USING HIGH-DEFINITION UNDERWATER VIDEOGRAPHY AND SOCIAL PSYCHOLOGY TO INCREASE PUBLIC INTEREST IN RARE FISHES

By

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1:

CHAPTER 2:

LIST OF FIGURES

CHAPTER 1:

CHAPTER 2:

ABSTRACT

Generating public interest in fish and their biology is often challenging. Many aquatic species are cryptic and largely invisible to the public. Therefore, it is important to be innovative in attempts at increasing public awareness of fish and in elevating the visibility of fisheries topics to broad audiences. Technological innovations now provide fisheries biologists, managers, and researchers with improved means for documenting fish in their natural habitat via underwater videography. I investigated such means to identify cost efficient and easy to use methods for capturing and creating high quality, high definition, and informative underwater videos. I tested 1) a variety of filming equipment including cameras and camera recording settings, lenses, batteries, and memory cards; 2) active and passive camera deployment techniques; and 3) a variety of free and paid postproduction software. The highest quality footage, i.e., the highest resolution, clearest, and most stable footage, was obtained using a GoPro action camera deployed underwater in a stationary position mounted to a metal base plate using a combination of stock and macro lenses, and filming in 4K resolution at 30 frames per second. The final production videos were created using Adobe Premiere Pro.

Furthermore, apathy of the public toward these fishes and their ecosystems hinders their conservation. After I filmed using the described methods, I then used that video footage and created low-cost, educational video presentations featuring the unique and rare desert fishes of Nevada and Death Valley, California. Using these videos, I tested the inclusion of various widely recognized social psychology principles (anthropomorphic [Chan 2012]; authority, commitment, rarity, reciprocity, similarity and liking, social proof [Cialdini, 2009]) in these videos to test their effectiveness at increasing presentation effectiveness when displayed to an audience that was apathetic towards the environment. Social psychology additions were screened by panels of

university faculty, graduate students, undergraduate students, and human subjects' experts to ensure they were ethical and truthful, not altering the accuracy of the information presented. I used text-only treatments surveyed through Qualtrics in the first round of treatment videos; enhanced text and different background image treatments surveyed through Qualtrics in the second round of treatment videos and enhanced text and different background image treatment videos surveyed through Mturk in the third round of treatment videos. In all three rounds of testing, regardless of control/treatment group, viewers' knowledge significantly improved post-viewing (Round 1: $t = 37.809$, df = 473, $P < 0.001$; Round 2: $t = 45.256$, df = 431, $P < 0.001$; and Round 3: $t = 43.860$, df = 352, $P < 0.001$). However, no significant differences in change in knowledge scores were found among groups in Round 1, 2, or 3. In addition, post-viewing New Ecological Paradigm (NEP) score, a measure of environmental attitude, was significantly higher than the pretest score, regardless of group (Round 1: $t = 7.805$, df = 498, $P < 0.001$; Round 2: $t = 3.459$, df = 451, $P < 0.001$; Round 3: $t = 5.824$, df = 352, $P < 0.001$). Significant differences in change in NEP scores among groups were only found in Round 3 ($F = 2.967$; df = 7, 345; $P = 0.00493$) with the reciprocity group scores significantly higher than similarity and anthropomorphic group scores (adjusted P-values of 0.0223 and 0.0336 respectively). These results indicate that all types of underwater videos, no matter the treatment type, have a positive effect on previously-apathetic viewers' knowledge and ecological attitude. In addition, adding specific social psychology elements in videos had a subtle, but positive effect on viewers' learning outcome and ecological attitude. Videos are a powerful tool to increase knowledge and ecological attitude among apathetic viewers. Research on the further development of ethical social psychological methods to help educate the public on conservation subjects is an important avenue of future investigation.

CHAPTER 1. INEXPENSIVE, SIMPLE TECHNIQUES FOR UNDERWATER HIGH-DEFINITION FILMING OF CRYPTIC AQUATIC ORGANISMS

INTRODUCTION

Popularity of video as a science communication tool has recently increased, coinciding with the greater availability of electronic media. Greater access to videos is afforded by newer forms of technology, such as smartphones combined with social media, which are internet-based applications that allow users to create and exchange content (Kaplan and Haenlein 2010). Devices that access social media and are able to view videos are wide-spread. Now 77% of adult Americans own a smartphone, while just 35% possessed one in 2011. Approximately 77% of Americans used the internet at least daily, and one in four Americans say they are “almost constantly” online (Pew Research Center 2018). Video-sharing social media platforms such as YouTube and Vimeo are popular among smartphone users and are used by 72% of adult internet users (Pew Research Center 2013).

Quality of videos have also increased. Recent technological advances have resulted in camera equipment that produces ultra-high definition (UHD) footage while being cost-efficient and easy to use. Footage from these cameras can be shown on UHD television, computer, and phone displays, making high quality videos accessible at a low price.

These increases in availability and quality of video provide a dynamic, interesting means of displaying environmental topics to people. Furthermore, advanced technology now puts exceptional quality, simple processes and affordable means to film a variety of environments in the hands of conservation managers and biologists, not just professional videographers. Channels on YouTube that focus on conservation, wildlife, or fisheries topics are widespread including Brave Wilderness with 10.8 million subscribers; National Geographic with 8.3 million; Texas Parks and Wildlife with 30,000; Arizona Game and Fish Department with- 19,000; the U.S.

Forest Service with 13,000; and the U.S. Fish and Wildlife Service with 5,000 subscribers respectively. However, online video-sharing platforms are only one way that videos with conservation messages may be displayed to a large audience. Other platforms include visitor centers where images are more important than text and other interpretive techniques for attracting and holding an audience (Benton and Sinha 2011); scientific conferences in both oral and poster presentations (Bozdag 2008; Carter 2012); and classroom teachings (Bull and Bell 2010).

One of the subjects that may benefit greatly from the explosion in video technology are rare, cryptic aquatic organisms. Many of these little-known among the general public, and are located in regions not typically recognized for their aquatic resources. For example, there are 29 aquatic species in Nevada listed as threatened or endangered under the Federal Endangered Species Act (USFWS 2017). These include rare and relatively unknown native fish species such as White River Spinedace *Lepidomeda albivallis*; Ash Meadows Speckled Dace *R. osculus nevadensis*; Moapa Dace *Moapa coriacea*; Pahrump Poolfish *Empetrichthys latos;* and White River Springfish *Crenichthys baileyi baileyi*. Many of the aquatic species in Nevada are endemic, perform important ecosystem functions and are vital parts of food webs. Showing these small, rare species to people is difficult because they often live in isolated, spring-fed riverine areas, where few people can access. Others are small, or non-descript with few distinctive colors or features to attract interest. Because many of these species are rarely seen by the public, a variety of means including underwater videography may be needed to get them in the public eye.

Here I evaluate new videography technology to reveal the best methods and equipment to capture video to display rare, small and cryptic species to people that may be otherwise unlikely to view such species.

Although my focus will be on obtaining high definition video of cryptic organisms is desert springs and streams; my techniques could be used to film in a wide variety of underwater environments.

The three main stages of producing a video are preproduction, production, and postproduction. The preproduction stage often includes the conceptualization of the video, storyboarding the various scenes, and creating a plan for how to achieve the desired footage; the production phase is the filming process itself; and the postproduction stage is the organization of raw footage, and editing that footage to create the final video. The preproduction phase of video editing for use by fisheries professionals has been thoroughly covered in literature (Danylchuck et al. 2018) and I will not repeat it here. The goal of my work is to provide biologists and managers, with no previous training in videography, inexpensive methods to produce high quality underwater footage of aquatic organisms, many of them hard to film and cryptic, using fishes of Nevada and California aquatic systems as an example. Specifically, I will describe equipment and techniques available, test them in field settings, and report which combination of methods and equipment gave me the best results.

METHODS

Cameras

Multiple camera types can be used to create high quality underwater video. At the entry-level tier are action cameras, at the mid-level tier are mirrorless cameras, and at the highest tier are digital single-lens reflex (DSLR) cameras. The use of action cameras has become increasingly popular as technology has advanced. Many action cameras are now able to capture footage at a 4K (4096 x 2160 – width x height in number of pixels) resolution, which can then be played back on consumer displays and televisions capable of displaying UHD (3,840 x 2,160

pixels) media. Online media outlets such as YouTube are also capable of distributing UHD video resolution. The advantages of an action camera go far beyond their maximum resolution capabilities. Most action cameras or their included cases are waterproof to specific depths, which allows underwater recording without risking harm to the camera. These cameras are widely available at retailers, and are affordably priced. For example, as of this writing, the most advanced GoPro action camera sells for $399.99 (GoPro Hero 7 Black). The GoPro Hero 7 Silver, which also records in 4K, is waterproof, but lack some features of the Hero 7 Black, retails for $299.99. A comparable mirrorless camera (Sony A7R II) and underwater housing (AquaTech Base Series II) is much more expensive, costing approximately $2994.99. A comparable DSLR camera (Canon EOS Rebel T5) and underwater housing (AquaTech Base) costs approximately $1544.00. Furthermore, mirrorless and DSLR cameras are more difficult to use, expensive to waterproof, and bulkier compared to action cameras. However, they offer greater video quality and imagery due to larger image sensors and depth of field, superior ISO and shutter speeds, and the ability to swap lenses that vary in focal length ranging from ultra-wide angle to narrow angle macro or telephoto.

Due to their ease of use, wide availability, waterproofing, relative affordability, and probable use by biologists and managers, I tested action cameras. Cameras I tested were the most recent models at the time, and had the highest reported resolutions and the most advanced features. These included GoPro Hero 3 Silver, GoPro Hero 4 Black, Garmin VIRB XE, and the Sony FDR-X1000V. To identify which action camera to select for use for filming underwater and above water, I assessed cost, degree of waterproofing, maximum video resolution, maximum frames per second, user reviews, and availability of accessories.

Camera Settings

The two most important recording settings are the resolution and the number of frames per second (FPS) that the camera records. Two settings that are commonly used for filming with action cameras are either 1)1080p and 120 FPS or 2) 4K resolution and 30 FPS. While assessing the action camera, I tested the settings available in video mode including (resolution-frames per second): 4K-30, 2.7K-60, 1440p-80, and 1080p-120.

Lenses

Lenses available for action cameras permit a wide variety of above and underwater filming. The first of these is simply the stock lens, which is included with the purchased camera. Stock lenses are best suited for filming large objects, medium- to wide-angle shots, or waterscapes far from the camera. However, stock lenses do not provide good quality close-up shots because they have difficulty focusing on subjects within 36 cm of the camera. To focus on subjects within 36 cm, macro lenses are especially suited. (Figure 1). These lenses easily attach to the outside of the action camera over the stock lens. Macro lenses are necessary for close-up filming of smaller, cryptic species and they can also add detail and depth to videos if filming larger species. Split-view lenses are dome-like lenses and housings that attach around the entire camera and use the stock lens. These lenses allow the camera to simultaneously film both underwater and above water, providing a pleasing split-level view.

I compared the stock lens; three different macro lenses including the Light in the Box 16X Diving HD Macro Lens Suit (LB lens), the PolarPro Macro Lens, and the Backscatter +15 MacroMate Mini system (Backscatter lens); and a KNEKT KSD6 Dome split-view housing.

Batteries and Memory

Battery life and storage memory are two other vital considerations when filming in remote locations without access to charging stations or computers for transferring video footage.

When working in location with extremely hot or cold temperatures, batteries tend to discharge quickly and having many spares is necessary. Name brand batteries are slightly costlier, but they are also more likely to be reliable in my experience.

All digital cameras use memory cards, but to film in full 4K High-Definition resolution, most action cameras require microSD cards that are: 1) built for extreme conditions and are temperature proof, water proof, shock proof, and have extended capacity, which is often denoted as a microSDXC card, and 2) be UHS Speed Class 3. The SD Association, who is responsible for setting industry-leading memory card standards, has recently created a new speed class dubbed Video Speed Class. Many action cameras now require microSDXC memory cards to have a Video Speed Class of V30, V60, or V90 to film in 4K resolution. Storage capacity is measured in gigabytes (GB) and the most common capacities are 32, 64, and 128 GB version cards. A 32 GB card likely has enough capacity to hold only a full day's worth of filming, but it is also useful to have a card with a larger capacity and spare memory cards.

For spare batteries for the GoPros, both GoPro branded batteries and the more affordable Wasabi Power batteries were tested. The two different types of spare memory cards tested were the Lexar 64GB microSDXC UHS-3 633x card and the SanDisk Extreme 64GB microSDXC UHS-3 card which were recommended for use by GoPro.

Deployment Techniques

Important aspects of underwater filming include deployment technique, duration filmed underwater, and camera aiming and location. Underwater filming can be either passive or active. While filming passively, the camera is mounted in a stationary position underwater and relies on the fish to swim to the camera to be in view. There are many ways a camera can be mounted in a stationary position, from a flat base that allows for filming in shallow depths to tripods that perch

the camera high in the water column. Active filming is when the user holds the camera to actively follow fish, usually while snorkeling or diving. While filming actively, the user can hold the camera itself, or hold a handle or extension pole to which the camera is attached. Handles can either be single handed, or double handed for added stability.

For passive filming, I tested three different base mounts to which the GoPro camera was affixed (Figure 2). The first of these was a flexible-legged Joby GorillaPod Action Tripod for GoPro. The next was a square 15.25 cm x 15.25 cm clay floor tile that was purchased at local hardware store. The final was a 25.40 cm diameter piece of 0.635 cm steel circular plate weighing about 2.5 kg and purchased at a local metal supply store. A base mount attached the camera to the tripod or plate. The GoPro cameras used a two-piece attachment system. The first piece bolted onto the camera and then clipped into the second piece which was permanently affixed to a flat surface, a tripod, handle, or other accessories. I tested two of the available fasteners that attached the camera to a base mount. Included with the purchase of the GoPro is a rigid, non-flexible bolt-on stock fastener that offers minimal range of motion for camera aiming when mounted to a stationary base mount. I compared this to a GoPro-branded Swivel Mount fastener with an internal swiveling ball joint that offers a larger range of motion for aiming the attached camera.

For active filming, I tested three different techniques, a single-handed GoPro handle, the KNEKT GPDL Trigger handle; an extension pole that extended the camera further away from the user; and a double-handed GoPro handle I created using PVC tubes and fittings. This equipment is commonly available at electronic stores or can be easily made by the user using supplies commonly available at hardware stores. The double-handed handle was a rectangular frame with four 90-degree angle fittings, and a single three-way T fitting with a pipe extending

out to another 90-degree fitting (Figure 3). From that, a connected pipe extended towards the middle of the frame where the camera mount was located.

While filming underwater, I tested the minimum recording duration and the camera aiming location needed to capture the highest quality footage. Fish are often disturbed by underwater filming, whether by passive or active deployment techniques, and take time to recolonize an area after an initial disturbance of placing the filming equipment or entering the water. If the recording concludes prior to complete recolonization, few fish will be recorded whereas if recording occurs for too long, the footage might become repetitive and battery life and storage space will be consumed. I also tested if the highest quality footage was produced using cameras aimed downstream, upstream, or perpendicular to the flow of water when mounted stationary.

Study Sites and Species Filmed

Preliminary tests to identify appropriate camera settings and the need for any additional gear or accessories prior filming in remote locations were conducted near Tucson, Arizona at streams in the Tohono Chul Park and a pond at the Arizona History Museum containing Gila Topminnow *Poeciliopsis occidentalis* and Desert Pupfish *Cyprinodon macularius.* These fish were similar in size and color to fishes I later filmed in remote Nevada and California waterbodies.

Locations and species to film in the wild were selected by contacting U.S. Fish and Wildlife Service, National Park Service, and Nevada Department of Wildlife (NDOW) staff. Locations chosen were based on the rarity of the inhabiting species and the lack of availability of high-definition underwater video footage or photos of those species and areas, and filming was conducted from February 2016 through October 2016 (Figure 4). Locations and species included

those found in the deserts of western Nevada and eastern California (Table 1). Waters filmed in ranged from clear-water springs with constant temperatures, to streams with perennial flows supported by reservoirs, to salt flats with water reaching summer temperatures greater than 38° C and salinity reaching 160 parts per thousand (ppt), which is approximately 4.5x that of seawater. Water depths in these filming locations varied from less than ten centimeters to greater than five meters.

Postproduction Software

A variety of postproduction video editing software was assessed. Different software tested included Adobe Premiere Pro CC 2017, GoPro Studio 2.5, Lightworks v14.00, and VSDC Video Editor v5.8.9.858. With the exception of Adobe Premiere Pro, these programs were available with free licenses online. These were all compared with one another for general functionality, ease of use, editing tools, and features.

Footage and Equipment Analysis

Filming equipment, deployment methods, and settings were ranked by cost, available features, general functionality, ease of use, and footage quality. Footage quality was analyzed based on qualitative observations made by independent observers who judged stability (i.e. minimal shakiness); visual clarity and sharpness of the focal subject/s; and lighting and color characteristics such as exposure levels and accurate color representation.

RESULTS

I successfully filmed all species in locations listed above. I collected a total of 601.46 gigabytes (GB), or 23.52 hours, of underwater video footage

Cameras

Based on multiple advantages (Table 2), I purchased two of the GoPro Hero 4 Black (GoPro/s) as the main cameras for filming and testing. This camera filmed in 4K resolution and created video suitable for UHD displays, recorded in the standard frames per second for cameras in its class, was mid-range in cost, and had the widest range of aftermarket accessories. These cameras were durable and no leakage or water infiltration occurred. The GoPro could film in waters as shallow as approximately 5 centimeters. These cameras performed well in high-salinity water, showed no signs of added wear over the season, and were easily decontaminated and rinsed with freshwater immediately after use.

Camera Settings

All GoPro settings provided high quality, clear footage. I found the best settings to use for filming underwater depended on the activity level of the fishes being filmed. The 4K-30 setting provided the clearest, most detailed, and highest resolution footage. This setting was best suited for slow moving and highly abundant fish. However, the 4K-30 setting recorded the fewest frames per second of any of the settings tested. Therefore, when slowed below normal playback speed in postproduction, 4K-30 provided poor video quality that appeared fragmented due to the limited number of individual frames recorded. For fishes that quickly darted across the water and were uncommon, slow motion was needed to discern fish. The 1080p and 120 FPS (1080p-120) setting was best for fast moving fish because the higher FPS allowed the video to be slowed in editing without loss of quality. The other setting has higher resolution and provides video footage with more detail, but less frames per second which lessens its quality if slowed in the editing process. Other settings with high FPS rates, i.e., 2.7K-60 and 1440p-80, resulted in smoother and clearer footage compared to 4K-30, but not as smooth as 1080p-120, when using slow motion in postproduction and there were no noticeable differences among them. In

addition, the high resolution settings, i.e., 4K-30 and 2.7K-60, drained the batteries quicker and consumed more space on the memory cards.

Lenses

The stock lens of the GoPro worked well for recording video footage when a large depth of field or large field of view was desired (Table 3). This was useful when background imagery was visually appealing, or when the focal species were large (greater than 30 cm) or farther than 36 cm from the lens. The stock lens produced blurry footage of the focal subject when it was within 36 cm of the lens. Documenting smaller species in sharp detail with only the stock lens was difficult, but for larger species, the stock lens was successful.

The macro lenses performed best when obtaining close-up footage. Objects further than 36 cm from the macro lens were blurry. Inexpensive macro lenses often use lower quality glass that is less clear and more susceptible to scratching than other macro lenses, therefore, spending a bit more on a higher quality macro lens is desirable. Of the three macro lenses I tested, the Backscatter MacroMate Mini +15 produced the highest quality video. The video from this lens was sharper, had higher contrast, and had deeper blacks than the other lenses tested. The magnification of the Backscatter lens allowed cameras to focus on a subject that was approximately 5-36 cm from the outer edge of the macro lens, and documented small and large fish close to the lens in great detail. The product was durable and could be securely attached to the water-resistant case of the GoPro. Furthermore, this lens could be easily and quickly flipped out of the way to film distant, larger objects with the stock GoPro lens. The drawback to this product was that it was the most expensive macro lens tested.

The PolarPro Macro lens also shortened the GoPro camera’s focal length, but not the same amount as the Backscatter lens. Footage produced using the PolarPro lens had good

contrast, but had to be closer to the subject to be sharp. This lens produced sharp footage when the subject was approximately 5-20 cm away, which was much closer than the Backscatter lens needed to be. The PolarPro lens attached to the GoPro less securely and relied on a design that snapped onto the stock lens. This lens was easier to entirely remove from the camera than the other macro lenses, but was more likely to fall off during use. Another advantage of this product was is was significantly more affordable than the Backscatter lens.

The Light in the Box 16X Diving HD Macro Lens produced less clear video than the Backscatter or the PolarPro lenses. This LB macro lens would sometimes record footage that had a horizontal water line running across the recording, which was caused by water slowly filling in between the two panes of glass on the lens. The range of focal length provided by this lens was much less than the other macro lenses.

The split-view housing KNEKT KSD6 Dome lens worked well for providing a specific type of video. The scenic video that was half under water and half above water provided by this lens was highly unique. However, obtaining attain high quality video using this lens was difficult. When using this lens type, it was best to film during dawn or dusk for proper lighting when the above-water colors were vibrant and at medium brightness. When used during the middle of the day, it resulted in high contrast footage with the above-water image over-exposed and the underwater portion under-exposed. This could be partially mitigated by ensuring the lens wasn't facing the sun and by filming in shady areas, but it was best to avoid filming with the split-view in the middle of the day. For the highest quality video, I held the dome lens exactly horizontally bisecting the water's surface. This was difficult to achieve without clear markings showing the middle of the lens and because of the high buoyancy of the lens itself. I used the

split-view lens while filming passively and actively but I produced the most stable footage when it was used passively, attached to a stationary base mount.

Batteries and Memory

There were no noticeable differences in any of the batteries and memory cards that were tested. Both brands of batteries seemed to drain at equal rates and had similar overall battery life. All GoPro branded batteries remained fully functional, while one Wasabi Power battery expanded and became unusable. Warranties for GoPro cameras are voided when damage occurs while using non-GoPro batteries, an advantage of using only the name-brand batteries. The two memory cards performed equally and as described with no issues.

Deployment Techniques

Passive filming produced higher-quality footage than active filming. Fish rapidly recolonized the area where a passively mounted camera was placed, were typically unafraid of the new object in their environment, and were often curious enough to investigate the camera. Therefore, this deployment technique consistently resulted in the highest number of fish in the recorded video with the most pleasing footage. While filming passively, I found that using a base mount that was relatively shallow but also had enough weight to maintain its location on the substrate resulted in the highest quality footage (Table 4). The best underwater footage was obtained when the cameras were affixed to the circular metal plate. This type of base mount always stayed where placed regardless of the flow of the water. The tile also worked well, but the camera fell over in fast flowing waters more often than when mounted on the heavy metal plate. Both of these base mounts had a large surface area that widely distributed the weight of the system, minimizing sinking into the substrate. The metal plate and the ceramic tile were thin and placed the camera close to the substrate, which was useful for filming in shallow waters. I

obtained the majority of useable footage using the metal plate or tile base mounts. The flexible tripod was lightweight and often toppled in waters with even minimal flows. Although footage from the camera mounted on a tripod was typically not as good as that from the camera mounted on a plate or the tile, it worked well when underwater debris was nearby that the tripod legs could be wrapped around securely.

The attachment piece that affixed the GoPro to a stationary object was an important component to the passive deployment technique. The Swivel Mount attachment piece, with an internal swiveling ball joint, provided greater flexibility for aiming the attached camera and allowed the base mount to be placed on uneven substrate and still obtain level footage. The rigid attachment piece that was included with the camera provided level footage only when the base mount was placed on level substrate and offered minimal flexibility for camera aiming. Though the Swivel Mount cost $19.99, it was a valuable equipment addition that provided greater flexibility while filming in a variety of locations.

While filming passively, I left the camera underwater and recorded for typically a minimum of 2-3 minutes after original placement to successfully film easily frightened fish. This allowed fish to recolonize the area after camera placement. If the water was disturbed within three minutes of placing the camera, few fish were recorded in the footage because they had presumably not yet recolonized the area. I left the camera in the water for the first three minutes, expecting that footage recorded in that time would not contain many fish. When left recording for four or more minutes, the camera captured footage with more organisms. In riverine systems, cameras aimed downstream captured more video footage featuring the full body of the fish, including the eyes, compared to cameras aimed upstream. Cameras aimed perpendicular to the

flow of water also produced full body video footage, and provided recordings with a variety of viewpoints of the subjects, lighting, and background imagery.

A majority of the footage obtained from the active filming methods was of low quality and unusable. The active filming methods often frightened fish, which caused difficulty in filming them up-close in great detail for long durations. When the camera was deployed using either the single-handed handle or the extension pole, the resulting footage was often shaky and moved quickly. The home-made dual-handed handle resulted in footage less-shaky than the other active techniques, but it was still not as stable as the passive deployment techniques. In general, I found four active filming steps that produced the best footage when used together; I 1) held the filming system with two hands for added stability, 2) moved very slowly and deliberately, 3) breathed slowly and remained calm while swimming, and 4) got as close to the focal subject as possible without frightening the subject.

Postproduction Software

Among those I tested, Adobe Premiere Pro was the most powerful video editing software. The program had the largest amount of various tools, such as video effects and transitions, and audio effects and transitions. This program was the most difficult to learn of those tested, but there were a large number of step-by-step tutorials available online that aided learning for novices. Adobe Premiere Pro also had the most export formats available ranging from standard definitions up to full 4K videos.

Of the free programs tested, GoPro Studio 2.5 was the easiest for a novice user, but lacked editing features common among all of the other programs tested. In addition, GoPro has since announced that GoPro Studio has reached its end-of-life support and is no longer downloadable from their website. Lightworks was a powerful free editing program that was

similar in functionality to Adobe Premier Pro, and with a similar steep learning curve despite a well-designed user interface. Lightworks had many built in on-screen text templates which minimized time spent adding text to a video. The free version of this software exported to a maximum of 720p resolution, and the resulting video was of noticeably lower resolution compared to the high definition videos exported from the other programs tested. The VSDC Video Editor had an unusual interface compared to other programs but was much easier to learn. This program also had a large array of video editing tools and many easy-to-apply video filters and color corrections. Exporting video in multiple formats, including ultra-high definition 4K, was also possible using VSDC.

DISCUSSION

I discovered inexpensive and user-friendly techniques that could be used successfully for filming highly cryptic aquatic organisms underwater in high definition. The gear used to obtain high-quality video footage was widely available and less costly than hiring a production company to film or purchasing comparable high-end do-it-yourself filming systems such as DSLR cameras. The gear and the described deployment methods were also easy to use and perform with no previous experience in videography needed to achieve good results. Using a combination of the stock, macro, and split-view lens resulted in the most dynamic and varied footage. The macro lens was the most important lens for capturing highly detailed recordings of fish. Filming passively with the camera affixed to a heavy base mount was the easiest filming technique and produced footage that featured more fish and was more stable and clear. Lastly, decontamination of both filming gear and personal gear while traveling between sites was vital for reducing the possibility of spreading aquatic invasive species.

Although the focus of this videography project was on small and often cryptic fishes, these same production techniques can be applied in a wide variety of situations. Larger or more charismatic aquatic organisms can be filmed using this gear and these deployment techniques to produce similar quality footage. For example, I used some of these methods to film adult Chinook Salmon *Oncorhynchus tshawytscha* in Ship Creek, Anchorage, Alaska, and Gila Trout *Oncorhynchus gilae* and Apache Trout *Oncorhynchus apache* in southern Arizona (Ulrich, unpublished data). A macro lens is still useful for larger species as it provides close-up footage of the organisms' eyes and coloration patterns in high detail, but filming with just the stock lens will also be important to gain a wider field of view.

An effective video can be produced affordably and with relative ease when these filming production techniques are used in conjunction with preproduction planning and storyboarding, such as those described by Danylchuk et al. (2018), and postproduction editing. Following filming, I downloaded the memory card contents directly onto a portable, fast solid state drive (SSD) external hard drive rather than uploading to the cloud which takes extensive amount of time and consumes large portions of available storage space. These backups were important to insure against loss. Video files were always classified to film type, location and date. For example: G:Raw Footage\Nevada\White River - Pahranagat\Kirch Management Area Springs\Summer 2016\100GOPRO. This and other metadata data attached to a video file described specifics about that video, such as species or location filmed, sped up the editing process. The video editing software that I used most successfully, Adobe Premier Pro, is a non-linear editing software used by professional and amateur filmmakers, television broadcasters, and journalists due to its relative ease of use for high-end video work (Kenworthy 2012). Although not free, it is often offered at discounted rates for various organizations, agencies, or

universities or may be available to those at groups without added cost. This software was chosen for overall filmmaking projects as it was personally recommended by professional videographers and film-makers, and a plethora of free online tutorials exist to show how to use the program effectively and efficiently. Within a few hours of learning the program, users can edit video, adjust color, refine audio, and more. However, the free VSDC Video Editor is a good alternative with common editing tools and is slightly easier to navigate than Adobe, albeit with less features and high-end functions.

The videos produced using these techniques are useful for science communication and can be used to raise awareness of cryptic underwater subjects, encourage great social media interaction and engagement, and enhance education of aquatic species all while supplementing existing outreach. The videos can be shared in a variety of distribution channels ranging from social media outlets such as YouTube, Instagram, and Facebook to in-person locations such as visitors' centers. A summary (Table 5) provides a compilation of techniques a beginning videographer can use to obtain a variety of high-quality footage of underwater organisms, based on my work in the springs and streams of Nevada and California.

In addition to the criteria I discuss above, I found several other items useful for optimizing films of underwater organisms.

Combining underwater footage with film above water adds context and frame of reference for the viewer, and can be used as a more natural transition in a video that features more than one distinct location. Above water footage can be simple shots where the camera was placed on the ground overlooking the water and stationary, or more live shots where the camera pans across the landscape or even a time-lapse. In addition, capturing aerial footage via drone or similar device was useful in providing wide, scene-setting imagery in final video productions.

Above water, plug-in microphones can be used to improve sound recording quality, mechanical and electronic gimbals to ensure stable video footage when recording above water, and different mounts and accessory lenses to capture suitable footage.

Turbidity, temperature, and salinity can affect the quality of underwater films. In highly turbid water, macro lenses helped capture high quality video footage when the subject could be seen only right next to the camera. I found it was important to not walk in or disturb the water upstream of a filming camera, because it sent plumes of turbid water and particulate downstream to the camera. The temperature of the water and the surrounding atmosphere impacted filming. When filming in cold water after the camera was in warm air, fog covered the lens underwater. Acclimating the camera and lenses to the water temperature prior to recording prevented fog buildup. This can be done by putting the camera in the water without recording footage at first to get the camera to the same temperature as the water. Cold water temperatures made active filming difficult due the shaky hands and arms, and filming passively was easier in these conditions. Finally, extremely hot or cold temperatures severely reduced battery life and it was important to have spare batteries while filming in such conditions. To prevent corrosion and damage to filming equipment, I rinsed all gear with freshwater after use in high-salinity environments.

The editing process for video creation seemed overwhelming, but I found the following useful. Providing contextual details at the beginning of videos, such as location, using text or voice with accompanying above water video footage captured, or using Google Earth Pro to record a video flyover of the landscape helps to situate the viewer with what is above ground and give them a fuller picture of the environment. While editing, keeping in mind how the video is to be distributed will help determine the final video length. For example, Facebook, YouTube, and

Vimeo all allow videos longer than two minutes, but Instagram and Twitter currently limit video length to one or two minutes, respectively. Audio is also an important aspect of video editing. Vocal narration, natural sounds, and music can help enhance the viewers' experience. For paid music, De Wolfe Music is what I used for productions, but good free options such as the built-in library on YouTube.com, and searches for Creative Commons music on Soundcloud.com, and Bensound.com are also available.

In summary, successful high quality underwater videography is now well within the range of novice skills and affordable equipment. In today's digital environment, creating videos and sharing them has never been easier and will continue to become easier. Using suggestions provided here will allow fisheries managers, students, and academics to successfully film underwater and produce a video that gives an audience a glimpse into a foreign world that may spark new interests.

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Table 1. Filming locations and species recorded.

Location	Common Name	Scientific Name
Amargosa River system (Ash Meadows National Wildlife Refuge; Beatty, Nevada; Death Valley National Park)	Amargosa Toad	*Anaxyrus nelsoni*
	Oasis Valley Speckled Dace	*Rhinichthys osculus*
	Ash Meadows Speckled Dace	*Rhinichthys osculus nevadensis*
	Ash Meadows Amargosa Pupfish	*Cyprinodon nevadensis mionectes*
	Cottonball Marsh Pupfish	*Cyprinodon salinus milleri*
	Salt Creek Pupfish	*Cyprinodon salinus salinus*
Southeastern and southcentral Nevada (Wayne E. Kirch Wildlife Management Area; Pahranagat Valley; Moapa National Wildlife Refuge; Moapa Valley; Condor Canyon; Virgin River)	White River Springfish	*Crenichthys baileyi baileyi*
	Morman White River Springfish	*Crenichthys baileyi thermophilus*
	White River Spinedace	*Lepidomeda albivallis*
	Big Spring Spinedace	*Lepidomeda mollispinis pratensis*
	Moapa Dace	*Moapa coriacea*
	White River Speckled Dace	*Rhinichthys osculus*
	Pahranagat Roundtail Chub	*Gila robusta jordani*
	Desert Sucker	*Catostomus clarkii*
	White River Desert Sucker	*Catostomus intermedius*

Table 2. Action cameras and associated characteristics.

Criteria	**GoPro Hero 3 Silver**	**GoPro Hero 4 Black**	**Garmin VIRB XE**	**Sony FDR-X1000V**
Cost[a]	$275.99	$399.99	$399.99	$499.99
Maximum depth of waterproofing (m)	40	40	50	9.75
Maximum video resolution	1080p (HD)	4K (UHD)	1440p (HD)	4K (UHD)
Maximum frames per second	120	120	120	240
Extras	Many accessories, easy to use	Many accessories, best battery life, easy to use		Digital Image Stabilization

[a] Cost reflects the cost of the action at the time of selection and may not be the current cost.

Table 3. Action camera lenses assessed and associated selection criteria.

Criteria	**Stock**	**Light in the Box**	**Polar Pro**	**Backscatter**	**KNEKT**
Additional cost[a]	$0.00	$19.99	$29.99	$148.00	$299.99
Lens type	Wide-angle	Macro	Macro	Macro	Split-view
Best use	Large fish, landscape	Small fish, highly abundant species	Small fish, highly abundant species	Small fish, highly abundant species	Landscape, scenery
Focal length range (cm)	36+	10-20	5-20	5-36	36+

[a] Cost reflects the cost at the time of selection and may not be the current cost.

Table 4. Base mounts and their associated specifications used for passive deployment filming.

Criteria	**Flexible Tripod**	**Tile**	**Metal Plate**
Cost	$24.95	$2.08	$17.37
Minimum height (cm)	3.5	0.8	0.6
Maximum height (cm)	25.7	0.8	0.6
Weight (g)	83.0	287.0	2495.0
Surface area (cm^2)	33.2-1057.2	232.3	506.7

Table 5. Summary of underwater videography techniques that can be used successfully by beginners to produce high quality footage of aquatic organisms.

Underwater Videography Gear and Techniques	**Recommendation**
Camera	Latest model of the GoPro Hero action camera with the most features[a]
Camera Settings	For slow or normal moving fish, 4K-30fps. For fast moving fish, 2.7K-60fps or 1080p-120fps
Lenses	A combined usage of the stock lens and the Backscatter macro lens
Batteries and Memory Cards	GoPro brand batteries
Memory Cards	Any memory card that: has a storage capacity of 32GB or larger, is Video Speed Class V10 or higher, and is recommended by GoPro[b]
Deployment Techniques	Passive deployment using a precut metal plate as a base mount
Postproduction Software	For paid software, Adobe Premiere Pro and for free software, VSDC Video Editor.

[a] At the time of testing, this was the GoPro Hero 4 Black Edition and at the time of writing, this is the GoPro Hero 7 Black.

[b] Use the chart found here (https://gopro.com/help/articles/block/microSD-Card-Considerations) to determine memory cards recommended for use by GoPro

Figure 1. Three of the various lenses tested and their associated images. Lenses include stock lens (top), LB lens (middle), and the Backscatter lens (bottom).

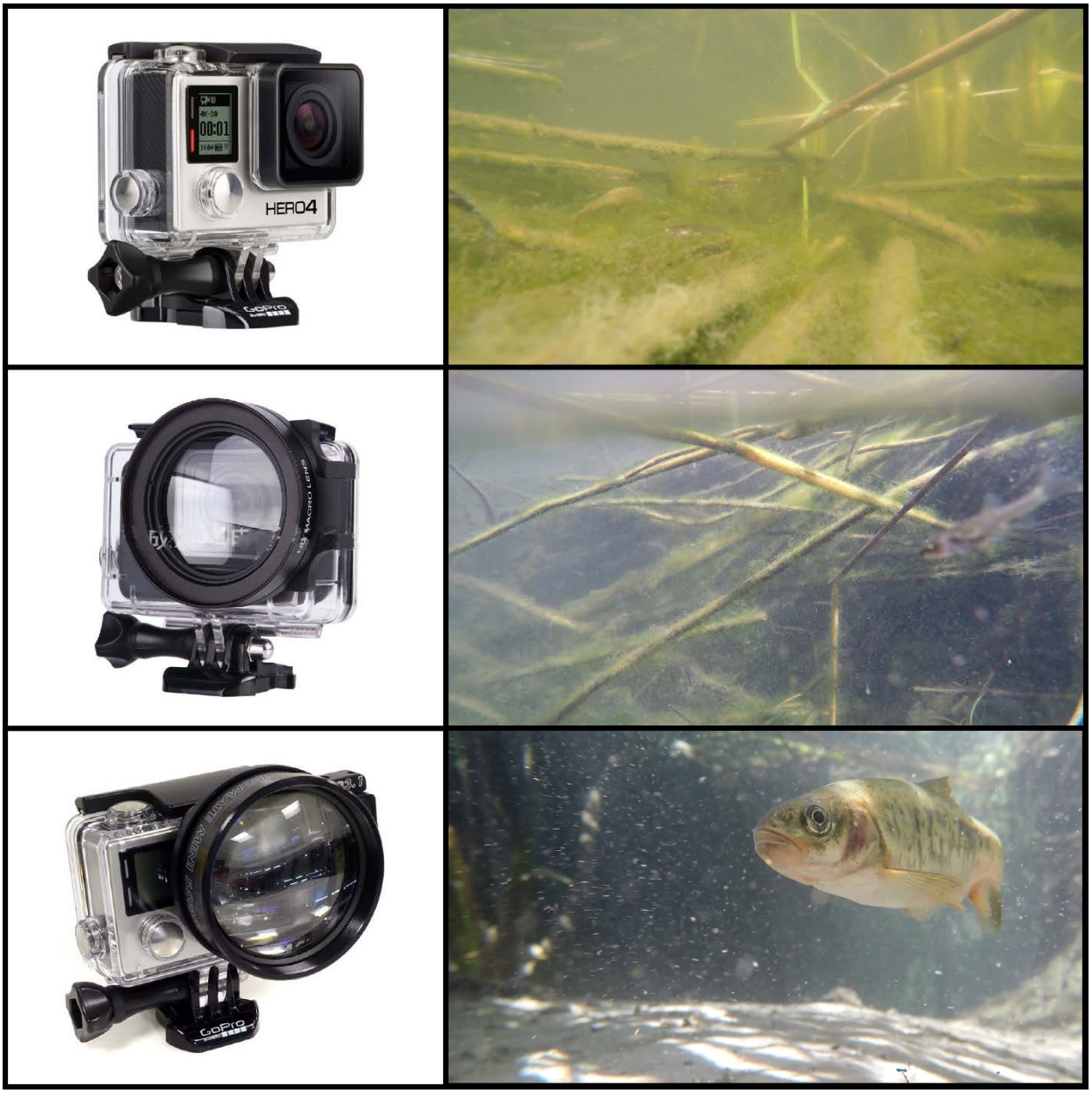
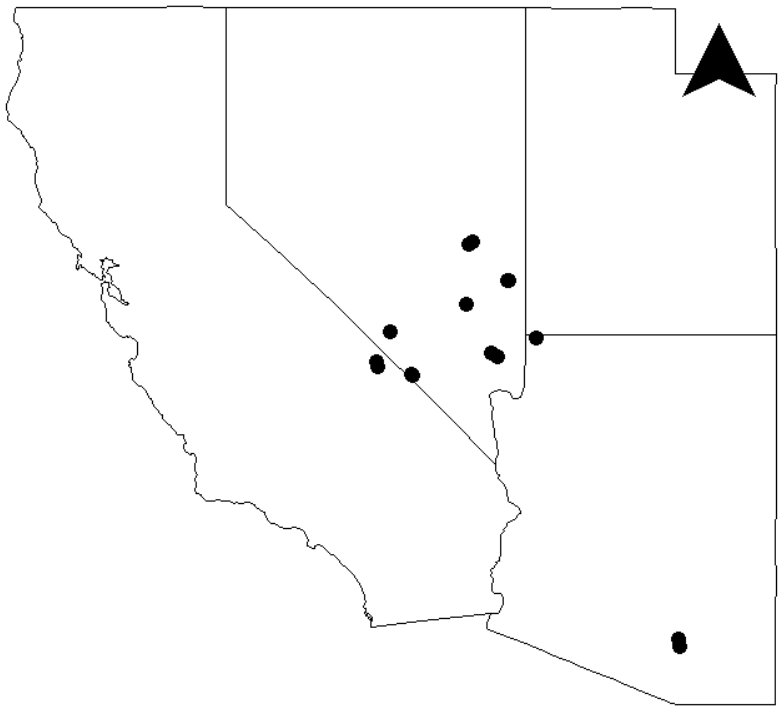


Figure 2. Side view of three passive filming systems including a flexible legged tripod (left), tile mount (center), and metal plate mount (right).

Figure 3. A two handed, self-made action camera active filming system in which the center extension mount is mobile and can be folded flat for storage.

Figure 4. Arizona, California, and Nevada filming sites (dots) during spring, summer, and fall 2016.



CHAPTER 2. USING SOCIAL PSYCHOLOGY IN VIDEOS TO ACQUAINT ENVIRONMENTALLY APATHETICAL PEOPLE WITH LITTLE KNOWN FISHES

INTRODUCTION

The success of conservation and natural resource management is often linked to people's environmental awareness, especially attitudes and knowledge (Gadenne et al. 2009). Conservation and natural resource management may be aided then by increasing awareness, particularly of those hostile or indifferent to environmental issues, and by making people familiar with such topics and then describing their value (Steel et al. 2005; Jefferson et al. 2015). Common psychological phenomena such as the Mere-Exposure Effect, suggest that people prefer things that are familiar over those that are less familiar (Zajonc 1968; Huberman, 2001; Fang et al. 2007). Therefore, efforts to get conservation topics and elements of nature in public view, thus increasing their familiarity, could provide tangible conservation benefits (Bonar 2007).

Audio-visual presentations (visual presentations) focusing on nature or wildlife can provide a multi-sensory experience that both educates and inspires (Zimmermann1996). These visual presentations can increase the familiarity, knowledge, and attitudes regarding wildlife, through the use of an emotive design, a knowledge-based design, or both designs (Pearson et al. 2011). Emotive designs are presentations that are intended to invoke an emotional reaction in the viewer, and often use powerful imagery and music to create a sense of deep reflection. Conversely, knowledge-based presentations are often emotionally neutral and use high amounts of factual information. Environmental educational visual presentations can be displayed in physical locations such as visitor centers, but recently they are more often shared over the internet due to increasing popularity of online social media platforms (Bombaci et al. 2015;

Shiffman 2012). In addition to these educational videos becoming easier to share, they are also becoming easier to create. Technological advances have resulted in wide-spread use of low-cost and easy-to-use equipment that produces ultra-high definition footage (Ulrich, this thesis). These advances in technology and distribution channels, allow conservation biologists and managers to easily and affordably create their own educational videos with associated conservation messages that help to increase peoples' familiarity with conservation and nature.

Although videos are increasingly easy to create and distribute, a pivotal question remains: How can the effectiveness of educational videos highlighting conservation and elements of nature be maximized to increase peoples' familiarity with conservation topics, and subsequently increase their favorable attitudes towards and knowledge of conservation.

Attitudes and their formation are often described as having affective, cognitive and behavioral components (Crano and Prislin 2008). The cognitive component of attitude formation is one's thoughts and beliefs on a particular subject that help guide the object evaluation process. Accumulation of knowledge plays an important role in formation of the cognitive component of attitude (Crano and Prislin 2006). By providing fundamental and basic knowledge of certain species of wildlife and their habitats, the cognitive component, and thus overall attitudes may be altered to benefit the overall conservation and protection of such species.

Public interest and attitudes towards wildlife may also be impacted through application of social psychological principles, which includes anthropomorphism techniques. These may affect both the cognitive component as if they alter one's thoughts and beliefs towards the subject, and the affective component if one's attitude or feelings toward the subject are changed. Social psychology approaches are commonly applied to the field of conservation education and studies have assessed their application with a goal of promoting conservation behavior (Katzev and

Johnson 1983, 1984; Goldstein et al. 2008) through a change in either attitude towards or knowledge of the subject. In fact, the employment of some common psychological influence methods has been shown to increase pro-environmental behavior (Cialdini 2001; Bonar 2007; Goldstein et al. 2008; Bonar and Fraidenburg 2010). Despite the existing body of literature that incorporates psychological methods to promote conservation-related behavior change, few have assessed their impacts on attitude and even fewer have assessed their effectiveness when presented in video presentations. Therefore, my research goal is to determine the relationship between the application of some common psychological influence principles and anthropomorphism in video presentations and their effect on audience attitude towards and knowledge of subject matter. I hypothesize that a video presentation without any psychological component will affect attitude formation to a degree and increase knowledge, while addition of psychological influence principles or anthropomorphisms will shift attitudes to even a further extent because additional cognitive and affective components are targeted and increase knowledge.

Influence Principles

During many years of scientific research, Robert Cialdini, Regents' Professor of Psychology and Marketing at Arizona State University, described six principle ways people are influenced to comply with a request(Cialdini 2009). They include: authority, commitment and consistency, liking, reciprocation, scarcity, and social proof. Although all could be applied in science communication and environmental education, when applied through informal science contexts, such as video presentations, they may have varying contributions to attitude and learning outcome regarding the subject matter.

Authority

The authority principle describes the way that people often have an automatic response in agreeing with the views of authority figures. Authority, which is one of the most influential of these six principles (Cialdini 2009), is deeply-seated within humans (Milgram 1974). Influence of authority may be so great because from an early age, authority figures were trustworthy and more knowledgeable, thus heeding their advice usually proved to provide a benefit of sorts. This combined with the pressure that accompanies authority figure commands, which is often too great to overcome, results in obedience with little conscious thought. The effect is greater when people believe the authority figure is impartial and has nothing to gain (Eagly et al. 1978).

Commitment/Consistency

The commitment and consistency principle of influence describes human desires to be consistent with past actions or attitudes. Inconsistency is often thought of as an undesirable trait (Allgeier et al. 1979; Asch 1946), while consistency is seen as a sign of intellectual strength. Remaining consistent allows for efficient and convenient reactions to the many complexities of modern life. Provoking the desire to remain consistent is a commitment which influences one's actions in a variety of ways from volunteering to voting on election day (Sherman 1980, Greenwald et al. 1987).

Similarity/Liking

If we perceive someone to be similar to us, we tend to like them. This similarity can come in the form of opinions, personality traits, background, or lifestyle (Burger et al. 2004). Therefore, similarity is an essential part of the liking principle which states that things or people that are more liked have greater ability to influence. Another noteworthy element of liking is that we prefer things that are familiar to us (Monahan et al. 2000), which is foundational to the Mere-Exposure Effect.

Reciprocation

The rule of reciprocation states that in general humans feel a need to repay what was provided to them by another person. When a favor is done for someone, it often creates a sense of obligation and indebtedness, thus influencing that recipient to repay this in the future. The reciprocation principle may be extended to favors being provided to humans by non-humans. An example of this is the notion that a fish species contributes to the annual tourist dollars which boosts the economy. The person receiving this knowledge may feel obligated to reciprocate this, perhaps through being influenced to like that fish species or by paying to protect it.

Rarity

The rarity principle of influence has great utility when educating people about desert fishes, as many of them are quite rare. This principle states that increased value is placed on things that are or are becoming rare. Social psychologists believe that the reason we place more value on scare things is because our freedom to have them is limited. Furthermore, the thought of losing something is more motivating than the thought of gaining something of equal value (Hobfoll 2001). This can be highlighted in communications with the public and could be useful in educating about the importance of conserving threatened and endangered species.

Social Proof

The role of others' opinions on a subject is very important to the development of an attitude as people judge what is correct based on what others believe (Lun et al. 2007). This is especially true in situations where an attitude has not yet been formed, resulting in a natural tendency to look to others and accept their thoughts and actions as correct (Sechrist & Stangor 2007; Wooten & Reed 1998, Zitek & Hebl 2007). This principle has been extensively studied and many caveats have been discovered, e.g., the number of people who subscribe to an attitude

or behavior plays a large role in the principle's influential capability, with more subscribers resulting in more influence. An additional key element to the social proof principle is that if we perceive the observed individual(s) to be similar to us, we are more inclined to be influenced by them (Abrams et al. 1990; Burn 1991; Schultz 1999; Stangor et al. 2001). Social proof may be particularly effective in quickly influencing a large number of people as simply providing information that a substantial number of individuals have already been convinced will convince others (Watts and Dodds 2007).

Anthropomorphism

The anthropomorphism of fish and wildlife is a long standing practice in the media, and is often done in television/movie productions such as Zootopia (2016) and Finding Nemo (2003). In the simplest form, anthropomorphism is defined as the attribution of human characteristics to non-human organisms or objects. However, a range of anthropomorphisms also exists, from more human like, to more animal like. For example, the animals in the Disney movie Zootopia are highly similar to humans; they live in human-like societies, have human jobs, and dress in human clothing. On the opposite end of the anthropomorphism spectrum is Disney movie Finding Nemo. The animals in this movie talk like humans and have human-like family dynamics, but they live in an environment much closer to what they would in nature, swim, and have other more realistic behaviors. In general, the use of anthropomorphisms has been discouraged in animal-behavior research (Kennedy 1992; Wynne 2007) and in educational settings for fear that it will interfere with factual scientific explanations, but it may be a useful tool in promoting conservation of, developing public support for, and spreading awareness of wildlife (Zohar & Ginossar 1998; Chan 2012).

Example Species

Aquatic species are perhaps among wildlife with which people are least familiar. In the United States, there are 165 species of fish listed as threatened or endangered under the Federal Endangered Species Act (USFWS ECOS 2017). Of those, 49 species are found in Nevada and/or California. The conservation of these small, rare species of fish is difficult as they face numerous threats such as non-native, invasive species and declining habitat due to human water use. In addition, many of species live in highly isolated locations such as desert springs or are non-descript. Because these desert fish species are rarely seen by the public and they face numerous conservation difficulties, I used these as the example focal subjects for educational videos.

Study Goals

Here, I assessed different educational video designs to evaluate which best acquaint people with rare fishes. The goal of my work was to test and evaluate the effectiveness of using video as a media technique to increase ecological attitudes and public knowledge of rare desert fishes. Additionally, I investigated ways to further maximize the effectiveness of such videos by ranking the relative contributions of the six social psychology techniques and one anthropomorphic technique on viewers' conservation attitudes and learning outcomes. Comparing the effectiveness of such techniques to increase public attitude and knowledge towards conservation could aid in determining which elements are worth including in similar videos specifically designed to educate people on environmental topics. In order to test these different messaging techniques for conservation and natural resource educational videos, I created videos featuring native desert fish species found in Southern Nevada and California. Specifically, the research objectives were to:

- select an audience hostile or indifferent to conservation;

- compare change in participant attitudes and knowledge after showing videos featuring information on these native desert fish species;
- compare change in participant attitudes and knowledge when shown eight contrasting educational video designs (seven designs based on social psychology and one control design - see below);
- identify participant characteristics that may be linked to attitude and learning change.

METHODS

Filming and Video Creation

I used GoPro Hero 4 Black Edition cameras, a variety of stock, macro, and split-view lenses, and a variety of mounting plates to obtain underwater footage of Nevada and California spring fish communities (Ulrich, this thesis). Various filming methods were tested in southern Arizona systems similar to those in the southern Nevada regions where filming for this project occurred. I filmed in western Nevada and California in the Amargosa River system (including Ash Meadows National Wildlife Refuge, and privately-owned springs) and Cottonball Marsh and Salt Creek, in Death Valley National Park, California. I also filmed in southeastern and southcentral Nevada. I worked closely with multimedia experts from the University of Arizona, to obtain footage both above and underwater at these locations.

To create the videos, I used Adobe Premier Pro, a non-linear editing software used by professional filmmakers, television broadcasters, and journalists, for its ease of use for high-end video work (Kenworthy 2012). Criteria for footage inclusion included the visual clarity of the focal species and the landscape, duration of desired content being on screen, stability of the footage, and lighting/color characteristics.

Experimental Design

I designed controlled experiments in which an experimental stimulus was applied through video presentations and compared to a control video that lacked stimulus, and I tested the effect of the stimuli and control videos with surveys. All qualified participants digitally accessed a survey package containing a consent form and three separate survey sections. The first section consisted of a screening question to only choose those either apathetic or hostile to environmental issues and a pretest to establish baseline measurements of knowledge and attitude. They were then randomly and equally distributed into one of eight groups, with a corresponding treatment or control video, and were asked to view that video. Participants then took a posttest. Treatment effects were measured through differences in pretest and posttest scores of viewers' knowledge of desert fishes and environmental attitude. There was one informational-only control video and seven different treatment video designs; one for each of the six influence principles and one for the anthropomorphic design. Each of the seven video designs had two different versions, intended to have two different levels of treatment effect. The control video had only one version.

Version 1 – On-screen text only treatments

The first version of these seven treatment videos, used only on-screen text statements that were reflective of the intended stimulus. For the anthropomorphic video, to draw an empathetic response towards target species, I highlighted the species: 1) high cognitive abilities, 2) abilities to experience and tolerate pain or extreme living conditions, and 3) prosocial behavior (Chan 2012). For the influence principles videos, I used a thorough understanding of each principle to develop the treatment statements. I added a total of four-six on-screen text statements in each of the seven treatment videos (Table 1); in-between the treatment statements, were informational-

only text statements. The informational-only statements remained consistent between the treatment videos and control video. Aside from the text statements that differed at four timestamps, each first treatment video used the same background videos and imagery.

Version 2 – Enhanced on-screen text plus background imagery treatments

The second versions of the treatment videos were intended to have a stronger treatment effect than the first versions and were designed with: 1) more treatment-reflective text statements (Table 2) and, 2) background imagery that differed between each video and was treatment-reflective (Table 3).

Survey Questionnaires

New Ecological Paradigm

The revised New Ecological Paradigm (NEP) was used in the pretest and the posttest as a proxy to evaluate attitudes towards the environment, as a higher NEP score reflects a more pro-ecological worldview (Dunlap et al. 2000). The NEP consists of fifteen statements where respondents use a Likert scale to indicate their level of agreement with each particular statement (Table 4). The Likert scale, a commonly employed measure in social science and surveys, uses the following levels of agreement: strongly agree, agree, unsure, disagree, strongly disagree. Eight of the fifteen statements of the NEP reflect a degree of endorsement of the ecological world view if agreed to by the respondent, and the other seven represent endorsement of the dominant social paradigm (DSP). Agreeing to the DSP statements represents an endorsement of three main ideas: human superiority over all other species, the Earth provides unlimited resources for humans, and that progress is an inherent part of human history. A score of three on the NEP assessment reflects a neutral worldview, while above three reflects an ecological worldview and below three reflects a dominant social paradigm worldview.

Knowledge Assessment

An 11-item quiz intended to assess respondents' knowledge of desert fishes was used in the pre- and posttest (Table 5). This quiz was created using information from Babbie (2014), and modeled after a similar animal knowledge quiz (Pearson et al. 2011). Only true or false questions were used because closed-ended responses such as these give a more uniform set of responses than open-ended questions and are easier to process (Babbie 2014). Respondents' learning outcome was evaluated by measuring changes in test scores following exposure to video experimental stimulus.

Demographics

Demographics characteristics queried included gender, age, ethnicity, political affiliation, and marital, familial, area of residence, and employment statuses. I also included questions to determine if respondents lived in rural or urban areas, and identify their employment type.

Survey Hosting and Distribution

To host these surveys, I used an online survey platform that integrated the survey materials and videos into one survey package. This platform, Qualtrics, is used by other social scientists at the University of Arizona and other institutions globally for scholarly surveys.

Broad distribution of the survey package to voluntary participants was vital. For this reason, online distribution methods that monetarily compensated respondents were used to maximize response rates and gather the desired sample size. The online survey participants were solicited using both Qualtrics Research Panels (Qualtrics) and Amazon Mechanical Turk (Mturk). These independent websites used their own databases of survey takers to gather responses from people who were accordingly compensated at a fair wage for their time.

Sample Size Calculation

To calculate the sample size needed for each survey, I used the "pwr" package for the R programming software (RStudio Team 2016). Within this package, I used the function "pwr.anova.test(*k* = , *n* = , *f* = , sig.level = , power =)" where *k* is the number of groups, *n* is the number of observations per group, *f* is the estimated effect size, and power is the probability of a type I error minus the probability of a type II error (Cohen 1988). This is based on the following formula where $p_i = n_i/N$, n_i = number of observations in group *i*, *N* = total number of observations, μ_i = mean of group *i*, μ = grand mean, and σ^2 = error variance within groups (Cohen 1988):

$$f = \sqrt{\frac{\sum_{i=1}^{k} p_i * (\mu_i - \mu)^2}{\sigma^2}}$$

Sample Audience

I desired an audience with a mixture of genders, political affiliations, ages, and geographic locations. However, the desired sample audience for this survey were also people apathetical or hostile towards the environment. To filter potential respondents by their level of concern with the environment, I created a screener question at the beginning of the survey based on a question asked monthly by Gallup where respondents identify what they think is the most important problem facing the country today. I modified this to a rank-sort type question where respondents were given a list of ten commonly described problems by Gallup respondents, one of which was environment/pollution. Each potential survey respondent had to rank the importance of the ten options, from most to least important, and if they ranked the environment/pollution option in 6th-10th place, then they could continue to participate in the survey. Those who ranked environment/pollution as a top five most important problem were not selected to continue. Research participation was voluntary, and fair monetary compensation was

offered as an incentive. All participants provided informed consent and responses were anonymous. The project received ethics approval from the University of Arizona Institutional Review Board (1801178468).

Manipulation Checks and Pilot Study

Preliminary manipulation checks and a pilot study were conducted and distributed using Mturk. Manipulation checks are common in social psychology research and are often used to check the effectiveness of the independent variable induction or as an attention check (Hauser at al. 2018). More accurate conclusions of the relationship between the independent and dependent variables can be drawn with successful (i.e. the participants correctly perceived the stimulus) manipulation checks (Hoewe 2017). I performed multiple successful manipulation checks, independent of other surveys, to ensure the text statements and associated imagery were reflective of the intended treatment. In addition to the independent manipulation checks, the pilot and large-scale surveys contained one attention check question to ensure only attentive participants continued to the entirety of the survey.

A pilot study, which consisted of the same sections as the main study, was distributed to target respondents. The information gathered from this helped finalize large scale survey material where question wording and knowledge assessment difficulty were altered using pilot study information.

Large Scale Surveys

Following manipulation checks and pilot study, three large-scale surveys (one with text-only treatments and two with enhanced text with background images) were conducted. Round 1 of the large-scale surveys used the Version 1 (text only) treatment videos and was distributed only using Qualtrics with a desired sample size of 400 respondents. Round 2 and Round 3 of the

large-scale surveys used Version 2 (enhanced text and background imagery) treatment videos and were distributed on Qualtrics (Round 2) and on Mturk (Round 3) websites, with a desired sample size of 400 for each of the two distribution platforms.

Analysis

Participants who viewed their assigned video for less than 23 seconds were removed from this analysis, because the first application of a treatment statement occurred at about 22 seconds. I used an analysis of variance (ANOVA) tests to assess differences in the changes in NEP and knowledge scores among all eight groups. When needed, Tukey-Kramer HSD post-hoc multiple comparison tests were conducted to assess where differences existed among treatments and control groups. In addition, Levene's Tests were used to test for homogeneity of variance. Independent samples *t*-tests were used to compare the results of the various post-tests. Paired samples *t*-tests were used to compare the pre-treatment NEP and knowledge scores to the post scores for each survey. Various demographics characteristics were analyzed using *t*-tests and ANOVAs to determine if the changes in NEP or knowledge scores varied by any of these characteristcs. Demographic information analyzed included age, gender, political party, marital status, familial status, proximity to an urban center, household income, and employment type. Participant ages were put into one of three bins: 18-30, 31-54, and 55+. I conducted all analyses in Program R Studio, version 1.1.456 (RStudio Team 2016).

RESULTS

Below, Round 1 will refer to the survey that used Version 1 (text only treatments) videos that were distributed using Qualtrics; Round 2 will refer to the survey that used Version 2 (enhanced text and different background image treatment) videos distributed on Qualtrics;

Round 3 will refer to the survey that also used Version 2 (enhanced text and different background image treatment) videos, but was distributed on Mturk.

There were a total of 1,591 people approached to participate in Round 1. Of those, 586 people were screened out on the environmental apathy screening question, 298 people did not provide consent to participate or provide their best answers, 205 people did not answer the attention check question correctly when given multiple attempts, and 28 people did not view the video for at least 23 seconds. In Round 2, a total of 1,860 people approached to participate in Round 1. Of those, 743 people were screened out on the environmental apathy screening question, 236 people did not provide consent to participate or provide their best answers, 428 people did not answer the attention check question correctly when given multiple attempts, and 21 people did not view the video for at least 23 seconds. Much of this information was not available for Round 3, except that 2 people did not view the video for at least 23 seconds.

Therefore, a total of 1,259 participants from the three pools of respondents (474 from Round 1, 432 from Round 2, 353 from Round 3), located across the United States, were included in this analysis (Figure 1). Of those from Round 1, 234 were females, 239 males, and 1 transgender; from Round 2, 296 were females, 132 males, 2 gender fluid, 1 transgender, and 1 unspecified; From Round 3, 190 were females and 163 males. The majority of participants in the Round 1 surveys were 55+ years old (52.8%), with 33.2% aged 31–54 years and 12.7% aged 18–30 years. The majority of participants in the Round 2 surveys were 55+ years old (51.1%), with 33.2% aged 31–54 years and 15.2% aged 18–30 years. The majority of participants in Round 3 were 31–54 years old (67.7%) with 13.6% age 55+ and 18.4% aged 18–30 years.

Round 2 vs Round 3

Because Rounds 2 and 3 both used the same treatment videos, I compared the pretest NEP and knowledge scores of the respondents in these two large scale surveys. The pretest NEP and knowledge scores did not differ significantly (NEP: $t = 0.5498$, df = 683.44, $P = 0.5827$; Knowledge: $t = 1.041$, df = 740.53, $P = 0.2982$). I also compared the NEP and knowledge posttest and pretest score differences. There was a significant difference between the Round 2 and Round 3 knowledge score differences ($t = 2.337$, df = 785.5, $P = 0.0197$), but no significant difference in the NEP score differences ($t = 1.416$, df = 801.3, $P = 0.1573$). Due to the knowledge score differences and the ability to use the survey round as a variable in the analysis, the data from Rounds 2 and 3 were not combined.

Attitudes

I found Round 1, Round 2, and Round 3 NEP assessments to be relatively highly internally consistent on both the pretests and the posttests (Cronbach's alpha scores of Round 1 pre: 0.846, post: 0.872; Round 2 pre: 0.848, post: 0.880; Round 3 pre: 0.904, post: 0.919). At baseline of both surveys, average NEP scores of participants were 3.409 [0.6356] (mean [SD]), 3.387 [0.6163], and 3.333 [0.7373] for Rounds 1, 2, and 3, respectively. In each trial, post-viewing NEP score was higher than the pretest score, regardless of group (Round 1: $t = 7.805$, df = 498, $P < 0.001$; Round 2: $t = 3.459$, df = 451, $P < 0.001$; Round 3: $t = 5.824$, df = 352, $P < 0.001$). For each of the three rounds, I also combined the treatment group NEP scores and compared these to the control groups, and the treatment groups in Round 2 had a significantly higher mean NEP score than the control group ($t = 2.436$; df = 80; $P = 0.00853$). There were no differences in Round 1 or Round 3 (Figure 2).

No differences in NEP score changes were found among any of the treatment or control groups in Round 1 or Round 2 (Round 1: $F = 1.479$; df = 7, 466; $P = 0.172$; Round 2: $F = 1.421$;

df = 7, 424; $P = 0.195$) (Figure 3). Significant differences were found among groups in Round 3 ($F = 2.967$; df = 7, 345; $P = 0.00493$). The reciprocity group was significantly higher than the similarity and the anthropomorphic groups (adjusted *P*-values of 0.0223 and 0.0336 respectively) (Figure 3).

Knowledge

On average, before both trials, participants answered less than 6 of 11 questions correctly (Round 1 mean [SD] = 5.31 [1.47], Round 2 = 5.31 [1.42], Round 3 = 5.21 [1.48]) with individual scores on text-only treatments (Round 1) ranging between 1 and 11, and on enhanced text and different background image treatments (Rounds 2 and 3) ranging between two and ten. Knowledge scores increased overall for Round 1 ($t = 37.809$, df = 473, $P < 0.001$), Round 2 ($t = 45.256$, df = 431, $P < 0.001$), and Round 3 ($t = 43.860$, df = 352, $P < 0.001$), after participants viewed videos, regardless of video treatments.

When comparing the combined treatment group knowledge scores to the control group scores for each of the three rounds, and there were no significant differences in any of the three rounds (Round 1: $t = 1.965$; df = 82; $P = 0.0528$; Round 2: $t = 0.9973$; df = 72; $P = 0.322$; Round 3: $t = 0.6558$; df = 55; $P = 0.515$) (Figure 4). I also found no differences in knowledge score changes among treatment/control groups in Round 1, ($F = 1.310$; df = 7, 466; $p = 0.243$), Round 2 ($F = 1.06$; df = 7, 442; $p = 0.391$), or Round 3 ($F = 0.46$; df = 7, 345; $p = 0.863$) (Figure 5).

Viewing Duration

No significant differences in viewing durations between any of the groups were found in any of the three rounds of testing (Round 1: $F = 0.979$, df = 7, 466, $P = 0.446$; Round 2: $F = 0.595$, df = 7, 424, $P = 0.760$; Round 3: $F = 0.796$, df = 7, 345, $P = 0.599$).

Demographics

Regardless of groups, the mean pre- and posttest knowledge scores differences in Round 1 varied by age ($F = 10.120$, df = 2, 470, $p < 0.001$) with all three age groups differing from one another. Those aged 55+ had significantly higher scores than those 31–54 aged individuals and 18–30 year olds, and those aged 31-54 had significantly higher scores that those aged 18-30. NEP and knowledge scores did not differ significantly by other demographics in Round 1, Round 2, or Round 3.

DISCUSSION

The findings of this study clearly indicate that any of the videos, whether treatment or control, increased both ecological worldview and knowledge in people previously hostile or indifferent to conservation issues. This should provide a higher level of confidence to those producing educational videos, that they could result in positive change in attitudes toward conservation. However, the effect of the addition of influence or anthropomorphic treatments on worldview and knowledge was subtle, and differed by the degree (text and images vs. text only) of treatment. These results suggest that videos that heavily incorporate such social psychology elements have a stronger positive impact on ecological worldview than a video that is purely informational or a video that minimally incorporates social psychology elements. In particular, I found the reciprocity principle particularly useful for shifting attitudes to be more pro-ecological, and observations from the three rounds of testing suggested that the rarity principle also often increased the NEP scores higher than other groups did. I believe the reciprocity NEP scores were significantly higher than the liking/similarity scores for the simple reason that it was difficult to incorporate the similarity principle into a video fully. This principle states that we are more likely to be influenced by those that we like, are similar to us, or we find attractive. In video form, this is hard to accomplish as it is unlikely that the people shown in the video will invoke

those described feelings in all viewers. Conversely, in the case of reciprocity, I described the actual ways that these fish are providing benefits such as via tourism dollars from those that traveled just to see them which is much less subjective than the liking/similarity video. In the anthropomorhic video, I relied on text statements from the third person point of view rather than having the fish themselves show that they have human-like characteristics, such as pro-social behavior, ability to feel pain, and have high cognitive ability (Chan 2012). This could explain why this group was found to have a significantly lower score than the reciprocity group. The trends I observed of the rarity group NEP scores being higher, though not significantly different thatn other groups, are also important. Many of the species that conservation is focused on are or are becoming rare. For this reason, it was easy to incorporate this principle into videos and would likely be easy for similarly rare species. The ease of incorporation of the rarity principle should also be considered when using these principles as a tool for science communication.

Knowledge scores from all three rounds of testing were consistently significantly higher on the posttest scores than on the pretest scores. Though no one treatment group had higher increases in knowledge than any other group, all participants showed large increases in learning by answering an average of over nine of the 11 questions correctly after viewing any video. This strongly suggests that, as hypothesized, these videos were effective at increasing the knowledge of the focal environments as well as the viewers' awareness of such areas. Videos of other focal environments would more than likely elicit similar results. Knowing that the control videos also elicited such a strong increase in knowledge, I suspect that any type of video with educational components would increase knowledge, at least short-term as measured in this study.

My results compliment the findings of other researchers where proenvironmental attitudes can be created in public service announcements using influence principles (Bator and

Cialdini 2000). In general, this study reflects what others have found with regard to the reciprocity principle which is that it had been shown to be effective even when there is not a direct benefit to the target individual (Goldstein et al. 2011). The success of the reciprocity principle in this research may be attributed to the ability for this principle to be operable in this indirect, impersonal manner using an online survey and with benefits that were indirect to the viewer. Much of the previous research that guided the development of these principles were conducted in a more personal manner, from door-to-door sales to automotive dealerships to restaurants (Cialdini and Schroeder 1976; Goldstein et al. 2008; Cialdini 2009), and creating that personalization through video, especially in when targeting a large population, is difficult.

Future Research

The respondents from this research were sampled from a general population, and did not reflect a more specific population from a certain area. In future research, a more geographically targeted audience that is closer in proximity to the focal environments is recommended. To improve results, I believe a more personal approach may be useful if the goal is to alter attitudes. One such way that these videos could be made more useful through a personal approach is by playing them in local venues that coincide with the featured landscapes and in places such as visitors centers in National Forests or Parks or similar. In this study, each treatment only featured one social psychology technique. However, it is often easier to design statements that incorporate more than one of these elements and studying the compounding effects of combining multiple elements in one video might produce interesting results. In addition to these changes in video design and distribution, both the attitude and the knowledge assessments in this project could be improved upon which may increase the ability to detect change. In an effort to minimize survey length, and therefore minimize financial burden, a modified version of the Animal Attitudes

Scale was removed from the survey. This assessment is commonly used in environmental education studies (Pearson et al. 2011, Herzog et al. 2015) and is complimentary to the New Ecological Paradigm assessment. The use of this would have likely resulted in more accurate measures of environmental attitudes, and specifically attitudes towards desert fishes. In addition to this, some respondents answered many, if not all, of the posttest knowledge questions correctly. To correct for this, questions differing in difficulty and questions that were multiple choice as opposed to all True or False could have been used which may have increased the resolution of the changes in knowledge as a result of viewing these videos.

Conclusions

The goal of this research was to test and evaluate the effectiveness of using video as a media technique to increase ecological attitudes and public knowledge of rare desert fishes. This research has demonstrated that videos are a useful and effective tool for familiarizing and teaching audiences who are apathetic or hostile to conservation about fishes. Videos, especially those that incorporated elements of social psychology as used in this research can, successfully and effectively increase viewers' attitudes and learning outcomes regarding desert fishes. I found that these video techniques are important tools that can be used to enhance conservation education and lead to protection of rare and seldom seen fishes like the desert pupfish. Tools such as these could additionally be successfully used to garner support and lead to greater advocacy for conservation of many other rarely seen, threatened or endangered species. Furthermore, videos like those used in this research could be displayed in a variety of venues such as social media, visitor centers, state and county fairs, museums and commercials to put important conservation topics into the public's view, that could result in furthering conservation and lead to greater sources of funding to support conservation.

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Table 1. Treatment reflective text statements used in the first round of treatment videos.

Statement Type	Statement
Anthropomorphic	1. Let's look at a water body that is home to two fish named Zoe and Silas. 2. Many families of friendly fish living in these springs make them worth protecting. 3. This is Zoe and Silas. 4. Zoe and Silas have many cousins. 5. Many cousins of Zoe and Silas live in this spring. 6. Understanding why the homes of Zoe, Silas, and their cousins should be protected is easy.
Authority	1. Let's look at a water body that amazes natural resource experts. 2. Experts agree that these springs and their fish are worth protecting. 3. Conservation authorities love to visit these springs. 4. Understanding why experts want to protect these springs is easy.
Commitment	1. Let's look at a water body that resembles wild places you have consistently enjoyed in the past. 2. Think of all you have done to protect environments like these springs and their fish. 3. Be consistent and keep your commitment to protecting wild places like these. 4. Continuing to commit your support to protecting wild areas like desert springs is easy.
Rarity	1. Let's look at one of the rarest types of water bodies in the world. 2. Because they are so rare, these springs and their fish are worth protecting. 3. Some of the rarest animals on Earth can be seen on a visit to these springs. 4. Understanding why these exceptionally rare desert springs should be protected is easy.
Reciprocity	1. Let's look at a water body that gives you amazing gifts. 2. These springs and their fish contribute tourism dollars to your economy and are worth protecting. 3. These springs also provide you with opportunities to hike, reflect, and relax. 4. Enjoying what desert springs provide to you is easy, now it is your turn to support their protection.

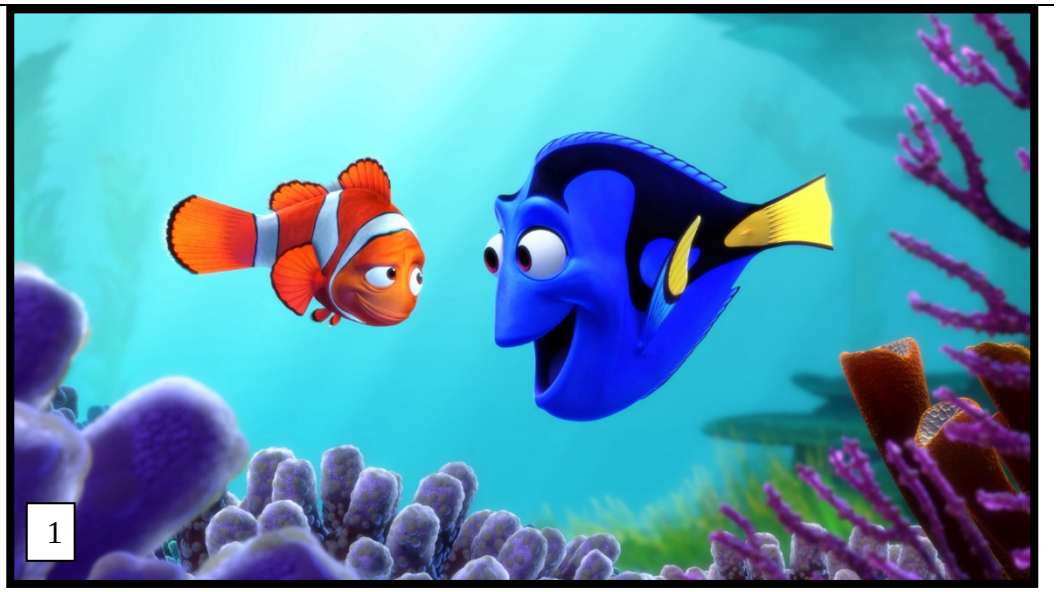
Similarity	1. Let's look at a water body that amazes people just like you. 2. A visitor like you agrees that these springs and their fish are worth protecting. 3. People just like you love to visit these springs. 4. Understanding why a person similar to you wants to protect desert springs is easy.
Social Proof	1. Let's look at a water body that amazes a lot of people. 2. Many people agree that these springs and their fish are worth protecting. 3. Crowds of people love to visit these springs. 4. Understanding why many people want to protect desert springs is easy.

Table 2. Treatment reflective enhanced text statements used in the second and third round of treatment videos.

Statement Type	Statement
Anthropomorphic	1. Let's look at a water body that is home to two fish named Zoe and Silas. 2. Though not the same type of fish, Zoe and Silas are like Finding Nemo characters in real life. 3. Families of friendly fish living in these springs make them worth protecting. 4. Here are Zoe and Silas. 5. Zoe and Silas are very social and have many cousins. 6. Many cousins of Zoe and Silas live in this spring. 7. Pupfish are so smart that they know who is an invader and who isn't. 8. Temperatures more extreme than those would be too painful for Zoe and Silas. 9. Understanding why the homes of Zoe, Silas, and their cousins should be protected is easy.
Authority	1. Let's look at a water body that amazes natural resource experts. 2. Authorities such as ranchers, land owners, and biologists believe these are worth protecting. 3. Here is a fisheries research specialist and the President of the American Fisheries Society. They agree that these springs and their fish are worth protecting. 4. Conservation authorities love to visit these springs. 5. Understanding why people at the top of their profession want to protect these springs is easy.
Commitment	1. Conserving and caring about wild places has always been important to you. 2. Will you commit a small bit of time to enjoy this story? 3. Think of all you have done to protect environments like these springs and their fish. 4. It has worked for you in the past, so keep doing what you've always done. 5. Be consistent and keep your commitment to protecting wild places like these. 6. Continuing to commit your support to protecting wild areas like desert springs is easy.

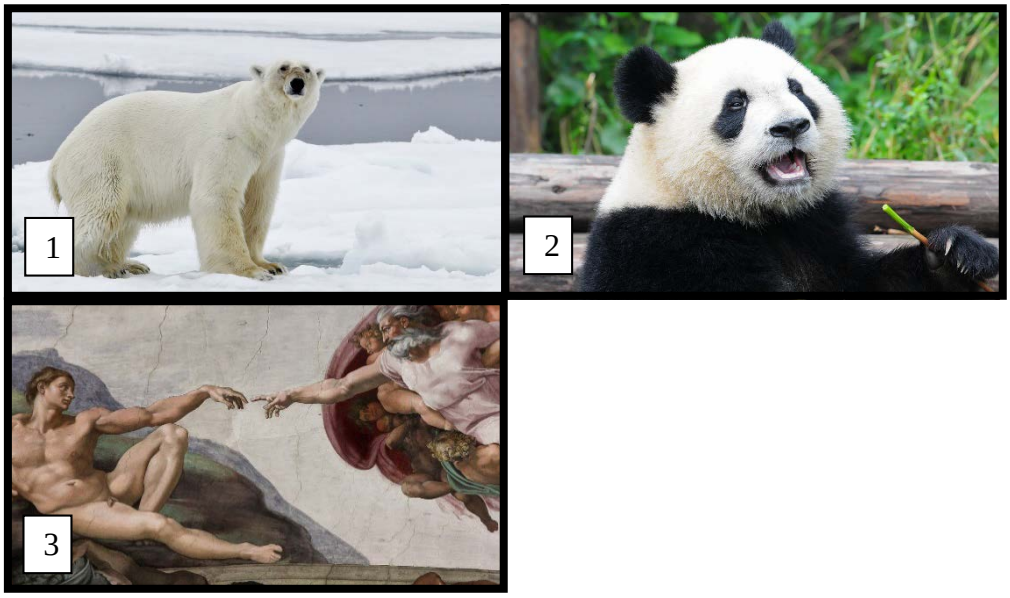
Rarity	1. Let's look at a waterbody that is home to some of the rarest species in the world. 2. What lives here are rarer than animals such as polar bears and pandas. 3. They are natures masterpieces and are as special as rare art. 4. Because they are so uncommon and unique, these springs and their fish are worth protecting. 5. The rarest species of fish can only be found here at this spring. 6. We are at risk of losing them. 7. Each spring is a unique universe of life, and understanding why they should be protected is easy.
Reciprocity	1. Let's look at a water body that gives you amazing gifts. 2. It is time to enjoy what nature is providing. 3. These springs and their fish contribute tourism dollars to your economy and are worth protecting. 4. These springs also provide you with opportunities to hike, reflect, and relax. 5. Now it is our turn to return the favor to nature. 6. Enjoying what desert springs provide is easy, now it is your turn to support their protection.
Similarity	1. Let's look at a water body that amazes those just like you. 2. People similar to you believe these are worth protecting. 3. Survey participants like you agree that these springs and their fish are worth protecting. 4. Folks you would be friends with love to visit these springs. 5. Understanding why a person similar to you wants to protect desert springs is easy.
Social Proof	1. Let's look at a water body that amazes a lot of people. 2. Most people believe these areas are worth protecting. 3. Many people agree that these springs and their fish are worth protecting. 4. Crowds of people love to visit these springs. 5. Join the thousands of people who want to protect desert springs.

Table 3. Treatment reflective photos used in the second and third round of treatment videos. Each individual photo was only used once in the video. Photos were displayed on screen ranging from three to eight seconds in duration.

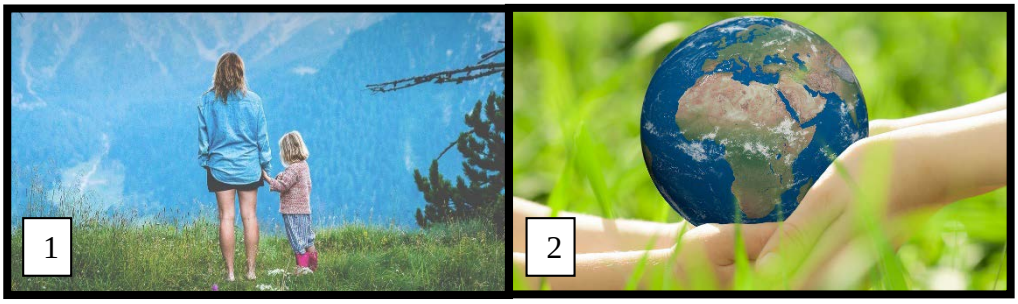
Statement Type	Statement
Anthropomorphic	
Authority	  

Commitment

Rarity



Reciprocity



Similarity

Social Proof

Table 4. Revised New Ecological Paradigm Statements. The seven even numbered items, if agreed to by a respondent, represent statements endorsed by the dominant social paradigm (DSP). The eight odd items, if agreed to by a respondent, reflect endorsement of the new ecological paradigm (NEP) and reflect a pro-ecological worldview. Source: Dunlap et al. (2000)

Statement Number	Statement
1.	We are approaching the limit of the number of people the Earth can support.
2.	Humans have the right to modify the natural environment to suit their needs.
3.	When humans interfere with nature it often produces disastrous consequences.
4.	Human ingenuity will insure that we do not make the Earth unlivable.
5.	Humans are seriously abusing the environment.
6.	The Earth has plenty of natural resources if we just learn how to develop them.
7.	Plants and animals have as much right as humans to exist.
8.	The balance of nature is strong enough to cope with the impacts of modern industrial nations.
9.	Despite our special abilities, humans are still subject to the laws of nature.
10.	The so-called “ecological crisis” facing humankind has been greatly exaggerated.
11.	The Earth is like a spaceship with very limited room and resources.
12.	Humans were meant to rule over the rest of nature.
13.	The balance of nature is very delicate and easily upset.
14.	Humans will eventually learn enough about how nature works to be able to control it.
15.	If things continue on their present course, we will soon experience a major ecological catastrophe.

Table 5. Aquatic species of Nevada and California knowledge assessment with the correct answer underlined.

Question Number	Question	Answer
1.	Rainwater is the main source of water in springs.	a. True b. False
2.	The Ash Meadows Amargosa Pupfish is native to Nevada.	a. True b. False
3.	Adult pupfish grow to be over 5 inches long.	a. True b. False
4.	Female pupfish are more colorful than male pupfish.	a. True b. False
5.	Pupfish got their name because they seem as playful as puppies	a. True b. False
6.	Pupfish can live in water that is over 110° F.	a. True b. False
7.	Pupfish can live in water that is 7x saltier than seawater.	a. True b. False
8.	Male pupfish are territorial.	a. True b. False
9.	There is between 10-15 species of pupfish in North America.	a. True b. False
10.	Pupfish mainly eat other fish.	a. True b. False

Figure 1. United States, locations of survey takers. Black, open, and grey dots represent locations of participants who took Round 1, 2, and 3, respectively. Round 1 was text alone treatment, Round 2 was enhanced text plus pictures treatment in Qualtrics, and Round 3 was enhanced text plus pictures treatment in Mturk.

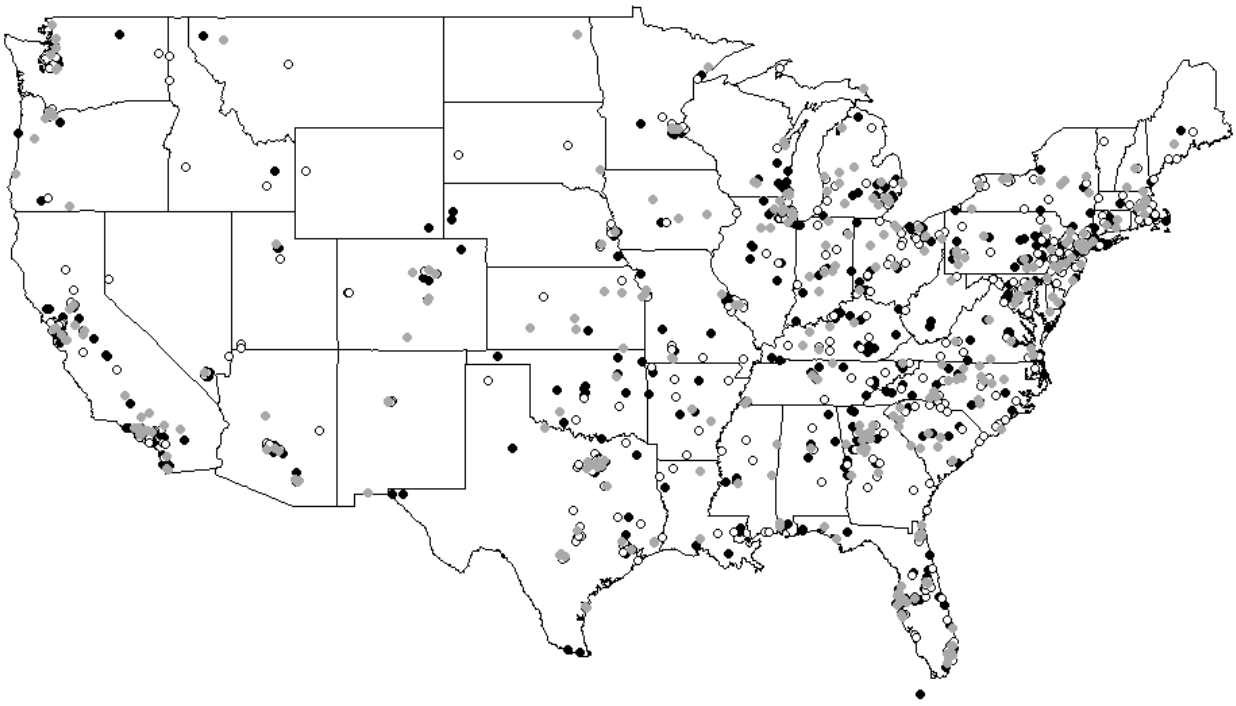


Figure 2. The change in New Ecological Paradigm (NEP; Dunlap et al. 2000) scores of three rounds of surveys (Round 1 [top] was text alone treatment, Round 2 [middle] was enhanced text plus pictures treatment in Qualtrics, and Round 3 [bottom] was enhanced text plus pictures treatment in Mturk) comparing the control groups to all of the treatment groups. NEP measures attitudes toward the environment. Only in Round 2 was the treatment group scores significantly higher than the control group. Rounds with letters in common were not significantly different (α = 0.05).

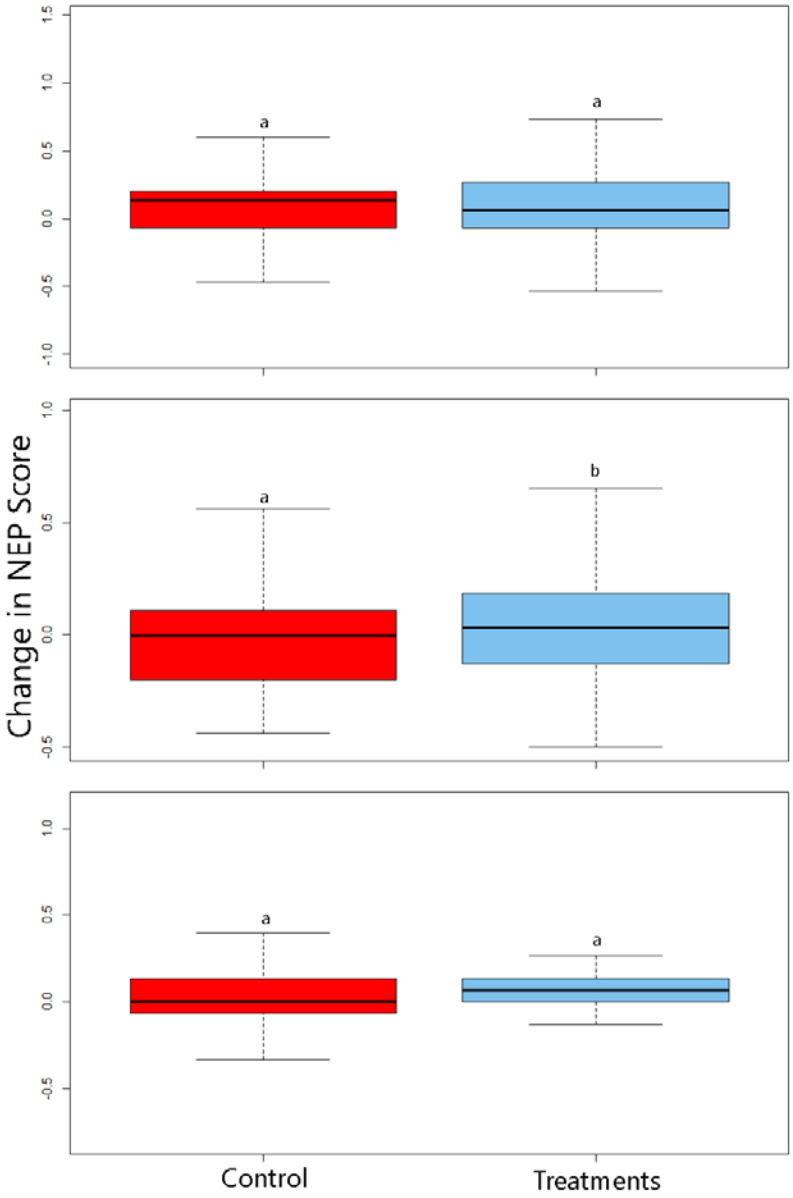


Figure 3. Changes in New Ecological Paradigm (NEP; Dunlap et al. 2000) scores among different social psychology treatments in videos from text alone treatment, enhanced text plus pictures treatment in Qualtrics, and enhanced text plus pictures treatment in Mturk (top, middle, and bottom). In the bottom image, the reciprocity group was significantly higher than the anthropomorphic and similarity groups. Treatments with letters in common were not significantly different (α = 0.05). Treatment group scores were only compared within each round, not between rounds.

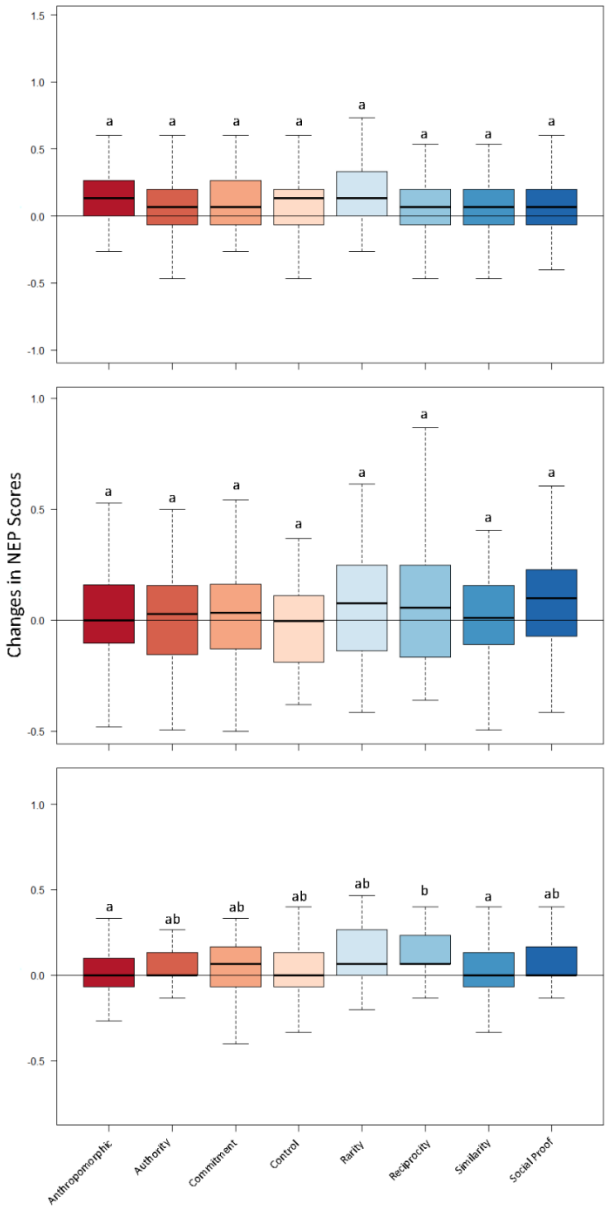


Figure 4. The change in knowledge scores of three rounds of surveys (Round 1 [top] was text alone treatment, Round 2 [middle] was enhanced text plus pictures treatment in Qualtrics, and Round 3 [bottom] was enhanced text plus pictures treatment in Mturk) comparing the control groups to all of the treatment groups. There were no significant differences. Rounds with letters in common were not significantly different ($\alpha = 0.05$).

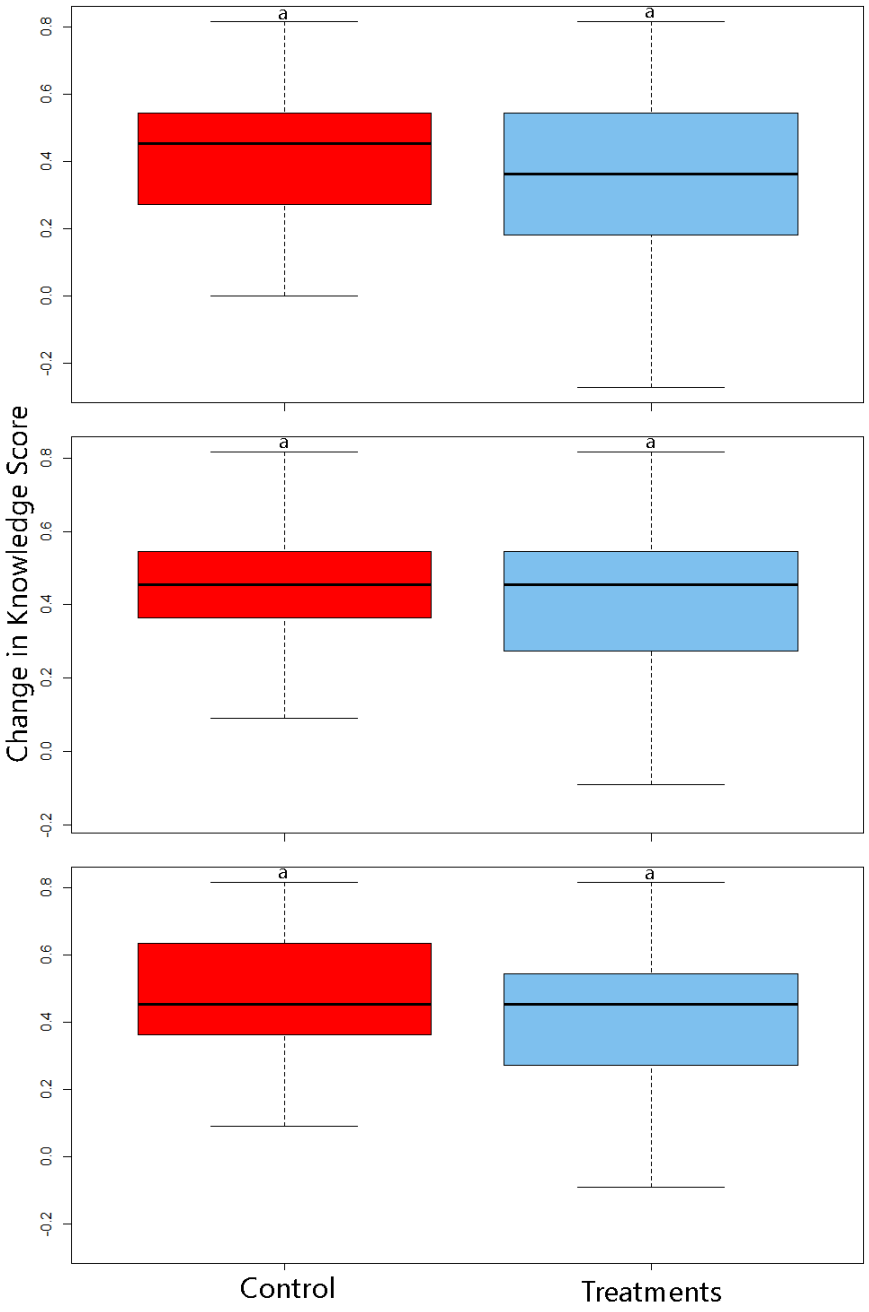


Figure 5. Changes in knowledge scores among different social psychology treatments in videos from text alone treatment, enhanced text plus pictures treatment in Qualtrics, and enhanced text plus pictures treatment in Mturk (top, middle, and bottom). No treatment group scores within each round were significantly different (α = 0.05)