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ORIGINAL RESEARCH

The influence of YouTube videos on human tolerance of sharks

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Abstract

Sharks are often depicted in the media as violent killers that actively seek out opportunities to harm humans. This framing may impact human tolerance and support of shark conservation, underscoring the need to identify strategies that counteract these negative representations. Social media, given its widespread use, could be an effective platform for shaping public tolerance for sharks and other wildlife species. In this experimental study, we conducted an online pre-post survey in Spring 2020 to determine how viewing shark-related YouTube videos impacted tolerance for sharks among residents (n = 335) in the coastal state of North Carolina (NC), USA and neighboring states. The study employed framing theory, which suggests that the ways in which information is presented influence how it is processed and the actions that result from it. Participants were randomly assigned to one of two video treatments where sharks were framed positively or negatively. Each video treatment impacted tolerance for sharks in the direction of their framing: positive framing influenced positive changes in tolerance (70% more positive attitudes toward sharks, a 130% increase in acceptance of sharks and a 46% increase in intended shark conservation behaviors), and negative framing influenced negative changes (25% more negative attitudes toward sharks, a 18% decrease in acceptance of sharks and a 3% decrease in intended shark conservation behaviors). These findings suggest positive messages about sharks on social media promote tolerance of sharks and can be more impactful than negative messages. At least one form of social media, YouTube, appears to be a valuable tool for encouraging tolerance for sharks.

Introduction

Although sharks provide several key ecological and economic benefits (Cisneros-Montemayor *et al*., 2013; Ruppert *et al*., 2013), they suffer from overexploitation and persecution globally (Friedrich, Jefferson & Glegg, 2014; Pacoureau *et al*., 2021). As an apex predator, sharks structure food webs both directly by regulating prey dynamics and indirectly by modifying prey behavior (Ferretti *et al*., 2010). Thus, the removal of sharks can result in altered ecosystem functioning and shifted food web dynamics (Heithaus *et al*., 2008). Sharks also provide key benefits to humans. For example, shark tourism is a rapidly growing industry that generates millions of dollars every year for communities worldwide (Gallagher & Hammerschlag, 2011; Cisneros-Montemayor *et al*., 2013). In many cases, shark tourism can help to stimulate the development of local communities while simultaneously benefiting conservation efforts (Vianna *et al*., 2018; Zimmerhackel *et al*., 2019). For these reasons sharks continue to be a top priority for conservation (Bräutigam, Callow, & Campbell, 2016; Dulvy et al., 2017).

Shark populations are threatened as a result of human impacts and activities, specifically commercial fishing (Pacoureau *et al*., 2021). Oceanic shark populations have decreased by an estimated 71% since 1970 due primarily to increased pressures from fishing (Pacoureau *et al*., 2021) and the shark fin trade (Cardeñosa *et al*., 2018). Compounding this issue, sharks are characterized by life-history traits such

as low fecundity and slow growth, making them more susceptible to human impacts and limiting their recovery after population declines (Snelson, Roman, & Burgess, 2008). These challenges highlight the urgent need for strategies that can help shark numbers recover and cultivate support for shark conservation among the public (Acuña-Marrero *et al*., 2018).

Ultimately, successful shark conservation depends on building human tolerance for sharks (Acuña-Marrero *et al*., 2018; Lucrezi, Ellis & Gennari, 2019). Tolerance, a key element of successful conservation outcomes (especially for carnivore species), can be viewed as a spectrum of behaviors ranging from intolerance to stewardship (Bruskotter *et al*., 2015; Casola *et al*., 2020). Identifying where the public falls along that spectrum can be accomplished by measuring attitudes, acceptance, and intended behaviors toward the species in question (Bruskotter *et al*., 2015). For sharks, tolerance is impacted by factors such as their perceived esthetic value, knowledge of their environmental role and perceived threat to humans (O'Bryhim & Parsons, 2015; Acuña-Marrero *et al*., 2018). Evidence suggests that attitudes toward sharks on a global scale are generally positive, and are influenced by several factors including knowledge of sharks and participation in conservation projects (Giovos *et al*., 2021). However, fear of sharks is persistent, even in nations where attitudes are most positive. Perceived risk of sharks is another driver of human tolerance for sharks (Lucrezi, Ellis & Gennari, 2019; Lapinski *et al*., 2020) and can be influenced by news media (Sabatier & Huveneers, 2018; Le Busque, Dorrian & Litchfield, 2021). These enduring negative perceptions of sharks highlight the importance of seeking out strategies to improve public attitudes toward sharks.

Popular media influences tolerance of sharks in key ways. For example, shark conservation efforts often suffer because common portrayals of shark species fuel the perception that sharks are violent killers who actively seek out opportunities to attack humans (Kellert *et al*., 1996; Muter *et al*., 2013; Friedrich, Jefferson & Glegg, 2014; Sabatier & Huveneers, 2018; Le Busque, Dorrian & Litchfield, 2021; Le Busque & Litchfield, 2022). Of 300 U.S. and Australian news articles about sharks, over half included references to shark attacks, whereas only 11% focused on shark conservation (Muter *et al*., 2013). Another study examining movies specifically found that, out of 109 shark-related films reviewed, 96% of them depicted sharks as threatening to humans (Le Busque & Litchfield, 2022). This finding is concerning, as the historical and media-driven representation of sharks as violent killers is often used in the policy arena to increase public support for shark mitigation policies – a process referred to as the '*Jaws* effect' (Neff, 2015). On the other hand, direct interactions with sharks, such as aquarium visits, SCUBA diving and saltwater recreational angling can lead to feelings of tolerance and support for sharks by increasing public familiarity with and appreciation of different shark species (Friedrich, Jefferson & Glegg, 2014; McClellan Press *et al*., 2016; Acuña-Marrero *et al*., 2018). Similar benefits associated with direct encounters have been observed with other carnivore species such as bears (Johansson *et al*., 2019) and alligators (Skupien, Andrews & Larson, 2016). However, authentic experiences with sharks in the wild are relatively infrequent and may be inaccessible to some members of the general public, underscoring the need to explore alternative methods for encouraging tolerance for wildlife species beyond direct exposure.

Social media may be a particularly effective means for promoting tolerance for sharks. Social media represents an efficient and cost-effective means of sharing content, with at least 3.5 billion people using the internet worldwide in 2016 (Our World In Data, 2019), and more than two-thirds of all internet users accessing social media in 2018 (Ortiz-Ospina, 2019). For instance, the popular social media platform YouTube has more than 2 billion monthly logged in viewers, with 27% of internet users accessing content from the platform at least once a day (Clement, 2019). Discussions surrounding sharks appear to be common on social media, as evidenced by one study that found that 87% of Facebook pages for Australian news outlets had at least one story about sharks for a total of 2643 posts and 40 373 associated comments in 2016 alone (Le Busque *et al*., 2019). Social media platforms such as these may be fruitful mechanisms for increasing tolerance of species, and videos of wildlife on social media may be particularly impactful (Casola *et al*., 2020).

Currently, social media represents an under-explored avenue for promoting public tolerance of sharks. While shark tourism is a growing field, relatively few individuals out of the global population engage in activities which directly expose them to sharks (Gallagher & Hammerschlag, 2011; Gallagher & Huveneers, 2018). Thus, social media may present a practical means of enhancing support for conservation efforts by engaging large audiences. However, social media coverage and framing of sharks varies widely. One study found that half of shark-related news stories posted on Facebook revolved around negative impacts of human-shark interactions (50%); very few focused on shark conservation (2.3%) and other stories (47.7%) focused on miscellaneous topics largely unrelated to conservation such as shark sightings, popular culture references and shark tourism (Le Busque *et al*., 2019). There is a need to understand how the framing of such messages about sharks on social media influences tolerance for them. Framing theory suggests that the way a message is presented influences how the message is processed and the actions that result from it (Chong & Druckman, 2007; Kusmanoff *et al*., 2020). Prior research focused on wolves, another controversial and charismatic carnivore species, found negative framings of wolves on YouTube decreased tolerance for them, whereas positively framed videos increased tolerance (Casola *et al*., 2020). Another experimental study focused on sharks suggests the types of media headlines people are exposed to (e.g. sensational vs. factual) had little impact on management preferences, but any exposure to sharks in the media tended to increase both risk perception and acceptance (Le Busque, Dorrian & Litchfield, 2021). However, for social media, the

impact of framing shark-related communications on tolerance is currently unknown.

We began addressing this need by conducting a case study measuring how social media consumption (via YouTube) affected viewers' tolerance of sharks. We used an experimental design following the approach described by Casola *et al*. (2020) and applying Bruskotter *et al*.'s (2015) measures of tolerance to determine if popular video content on YouTube changed viewers' tolerance of sharks. We hypothesized that, for all viewers, (H1) positive YouTube messaging would increase tolerance for sharks, and (H2) negative YouTube messaging would decrease tolerance. 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 (H3) positively framed videos of sharks on social media would have a greater influence on changes in tolerance than negatively framed videos. We also explored the roles that several demographic attributes play in these changes.

Materials and methods

We identified and surveyed a convenience sample that consisted primarily of residents of North Carolina (NC), USA – a state with 484 km of ocean coastline and 5432 km of tidal shoreline (National Oceanic and Atmospheric Administration [NOAA], 1975). Most respondents were within the personal social network of students in the North Carolina State University Fisheries, Wildlife, and Conservation Biology Program (FWCB). The criteria for inclusion in this study were as follows: participants must be over the age of 18, currently live in North Carolina or an adjacent state, and must not be a student of North Carolina State University or an immediate family member of the student collecting the data. We restricted participation to exclude immediate family members and students at North Carolina State University to limit potential bias, as previous research suggests more educated study participants are less likely to be persuaded by social media messaging (Theobald & Freeman, 2014; Bode, 2016). Respondents were asked their state of residence as part of the survey, and those who were not currently living in North Carolina or an adjacent state were removed from the sample prior to analysis. A small portion of total responses (n = 4) of all adults sampled was collected from neighboring states (Georgia, South Carolina) and was retained for final analysis.

Using keyword searches on YouTube, we developed two shark video playlists, a positive or pro-shark treatment and a negative or anti-shark treatment. We identified 16 potential YouTube videos using criteria involving keyword searches in YouTube of the words "shark", "shark week" and "Discovery Channel", selected based on how obvious their positive or negative message framing was, the view count (minimum 3000 views in order to avoid videos that were unpopular among social media audiences), and the fact that they were a part of 'Shark Week' programming from the Discovery Channel. Videos were considered positive if they portrayed sharks through a scientific lens or showed sharks behaving non-aggressively; videos were considered negative if they represented sharks behaving violently toward humans. The final 10 videos used in the two treatments were selected by a panel of 73 undergraduate students at NC State University. Each student watched the 16 videos and responded to four prompts asking how the video portrayed sharks on −3 to +3 value scales of 'worthless to valuable', 'unpleasant to pleasant', 'harmful to beneficial' and 'bad to good'. For each video, we aggregated the scores from these four scales, calculated 95% confidence intervals, and then selected five positive and five negative videos (Table 1). The positive group and negative group were chosen through a process of elimination where videos with overlapping 95% confidence intervals with any videos in the other group were removed. All positive videos had an average attitude score greater than 0, and all negative videos had an average score less than 0. The negative treatment videos consisted of 14:10 min, and the positive treatment videos lasted 11:32 total minutes. While the research team attempted to collect videos that were only associated with Shark Week, one video that was not Shark Week content ('Sharks Love to be Petted, They're Like Dogs') was ultimately included due to the relative scarcity of positively framed Shark Week content that met our criteria for inclusion (see footnote, Table 1). We did not include a neutral treatment group, because there was no Shark Week content identified that appeared to represent sharks in a neutral fashion. Each treatment playlist was shuffled and viewed in a random order. Participants were randomly assigned to one of the two treatment groups (Lawson *et al*., 2019).

Each participant completed both a pre-treatment and post-treatment survey. In both surveys, participants' tolerance for sharks was broken down into three specific measures: attitudes, acceptance and intended behaviors (Table 2). We measured attitudes (four item, 7-point scale from −3 = strongly disagree to 3 = strongly agree), acceptance (three item, 7-point scale from −3 = strongly disagree to 3 = strongly agree) and intended behavior toward sharks (11 item, 5-point scale from −2 = very unlikely to 2 = very likely) following Casola et al. (2020; Tables 3–5). Exploratory factor analysis and Cronbach's alpha were used to test for scale validity and reliability. Individual scale items, scale metrics and summary statistics for pre and post-treatment attitudes, acceptance and intended behaviors are reported in Tables 3–5, including exploratory factor analysis (principal components analysis with Varimax rotation) values and Cronbach's alpha values. To account for the reverse-coded questions used in the behavioral intention scales, anti-shark behavioral intention items were flipped (e.g. anti-shark scale value of −2 flipped to a pro-shark value of +2). All three measures of tolerance displayed high internal validity ($\alpha > 0.76$; Hair *et al*., 2014). Exploratory factor analysis led to the removal of one item within the behavioral intention scale 'Kill a shark if you caught one' in response to the prompt 'If you were to take action based on your opinions toward sharks, how likely are you to do each of the following'? due to a low factor loading on either factor of the behavioral intention scale (0.31, 0.28). After the removal of this item, exploratory factor

Table 1 Videos included in the positive and negative treatments with duration and views as of April 24, 2021[a]

Video name and URL	Duration (min:sec)	Views (April 24, 2021)
Negative treatment		
18-Foot Shark Attacks Cage|Great White Serial Killer URL: https://www.youtube.com/watch?v=73PW56YHvXs	2:37	14 775 339
Man Loses Arm to Shark|Shark Bites URL: https://www.youtube.com/watch?v=psftY9DV9iE	3:56	2 984 905
Meet 'Slash' The Shark|Shark Week URL: https://www.youtube.com/watch?v=w5A2FmNQv8g	2:59	4 571 265
Oceanic Whitetip Shark Bites Diver URL: https://www.youtube.com/watch?v=WkF7yW4oaDU	1:51	4 720 154
Giant Great White Attacks the WASP| Air Jaws: Fins of Fury URL: https://www.youtube.com/watch?v=Sh_aWElP5F0	2:47	191 231
Positive treatment		
Lemon Shark Gives Birth|Shark Week URL: https://www.youtube.com/watch?v=LfQgRCg1bNA	1:28	568 869
Reef Shark Nods off After Nose Rub URL: https://www.youtube.com/watch?v=7UMrDC3jpUU	2:05	39 826
Shark Week 2011: Sand Tiger Sharks Deceive with Toothy Look URL: https://www.youtube.com/watch?v=e-PpG3fcBJc	3:10	68 853
Understanding Sharks|Shark Week (360 Video) URL: https://www.youtube.com/watch?v=XYrrlbltfPg	2:57	226 935
Sharks Love to be Petted – They're Like Dogs[b] URL: https://www.youtube.com/watch?v=l4Al6T0-isc	1:52	19 185 889

[a]Videos were required have no less than 3000 views, could not be celebrity video or a compilation, and were required to be less than 4 min long. Genuine Shark Week footage and videos with high view counts were prioritized. Terms searched for negative connotation: 'shark + week + diver'. Terms searched for positive connotation 'shark + week + petting' and 'shark + week + birth', 'shark + week + understanding', 'shark + week + sleep' and 'shark + week + migration'.

[b]Not a Shark Week video.

analysis revealed that measures for each scale loaded strongly on a single factor for attitudes and acceptance, and two factors for the behavioral intention scale (Tables 3–5). We also included a binary variable, entitled 'shark experience,' to account for whether participants had encountered a shark in the wild before ('0' = No, '1' = Yes). Participants also reported other demographic attributes including gender, age, education and income.

Surveys and videos were administered with a three-step process. First, participants filled out the pre-treatment survey. Then each participant watched the YouTube videos within their assigned treatment video playlist in random order. Once finished with the video playlist, participants filled out the post-treatment survey. Both the pre-treatment and post-treatment surveys were completed online using *Qualtrics* survey software (n = 467) between March and April 2021. After cleaning the data (e.g. removing straight-lined responses, those with abnormally fast completion times, those from participants that did not live in North Carolina or a neighboring state), 335 usable responses remained.

To test H1 and H2, we developed three ordinary least squares regression models to predict change in attitudes, acceptance and intended behavior. Change in each measure of tolerance was modeled as a function of video treatment, corresponding pre-treatment score (to control for a ceiling effect; Theobald & Freeman, 2014), demographic attributes (e.g. age, gender) and a variable to measure whether or not the respondent had seen a shark in the wild previously (to control for the impact of a direct experience with sharks). Change in attitudes, acceptance and intended behavior was calculated as the respective difference between the sum of post-treatment values and pre-treatment values. A positive change indicated the participant became more tolerant of sharks after exposure to the video treatment and a negative change indicated the participant became less tolerant after exposure to the video treatment. Video treatment was included as a binary indicator variable in all models. The negative treatment served as the reference level from which the effect of the positive treatment was estimated. We calculated standardized beta values to determine effect size within all three models. To test H3, we used t-tests and descriptive comparisons of change in attitudes, acceptance and intended behaviors toward sharks between the two treatment groups. We used the Bonferroni adjustment to account for multiple comparisons. All analyses were completed using R Version 4.0.4. The NC State University institutional review board (IRB #23605) approved this study.

Results

Our sample was 48.3% female and 51.7% male with an average age of 32 years old and a median age of 25. As a point of reference, the population of NC is approximately 51% female with a median age of approximately 39 years (US Census Bureau, 2019). Of all participants, 47.2% had completed college with a bachelor's degree or higher, and 61% reported seeing a shark in the wild. Approximately 78% of respondents reported positive initial attitudes toward sharks, meaning that, when their Likert responses for each of the four scale items (scale: −3 to 3 for each individual item) were summed together, they at least scored a positive number. This was also true of approximately 44% of respondents for their acceptance of sharks when three scale items were summed together (scale: −3 to 3 for each individual item), and 77% of respondents for intent to engage in pro-shark

Table 2 Key variables comprising human tolerance of sharks, including definitions and rationale for inclusion

Variable name	Definition	Rationale	Source
Attitudes	An individual's feelings (both evaluative beliefs and general affect) toward the species in question.	Attitudes are a key component of tolerance, the focus of our study. Negative attitudes can affect behaviors relevant to conservation, so understanding changes in attitudes toward sharks after exposure to social media content was a key aim of our study.	Bruskotter *et al.* (2015) and Casola *et al.* (2020)
Acceptance	The maximum population of a particular species that is acceptable to people in a given area.	Acceptance (and wildlife acceptance capacity, more broadly) is a key component of tolerance. Furthermore, acceptance is related to individual behaviors that have the potential to shift or limit numbers of species in an area. Thus, we sought to examine how exposure to shark-related social media content might impact public acceptance of shark populations.	Bruskotter *et al.* (2015) and Casola *et al.* (2020)
Intended behaviors	The extent to which an individual will engage in behaviors to support or hinder conservation of the species in question.	Intended behavior is a key component of tolerance, the focus of our study. Measuring changes in intended behaviors can also help ascertain the impact of exposure of shark content on social media, as these behaviors may translate into actual conservation behaviors.	Bruskotter *et al.* (2015) and Casola *et al.* (2020)

Table 3 Individual measures of attitudes toward sharks and associated pre and post treatment exploratory factor analysis results, mean response values and Cronbach's alpha values

Attitudes toward sharks						
Attitude scales[a] (Pre α = 0.87, Post α = 0.90)	Factor loading		Mean response (Positive treatment)		Mean response (Negative treatment)	
	Pre[b]	Post[c]	Pre	Post	Pre	Post
Bad: Good	0.86	0.92	1.16	1.93	1.38	0.91
Harmful: Beneficial	0.89	0.91	1.30	1.85	1.62	1.22
Unpleasant: Pleasant	0.65	0.74	−0.08	1.33	0.19	−0.06
Worthless: Valuable	0.79	0.79	1.78	1.95	1.96	1.76

[a]Measured using 7-point scales from −3 (Bad/Harmful/Unpleasant/Worthless) to 3 (Good/Beneficial/Pleasant/Valuable).
[b]Eigenvalue: 2.91; principal components analysis with Varimax rotation.
[c]Eigenvalue: 3.12.

behaviors when 11 items were summed together (scale: −2 to 2 for each individual item).

Regression estimates support H1: positive YouTube messaging about sharks increased positive attitudes, tolerance and intended behavior toward sharks. Those who received the positive treatment reported approximately 70% more positive attitudes toward sharks (pre $M = 4.16$, post $M = 7.06$, Scale: −12 to 12; $B = 4.07$, $P < 0.001$), a 130% increase in their acceptance of sharks (pre $M = 0.46$, post $M = 1.06$, Scale: −6 to 6; $B = 0.75$, $P < 0.001$), and a 46% increase in their intended behaviors toward sharks following the video treatment (pre $M = 4.44$, post $M = 6.46$, Scale −22 to 22; $B = 2.13$, $P < 0.001$, Table 6). Regression estimates also support H2: negative YouTube messaging about sharks decreased tolerance for sharks. Those who received the negative treatment reported approximately a 25% more negative attitudes toward sharks (pre $M = 5.15$, post $M = 3.85$, Scale: −12 to 12; $B = 4.07$, $P < 0.001$), a 18% decrease in their acceptance of sharks (pre $M = 0.73$, post $M = 0.60$, Scale: −6 to 6; $B = 0.75$, $P < 0.001$) and a 3% decrease in their intended behaviors toward sharks (pre $M = 5.35$, post $M = 5.20$, Scale: −22 to 22; $B = 2.13$, $P < 0.001$, Table 6). We also found support for H3: changes in attitudes ($t[332] = -11.71$, $P < 0.001$), changes in acceptance ($t[333] = -5.60$, $P < 0.001$) and changes in intended behaviors ($t[305] = -4.90$, $P < 0.001$) were significantly larger for

Table 4 Individual measures of acceptance of sharks and associated pre and post treatment exploratory factor analysis results, mean response values and Cronbach's alpha values

Acceptance of sharks						
Tolerance scales[a] (Pre α = 0.81, Post α = 0.85)	Factor loading		Mean response (Positive treatment)		Mean response (Negative treatment)	
	Pre[b]	Post[c]	Pre	Post	Pre	Post
Shark numbers in my state should be...	0.86	0.92	0.20	0.37	0.26	0.24
Shark numbers globally should be...	0.86	0.85	0.46	0.73	0.59	0.52
Shark populations near populated areas should be...	0.60	0.67	−0.19	−0.04	−0.11	−0.17

[a]Measured using 5-point scales from −2 (decreased greatly) to 2 (increased greatly).
[b]Eigenvalue: 2.18; principal components analysis with Varimax rotation.
[c]Eigenvalue: 2.31.

Table 5 Individual measures of behaviors toward sharks and associated pre and post treatment exploratory factor analysis results, mean response values and Cronbach's alpha values

Behaviors toward sharks[a]						
Behavior scales[b] (Pre α = 0.76, Post α = 0.79)	Factor loading		Mean response (Positive treatment)		Mean response (Negative treatment)	
	Pre[c]	Post[d]	Pre	Post	Pre	Post
Pro-shark scale						
Write to your congressperson in support of shark recovery efforts	0.82	0.90	−0.60	−0.27	−0.69	−0.67
Contribute to an organization that supports shark recovery	0.72	0.69	−0.02	0.38	0.07	0.08
Sign a petition in support of shark reintroductions (by the federal government)	0.53	0.63	0.43	0.65	0.51	0.26
Write a letter to the editor of your local newspaper in support of shark recovery	0.84	0.89	−0.71	−0.44	−0.77	−0.69
Protest against shark fishing	0.65	0.65	−0.28	−0.09	−0.32	−0.33
Anti-shark scale						
Write your congressperson to oppose shark recovery efforts[e]	0.71	0.83	1.11	1.24	1.33	1.39
Contribute to an organization that opposes shark recovery efforts[e]	0.74	0.78	0.89	1.15	1.17	1.30
Sign a petition to stop any shark reintroductions (by the federal government)[e]	0.71	0.70	1.29	1.14	1.42	1.08
Write a letter to the editor of your local newspaper opposing shark recovery[e]	0.84	0.82	1.26	1.35	1.43	1.41
Protest against shark reintroductions[e]	0.83	0.81	1.42	1.34	1.42	1.38

[a]The following variables were excluded from this scale due to a factor loading < 0.40: kill a shark if you caught one.
[b]Measured using 5-point scale from − 2 (very unlikely) to 2 (very likely).
[c]Eigenvalue: 3.46; principal components analysis with Varimax rotation.
[d]Eigenvalue: 3.60.
[e]Indicates a reverse-coded variable in the analysis. Means reflect reverse coded values.

the positive treatment group than the negative treatment group (Fig. 1).

Higher pre-test attitudes ($B = -0.24$, $P < 0.001$), higher pre-test acceptance ($B = -0.16$, $P < 0.001$) and higher pre-test intended behaviors ($B = -0.19$, $P < 0.001$) were all related to smaller positive changes in attitudes, acceptance and intended behavior, respectively. College education predicted positive changes in attitudes ($B = 0.78$, $P < 0.05$) and acceptance ($B = 0.38$, $P < 0.01$) irrespective of treatment. Respondents with a bachelor degree or higher scored 0.78 points higher on the changes in sharks attitudes scale and 0.38 points higher on the changes in acceptance of sharks scale compared to those with no college degree. A 10-year increase in age resulted in a 0.10 unit decrease in change in acceptance of sharks ($B = -0.01$, $P < 0.05$) and a 0.50 unit decrease in change in intended behaviors toward sharks ($B = -0.05$, $P < 0.01$, Table 6) irrespective of treatment. We did not detect a significant relationship between prior experience with sharks and changes in any of the three measures of tolerance, nor did we detect relationships between gender and the dependent variables.

Discussion

This study suggests consumption of positive YouTube videos about sharks promotes tolerance of sharks. This positive effect was larger than the negative shift in tolerance of sharks following consumption of negative YouTube videos. This finding aligns with previous research suggesting positively framed communications about conservation tend to be more impactful than negatively framed messaging (Jacobson *et al.*, 2019; Casola *et al.*, 2020). These findings also contribute to prior research rooted in framing theory indicating that social media can impact public attitudes toward a broad range of topics

Table 6 Summary of ordinary least squares regression models predicting change in attitudes toward sharks, change in acceptance of sharks and change in intended behavior toward sharks

Change in attitudes toward sharks (n = 335) R^2 = 0.39			
Variable name	*B*	SE	Standardized beta
Constant	−0.58	0.50	0.00
Pre-test attitude	−0.24***	0.03	−0.32
Treatment (positive)	4.07***	0.34	0.52
College education	0.77*	0.36	0.10
Gender (female)	−0.14	0.34	−0.02
Age	−0.005	0.01	−0.02
Experience with sharks	0.46	0.35	0.06
Change in acceptance of sharks (n = 335) R^2 = 0.15			
Variable name	*B*	SE	Standardized beta
Constant	−0.02	0.18	0.00
Pre-test acceptance	−0.16***	0.04	−0.24
Treatment (positive)	0.75***	0.13	0.30
College education	0.38**	0.14	0.15
Gender (female)	−0.10	0.13	−0.04
Age	−0.01*	0.004	−0.12
Experience with sharks	0.21	0.13	0.08
Change in intended behavior toward sharks (n = 335) R^2 = 0.15			
Variable name	*B*	SE	Standardized beta
Constant	1.72**	0.63	0.00
Pre-test behavior	−0.19***	0.04	−0.26
Treatment (positive)	2.13***	0.43	0.25
College education	0.58	0.45	0.07
Gender (female)	0.60	0.43	0.07
Age	−0.05**	0.01	−0.18
Experience with sharks	0.10	0.44	0.01

Significance levels: *P < 0.05, **P < 0.01, ***P < 0.001. College education is a binary variable where 0 = 'no college education' and 1 = 'college education'. 'Experience with Sharks' is a binary variable where '0' = respondent has not seen a shark in the wild and '1' = respondent has seen a shark in the wild. Age is a continuous variable.

such as political attitudes and behavior (Zhang *et al.*, 2010), cigarette smoking (Yoo, Yang & Cho, 2016), vaccinations (Mitra, Counts & Pennebaker, 2016) and climate change (Lewandowsky *et al.*, 2019). That influence may extend to wildlife conservation issues, including often maligned and charismatic species such as sharks.

Exposure to YouTube videos of sharks appeared to have a strong influence on tolerance regardless of whether people had previously seen sharks in the wild. However, it is important to note that our methods for measuring an experience with sharks were limited because we only asked respondents whether or not they had seen a shark in the wild before. We did not capture other important details, such as number of encounters, type of encounters (e.g. diving, from a boat) or other positive interactions with sharks (e.g. in an aquarium). This could explain why, unlike other studies, we did not observe a strong connection between previous experiences with sharks and positive attitudes (e.g. Friedrich, Jefferson & Glegg, 2014; Acuña-Marrero *et al.*, 2018). In fact, in our study, brief exposure to shark-focused social media had a more pronounced effect than previous contact with sharks in the wild. Future research could explore how authentic experiences with sharks interact with vicarious exposure (e.g. social media of sharks) to influence risk perceptions and changes in human tolerance.

The influence of college education on attitudes and acceptance of sharks aligns with prior research examining the influence of education on tolerance for wildlife species (Bath & Buchanan, 1989; Røskaft *et al.*, 2003; Kaczensky, Blazic & Gossow, 2004). Specifically, more education predicts less fear of large carnivorous species including brown bears and wolves (Røskaft *et al.*, 2003), and more positive attitudes toward species including brown bears (Kaczensky, Blazic & Gossow, 2004) and wolves (Bath & Buchanan, 1989). The tendency for change in acceptance of sharks and intended behaviors toward sharks to become more negative with increasing age may exist for several reasons. Older generations may be less skeptical, and more susceptible, to online content (Guess, Nagler & Tucker, 2019). Older generations may also be more fearful and less tolerant of large carnivores in general (Røskaft *et al.*, 2003; Lischka *et al.*, 2019; Casola *et al.*, 2020). Future research should seek to illuminate possibilities for differential impacts of social media on tolerance for different species among distinct age cohorts.

Our findings have two major implications for communicating about, and influencing tolerance for, controversial species such as sharks. First, positive messages about sharks distributed on social media are more impactful than negative ones. This reveals an opportunity for wildlife professionals and communicators to counteract the negative representations of sharks that have been sensationalized in popular media and film with more impactful, positive messaging about sharks (Friedrich, Jefferson & Glegg, 2014; Bombieri *et al.*, 2018; Le Busque & Litchfield, 2022). Such positive messaging may help counteract beliefs that sharks are predators of humans (Neves *et al.*, 2021), a general fear of sharks (Giovos *et al.*, 2021) and negative outcomes associated with common portrayals of sharks including heightened risk perceptions (Lucrezi, Ellis & Gennari, 2019; Le Busque, Dorrian & Litchfield, 2021).

Second, social media may provide an especially fruitful outlet for communication about controversial species such as sharks. These findings suggest that at least one type of social media, YouTube, may be utilized to quickly, cheaply and effectively enhance tolerance for sharks. Although rapid change in attitudes toward wildlife conservation can and does occur (Niemiec *et al.*, 2022), a single exposure to content such as this may not create long-term changes in behavior (Dunn, Mills & Veríssimo, 2020). However, repeated exposures to communications may establish long-term knowledge about a subject (Chaffee & Kanihan, 1997; Bode, 2016). Our findings, combined with the relationship

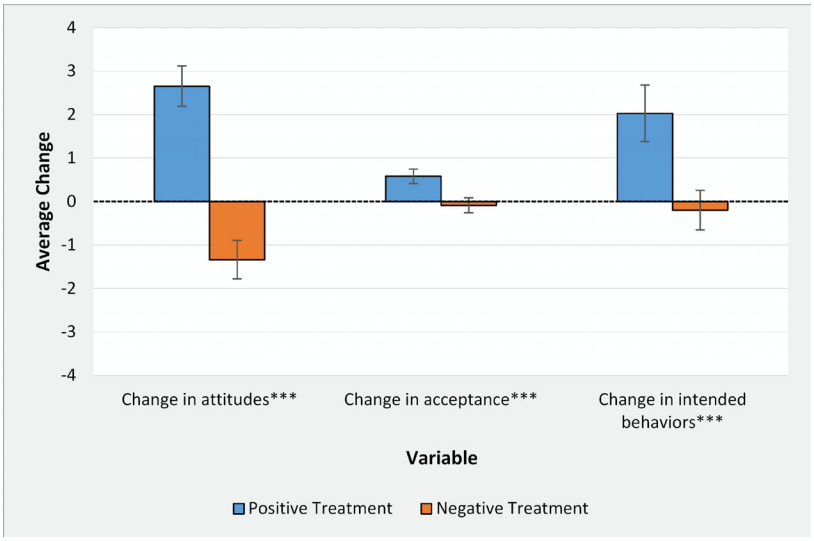

Figure 1 Differences in change in attitudes, change in acceptance and change in intended behaviors between the positive treatment and negative treatment groups. Change in each variable was calculated by subtracting the pre-test score from the post-test score for each variable. Significance levels: $*P < 0.05$, $**P < 0.01$, $***P < 0.001$ for Welch's *t*-test adjusted with the Bonferroni correction for multiple comparisons. Error bars represent 95% confidence intervals. The dashed line represents a baseline of no change.

between knowledge and tolerance of sharks (O'Bryhim & Parsons, 2015; Acuña-Marrero *et al.*, 2018), suggest that repeated, positively framed communication and messaging on social media may represent a cost-effective method of influencing human tolerance for sharks. However, this process must be conducted carefully, as some research suggests that large amounts of media exposure to sharks can inadvertently generate higher risk perceptions of sharks (Le Busque *et al.*, 2019; Le Busque, Dorrian & Litchfield, 2021).

Future research can address limitations of this study in several ways. First, adopting random sampling would help extend strong inference from this experimental approach to larger populations. For example, there was a significant gap in median age from our sample (25 years old) and from the median age of the population in NC (39 years old). Second, our sample was focused on a coastal region, and residents of coastal and non-coastal regions may perceive sharks in different ways (Friedrich, Jefferson & Glegg, 2014). The study setting may also explain why so many respondents (61%) reported seeing a shark. Thus, research accounting for geographic location may provide important insights about how social media influences tolerance for sharks. Future research should examine how different types of media (e.g. text, images) and different forums (e.g. Facebook, Instagram) impact the efficacy of messaging intended to promote tolerance of diverse species. For instance, prior research has uncovered a significant bias toward sensationalized news stories about sharks on Facebook (Le Busque *et al.*, 2019), but it is unclear how these patterns might differ on other platforms. Another limitation to consider is that, while we carefully selected videos based on specific criteria for inclusion in the positive and negative playlists, our methodology was limited to what was available and produced by others. Shark Week content features a somewhat sensational style that may introduce bias despite our approach to selecting positive and negative videos. Future research could provide a more rigorous means of message framing by strategically producing videos of sharks designed purposively to test hypotheses. Future research could also advance the theoretical conceptualization of tolerance by including emotional dispositions (Jacobs & Vaske, 2019) in addition to attitudes, acceptance and behaviors (Bruskotter *et al.*, 2015; Casola *et al.*, 2020). Furthermore, integration of broader and more diverse view of tolerance and coexistence with wildlife (Glikman *et al.*, 2021), including tangible and intangible perceived benefits and costs (Kansky, Kidd & Knight, 2016), may further highlight factors that promote positive human interactions with and tolerance for sharks. Finally, future research should conduct longitudinal studies to examine how long these changes in tolerance persist over time, and if multiple instances of video treatment are needed to reinforce these relationships.

Conclusion

Promoting tolerance for wildlife species is a crucial component of wildlife conservation because attitudes, acceptance and intended behaviors toward species drive public support for policies that increase wildlife populations and promote coexistence with humans (Bruskotter *et al.*, 2015). This may be especially crucial for sharks, a species that is already experiencing severe declines worldwide (Pacoureau *et al.*, 2021) and consistently suffering from negative portrayals in popular media (Muter *et al.*, 2013; Friedrich, Jefferson & Glegg, 2014; Bombieri *et al.*, 2018; Sabatier & Huveneers, 2018; Le Busque, Dorrian & Litchfield, 2021; Le

Busque & Litchfield, 2022). Our findings highlight the potential to use social media such as YouTube as a cost-effective means of increasing tolerance for sharks. The fact that positive messaging appears to be more effective than negative messaging is especially promising, and it highlights the potential value of social media campaigns supporting shark conservation.

Author contributions

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

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