more detail (e.g., efficacy at reducing future incidents, cost, impacts on sharks). This study used two basic measures to gauge fear among respondents. Future studies should build upon scales used in parallel contexts, such as the "Snake Anxiety Questionnaire," to better understand the psychometric components contributing to overall fear (Klieger, 1987; Zsido et al., 2018) or explore implicit attitudes and their connection with self-declared attitudes. Similarly, future studies might consider impacts of a broader suite of messaging on various types of conservation policy support for sharks, extending beyond management preferences to include behaviors such as donations and volunteerism (Drymon and Scyphers, 2017; Bargnesi et al., 2020). These may include other forms of social media content or other public facing communiques such as educational signage, museum/aquarium content, or coastal tourism campaigns. Additional experimental research will continue to reveal the various ways that positively and negatively framed communication can influence public perceptions of and support for controversial species such as sharks.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by NC State University Institutional Review Board. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

MP, LL, CP, and WC conceived the ideas and designed methodology. JB, WC, and MP collected the data. WC, JB, MP, and LL analyzed the data. WC and JB led the writing of the paper. All authors contributed critically to the drafts and gave final approval for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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