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A Killer Whale's (*Orcinus orca*) Response to Visual Media

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Abstract:

Environmental enrichment is critical for maintaining cognitive welfare for animals in human care but is subject to individual preferences. The interest in a video-based enrichment was assessed for a single killer whale (*Orcinus orca*) in human care. The adult female was presented 20 video recordings featuring cetaceans, elephants, or humans with each video presented in two conditions: (1) with sound and (2) without sound. Four additional presentations in which the television displayed a blank screen served as controls. All sessions were videotaped and coded



for time spent viewing the recordings, behavioral responses, and visual laterality. The killer whale spent significantly more time at the television when programs were on screen compared to when the television was present but blank. She was more likely to watch videos accompanied by sound than those presented without sound. Videos were more likely to be viewed monocularly rather than binocularly, with a right eye preference when viewing the videos the first time they were presented. The highest rates of behavioral responses occurred during videos of cetaceans. These results demonstrate that one killer whale responded to video recordings of different stimuli, suggesting that video recordings may be used as a form of enrichment for cetaceans and that not all video content and formats are equally interesting.

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A Killer Whale's (*Orcinus orca*) Response to Visual Media

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Environmental enrichment is critical for maintaining cognitive welfare for animals in human care, but is subject to individual preferences. The interest in a video-based enrichment was assessed for a single killer whale (*Orcinus orca*) in human care. The adult female was presented 20 video recordings featuring cetaceans, elephants, or humans with each video presented in two conditions: (1) with sound and (2) without sound. Four additional presentations in which the television displayed a blank screen served as controls. All sessions were videotaped and coded for time spent viewing the recordings, behavioral responses, and visual laterality. The killer whale spent significantly more time at the television when programs were on screen compared to when the television was present but blank. She was more likely to watch videos accompanied by sound than those presented without sound. Videos were more likely to be viewed monocularly rather than binocularly, with a right eye preference when viewing the videos the first time they were presented. The highest rates of behavioral responses occurred during videos of cetaceans. These results demonstrate that one killer whale responded to video recordings of different stimuli, suggesting that video recordings may be used as a form of enrichment for cetaceans and that not all video content and formats are equally interesting.

The primary goal of any enrichment device is to improve the well-being of captive animals physically and psychologically (Mellen & Sevenich MacPhee, 2001). Over the past several decades, many different forms of enrichment have been used to improve the environment of animals in managed care settings, such as laboratories, zoos, and aquaria (Hoy, Murray, & Tribe, 2009; Mellen & Sevenich MacPhee, 2001). Enrichment is broadly defined and can include physical changes within the environment, training and other interactions with humans, food puzzles, objects and toys, social enrichment, and sensory enrichment, such as scents, sounds, visual stimuli, and tactile stimuli (Hoy et al., 2009; Kuczaj, Lacinak, & Turner, 1998; Newberry, 1995; Shyne, 2006). Enrichment devices have been productive in reducing stereotypic behavior and increasing species-typical behavior, by providing more complex environments that increase the inhabitants' choices within the environment (Markowitz, 1982). In a meta-analysis on the effectiveness of enrichment devices in reducing stereotypic behaviors, Shyne (2006) found that the majority of enrichment devices were successful in reducing stereotypic behaviors. However, the results of studies restricted to short-term time frames (typically three months) and small sample sizes must be interpreted with caution, as reductions in these types of behaviors may be more difficult to maintain over time and specific to individuals, demonstrating the need for long-term evaluations of enrichment devices (Alligood & Leighty, 2015; Eskelinen, Winship, & Borger-Turner, 2015; Kuczaj, Lacinak, Otto, Trone, & Solangi, 2002; Shyne, 2006). Kuczaj and colleagues (2002) found that one way of sustaining the effectiveness of an enrichment device was to vary its accessibility. Habituation to enrichment devices was inhibited when a device was only made available to the animal for short, variable time intervals, making the enrichment unpredictable and consequently sustaining its novelty.

Another way of decreasing the likelihood of an animal habituating to a specific enrichment device is to increase its flexibility. Video recordings are an example of a flexible form of enrichment because a variety of new stimuli can be presented to the animals using the same presentation modality, which minimizes the possibility of habituation. Unfortunately, relatively few studies have tested the effectiveness of this type of enrichment, and the majority of the studies conducted focused on various species of nonhuman primates housed for laboratory research.

One study assessed the effectiveness of videotapes of familiar and unfamiliar monkeys or humans and a video game as a means of enrichment for captive rhesus monkeys (*Macaca mulatta*, Platt & Novak, 1997). The results of this study indicated that 25% of the visual scans by the monkeys were directed towards the television screen, paired with increased activity of the monkeys during the video presentations. The video enrichment had positive behavioral impacts for socially-housed animals and individually-housed animals. Socially-housed animals increased locomotion and decreased passive social behaviors, whereas individually-housed animals increased agonistic behavior and spent less time sleeping while videotapes were present. Since these are individually housed animals, this could be an indication for maintaining a normal repertoire as well as an overall increase in activity level. The monkeys in this study watched videotapes of unfamiliar humans and unfamiliar monkeys more than videos of familiar humans or monkeys and spent more time watching the video than manipulating the game.

Several studies found similar results to the Platt and Novak (1997) study (Bloomsmith, Keeling, & Lambeth, 1990; Bloomsmith & Lambeth, 2000). The first observed socially- and individually-housed chimpanzees (*Pan troglodytes*, Bloomsmith, Keeling, & Lambeth, 1990). On average, the chimpanzees spent 42% of their time watching the various television-based visual media when it was available. Differences between the socially- and individually-housed chimpanzees in the amount of time spent watching the visual media emerged. Individually-housed chimpanzees watched the visual media 74% of the time it was available compared to 20% of the time by socially-housed animals. The chimpanzees in this study preferred tapes depicting a variety of human caretaker and chimpanzee behaviors to those that depicted agonistic behaviors of chimpanzees. Only the socially-housed animals showed evidence of habituation to multiple presentations of the same program as the viewing rates of the individually-housed chimpanzees remained consistent throughout the study (Bloomsmith et al., 1990). The second, reported by Bloomsmith and Lambeth (2000), in which chimpanzees viewed visual media for an average of 38.4% of the viewing time. A variety of video programs or clips were used. These included a chimpanzee with a human caretaker, various chimpanzee behavior, television programming, specific chimpanzee behavior (i.e. agonism, grooming, feeding, and playing), and behavior of other species. The chimpanzees did not show a preference for any one type of video, but some evidence of habituation emerged. It is unclear if these results were related to the housing method as the viewing times reported included the combined results of individually- and socially-housed animals.

Brent and Stone (1996) simultaneously exposed 20 individually and socially housed chimpanzees to television, balls, and mirrors as long-term enrichment. Television viewing occurred significantly more often than interactions with either the ball or the mirror (Brent & Stone, 1996). Unlike the findings from Bloomsmith et al. (1990), there was no significant difference in television use between individually-housed chimpanzees and those housed socially. It is important to note that the television was a more novel item in comparison to the ball and mirror, and other more recently introduced items captured the attention of the chimpanzees more often (Brent & Stone, 1996).

Domestic cats (*Felix catus*) housed in a shelter were exposed to videos involving humans and animate or inanimate movement (Ellis & Wells, 2008). While the cats preferred scenes of animate and inanimate

movement, the cats spent only 6.10% of their overall time watching the videos. Similarly, domestic dogs (*Canis familiaris*) watched video presentations 10.8% of their exposure time, which was significantly more than the blank screen conditions (Graham, Wells, & Hepper, 2005). In both studies, the authors argue that species, such as cats and dogs with visual systems that are more developed may find such stimulation more interesting (Ellis & Wells, 2008; Graham et al., 2005).

Multiple factors influence what forms of enrichment will be most beneficial to an animal, including the species, number of conspecifics present, the animals' cognitive abilities, and individual preferences (Eskelinen et al., 2015; Kuczaj et al., 2002; Newberry, 1995). It has been proposed that the most beneficial forms of enrichment are those that utilize the animal's natural repertoire of behaviors (Newberry, 1995). For example, visual media may be particularly effective as a form of enrichment for primates as it variably modifies the visual environment of the primates, which capitalizes on their primary sensory modality of vision.

The purpose of the current study was to assess whether video media could be a useful form of enrichment for a killer whale. Bottlenose dolphins (*Tursiops truncatus*) are capable of processing, following, and discriminating visual and auditory media presented through television monitors or underwater touchscreens to respond to discrimination tasks (Delfour & Marten, 2006), displacement tasks (Johnson, Sullivan, Buck, Trexel, & Scarpuzzi, 2014), or gestural behavioral commands (Herman, Morrel-Samuels, & Pack, 1990). These results suggest that video-based media could elicit the attention of other cetaceans and be utilized as a form of enrichment. To assess this possibility, a variety of visual stimuli were presented randomly to a solitary killer whale in managed care in two conditions – with and without sound.

Method

Subject

The subject for this study was a female killer whale born in 1993 and housed at Six Flags Discovery Kingdom in Vallejo, CA. The killer whale's habitat consisted of a large show pool and three back pools, with underwater viewing windows. All the pools were inter-connected with gates.

Apparatus

A 32 in color television was placed approximately 6 in from the center of an underwater viewing window, with a Sony MiniDV camcorder mounted on a tripod approximately two meters (5 – 6 ft) behind the television to record the subject's behavior during a session (Figure 1).



Figure 1. Photograph of the experimental set-up with subject present

Measures

The recorded sessions were analyzed for overall time spent at the television, eye orientation when observing the television, and any behaviors (Table 1) exhibited while observing the television. Behaviors and viewing times were only recorded when at least one eye was visible. Viewing was coded as monocular when one eye was visible or binocular when both eyes were visible (Figure 2).



Figure 2. Subject viewing the television in the underwater viewing window with her right eye.

Procedure

The video media presented on the television included videos of two familiar humans, a whale documentary, a dolphin documentary, and an elephant documentary. Each video was presented both with and without sound at least once. The order of the video presentations was randomized. A control condition was used in which the television was present but not showing any video media. All together there were a total of 24 video media presentations lasting 30 to 60 min each. Table 2 summarizes the number of times each video was presented. Data collection took place from January to March 2012 between 0700 h and 0900 h, before the park opened. Only one video presentation session was conducted each day, outside of training sessions, to minimize distractions during experimental presentations.

After the equipment was set up, a trainer played the video media and started the video camera to record the session. The trainer recorded which video was selected for the session, the condition (sound vs. no sound), the time, and the date. No primary reinforcement (e.g., food) was provided for coming to the test window or for viewing the video media. Following this set-up, the trainer left the underwater viewing area and did not return until the session was over to control for any potential confounds related to the presence of a trainer.

Each video session was coded by two independent coders. All coders practiced coding the behaviors of interest until inter-rater reliability was consistent. A Cohen's Kappa indicated that the final inter-rater reliability was greater than 80%.

Table 1
Behavioral Definitions

Behavior	Definition
Bubble Burst	A large bubble is released from the blowhole
Bubble Stream	String of small bubbles is released from the blowhole
Head Bob	Head moves in up-and-down motion
Head Jerk	Sharply turning head toward the television
Head Jerk with Open Mouth	Sharply turning head toward the television while also performing an open mouth
Head Up	Head breaks the plane of the television
Open Mouth	The mouth is not in a closed position

Table 2
Frequency of Video Presentations

Video	Presentations with Sound	Presentations without Sound
Elephant Documentary	2	2
Familiar Trainer A	3	2
Familiar Trainer B	2	2
Whale Documentary	2	2
Dolphin Documentary	2	1
Control	N/A	4

Results

Time Viewing Television

Overall viewing time. The viewing time for each video, represented as a percentage of the session spent watching the television, is presented in Figure 3. When a video was playing, the killer whale spent between 8.7% and 77.2% of the trial at the television, $M = 49.4\%$, $SE = 4.2$. The shortest average viewing was during familiar human B condition (34.1%), and the longest average viewing time was during dolphin documentary condition (64.0%). The average viewing time during the blank screen control was $7.7\% \pm 3.1\%$. A one-way independent ANOVA was conducted to analyze the difference in percent of viewing time between when a program was presented versus the blank screen control. A significant difference in viewing time emerged, $F(1, 22) = 19.15$, $p < 0.001$, partial $\eta^2 = 0.47$, which indicated that the killer whale spent more time, on average, watching programs than watching the television with a blank screen. An independent one-way

ANOVA was conducted to determine the effect of the six different video conditions on overall percent of viewing time. There was a significant effect of video condition on viewing time, $F(5, 18) = 7.85$, $p < 0.001$, partial $\eta^2 = 0.69$. Tukey post hoc tests indicated that the killer whale watched the video of familiar human A, $M = 57.8\%$, $n = 5$, $p = 0.001$, whale documentary, $M = 56.2\%$, $n = 4$, $p = 0.002$, and dolphin documentary, $M = 64.0\%$, $n = 3$, $p = 0.001$, significantly more than the blank screen control (Figure 3).

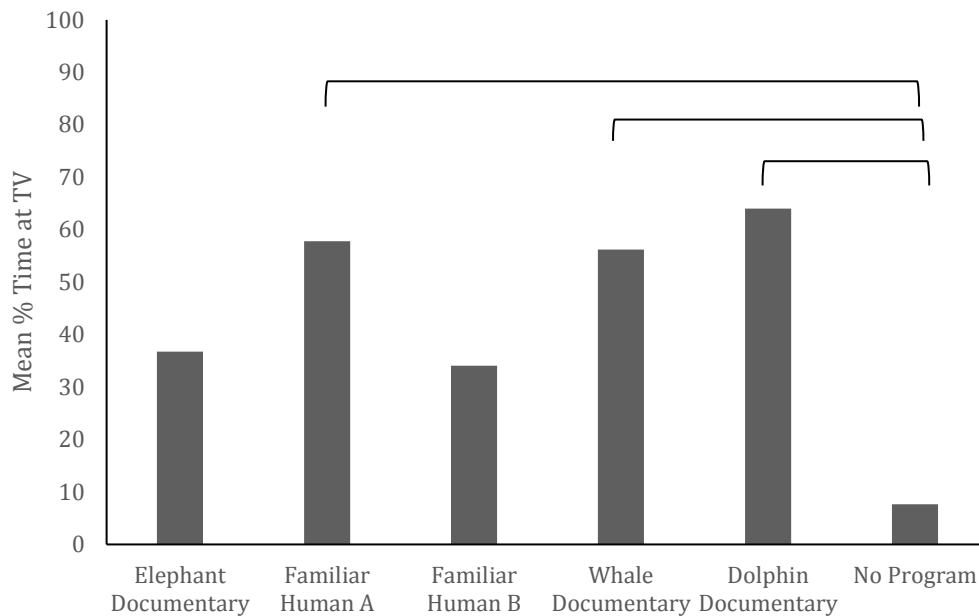


Figure 3. Average viewing time for each video condition. Bars represent significant differences between the control and other conditions.

Approaches and average duration of each viewing bout were also examined across each video condition. Table 3 summarized the number of times within a session the killer whale approached the television and the average duration of her viewing time after each approach. An independent one-way ANOVA indicated that there was a significant effect in the number of times the killer whale approached the television based on the video playing, $F(5, 18) = 3.12$, $p = 0.034$, partial $\eta^2 = 0.4$. Tukey post hoc analyses indicated that the killer whale approached the television significantly more during the dolphin documentary compared to the blank screen control, $p = 0.049$. No other comparisons were significant. As seen in Table 3, the killer whale approached the two cetacean documentaries and the familiar human A video most often and appeared to gaze at these three conditions the longest. Although she approached the television equally to view the two familiar trainer videos, she spent half the time, on average, at the television following an approach to view the familiar human B condition as compared to the familiar human A. To examine these qualitative differences, an independent one-way ANOVA was conducted to assess the effect of viewing condition on the difference in the average length of a viewing bout. The effect for video on average bout length was not significant, $F(5, 18) = 2.75$, $p = 0.051$, partial $\eta^2 = 0.43$.

Table 3
Summary of Number of Viewing Bouts and Duration of Each Bout Per Video

Video Condition	Average number of viewing bouts	Average bout duration (s)
Elephant Documentary	13.5	43.8
Familiar Human A	16.4	68.6
Familiar Human B	17.5	33.3
Whale Documentary	24.5	43.3
Dolphin Documentary	26.3*	51.0
No Program	9.0*	15.3

* $p < 0.05$

Effect of sound on viewing time. A one-way repeated measures ANOVA was used to determine any differences in viewing time based on whether sound was present or not. To compensate for unequal sample sizes, the mean viewing time for each video with and without sound was used. There was a significant effect of sound on viewing time, $F(1, 4) = 29.13$, $p = 0.006$, partial $\eta^2 = 0.88$. On average, the killer whale spent 57.7% of her time watching the television when a video was accompanied by sound as compared to 39.4% of her time when sound was absent. This preference for sound was observed for each video (Figure 4). Paired sample t-tests indicate that the killer whale watched significantly more with sound in the familiar human A, $t(2) = 19.59$, $p = 0.003$, $d = 11.3$, and the whale documentary conditions, $t(1) = 13.71$, $p = 0.046$, $d = 9.70$.

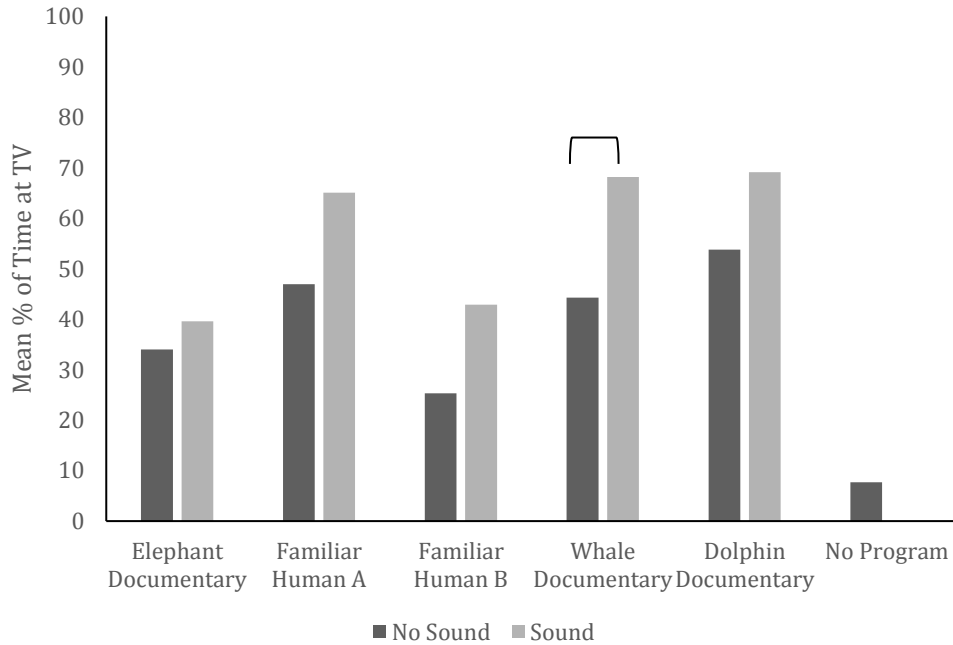


Figure 4. Comparison of sound and no sound trials for each video type. Bar represents a significant difference per post hoc.

Behavioral Response While Viewing the Television

An independent one-way ANOVA was conducted to assess the difference in the total number of behaviors exhibited by the killer whale when a program was playing versus a blank screen. The results indicated that significantly more behaviors were performed when the television was playing any program ($M = 31.1$, $SE = 4.34$) compared to the blank screen control, $M = 7.75$, $SE = 3.15$, $F(1, 22) = 5.47$, $p = 0.029$, partial $\eta^2 = 0.20$. Table 4 summarized the average frequency for each behavior coded.

A series of independent measures one-way ANOVAs was conducted to assess the average frequency of each behavioral category across each condition tested. The results were significant for only open mouths. The frequency of open mouths varied significantly based on the specific video shown, $F(5, 18) = 6.55$, $p = 0.001$, partial $\eta^2 = 0.65$. Tukey post hoc tests demonstrated that there were more open mouths performed while watching the whale documentary compared to the elephant documentary, $p = 0.012$, familiar human A, $p = 0.018$, familiar human B, $p = 0.005$, and the control condition, $p = 0.001$. See Figure 5 for a comparison open mouths across conditions.

Table 4
Average Frequency of Each Behavior for Each Video

Video Played	Bubble Burst	Bubble Stream	Head Bob	Head Jerk	Head Jerk with Open Mouth	Head Up	Open Mouth
Elephant Documentary	1.25	2.75	4.75	1.75	2.00	5.00	4.25*
Familiar Human A	2.40	2.60	2.00	2.60	4.40	9.20	5.40*
Familiar Human B	1.75	3.25	1.00	1.00	2.75	8.75	3.00*
Whale Documentary	4.50	17.50	3.50	5.00	3.75	10.50	16.25*
Dolphin Documentary	2.00	9.00	2.00	3.67	.67	11.67	10.67
No Program	0.75	1.75	0.25	0.50	0.00	3.50	1.00*

Note. Aside for open mouth, all other behaviors did not differ significant across video conditions. * $p < 0.05$

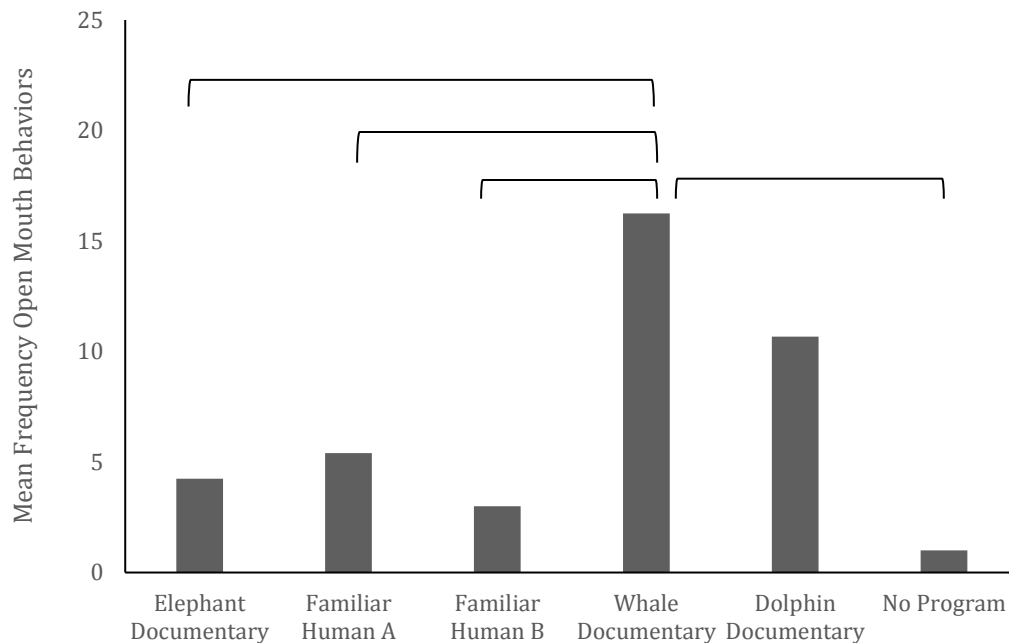


Figure 5. Frequency of open mouth behaviors. Bars represent significant differences between conditions.

Laterality Differences

Monocular vs. Binocular Viewing. The killer whale spent 67.7% of her television viewing time using one eye (either right or left eye) and 31.6% using both. A repeated-measures one-way ANOVA was used to analyze the difference in monocular and binocular viewing. There was a significant preference for monocular viewing, $F(1, 23) = 42.24, p < 0.001$, partial $\eta^2 = 0.65$. Paired sample t-tests were used to determine whether this effect was found for each video condition as well. These results are summarized in Table 5 and Figure 6.

Table 5
Mean monocular and binocular viewing

Video	Mean % Monocular Viewing (SE)	Mean Binocular Viewing (SE)
Elephant Documentary*	81.3 (4.97)	18.7 (4.97)
Familiar Human A*	76.7 (5.91)	23.3 (5.91)
Familiar Human B*	63.7 (3.87)	36.3 (3.87)
Whale Documentary	58.2 (7.04)	41.8 (7.04)
Dolphin Documentary	68.0 (6.11)	31.9 (6.18)
No Program	56.1 (8.69)	39.9 (7.22)

* $p < 0.05$.

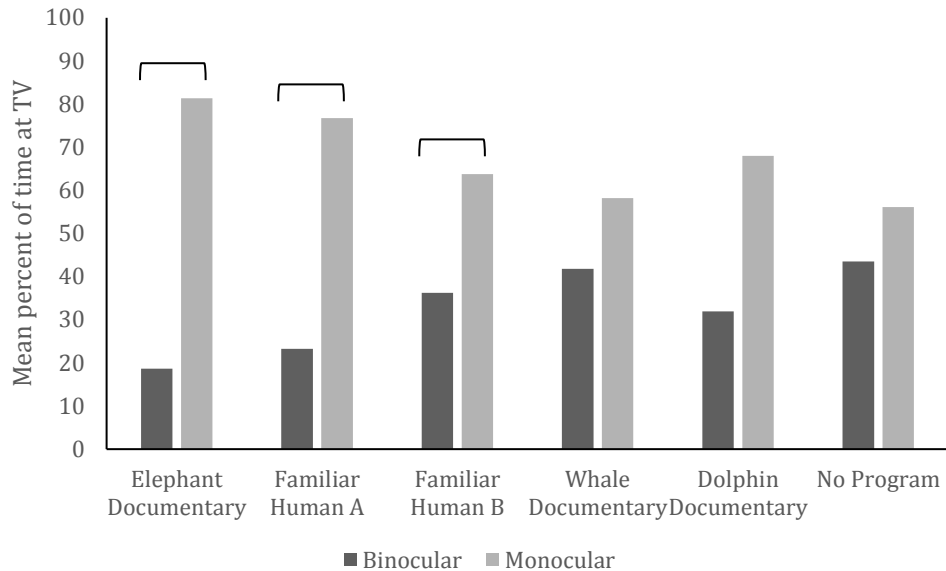


Figure 6. Comparison of monocular and binocular viewing for each video. Bars represent significant differences between conditions.

First presentation. A repeated measures one-way ANOVA was used to determine if there was an eye preference the first time a video was presented. An eye preference was demonstrated when programs were presented for the first time, $F(2,8) = 5.78$, $p = 0.028$, partial $\eta^2 = 0.59$. During these trials, the right eye was used on average 45.9% of her total viewing time, the left eye was used 26.9% of her viewing time, and both eyes were used for 21.5% of her viewing time. Post hoc paired-sample t-tests revealed that the right eye was used significantly more than both eyes, $p = 0.031$, while watching a video for the first time.

Discussion

The purpose of the current study was to assess the level of interest by an adult killer whale without conspecifics to a visual-based enrichment — a television playing different types of programs with or without sound. When examined as a whole, the visual media condition produced greater levels of interest than the control of the television by itself. The killer whale viewed the visual media an average of about 50% of the time it was available, spending up to 77.2% of a trial in front of the television. In contrast, she averaged less than 10% of her time during control trials when the television was present but nothing was being played. This overall measure was supported by the increased frequency with which she returned to the television during a session and longer viewing durations when visual media playing as opposed to control sessions (Table 3). These results of the experimental manipulations suggested that the video media being played affected her behavior rather than simply the unpredictable presence of the television itself.

The addition of sound appeared to enhance the interest of the killer whale as she spent significantly more time viewing videos that were presented with sound than when presented without sound. This pattern was observed for each video she was shown throughout the study. Although she watched the television more when sound was played with the video, her behavioral response to the video did not differ as a result of whether sound was presented with the video or not. This finding may indicate that sound is important in establishing her initial interest and whether she approaches the television. However, the visual aspect of the video may ultimately determine her behavioral response. Clearly, the relationship between sound and visual media needs to be explored in more depth to better understand how these two modalities interact and create an enriching experience.

The killer whale exhibited a wide variety of behaviors, and did so more often when viewing a video as opposed to just looking at the television itself. She displayed more behaviors overall while watching the whale and dolphin documentary than any other videos, including open mouth and bubble stream behaviors. These differences in types of behaviors displayed suggest that she paid attention to the content of the visual media. For example, in the familiar trainer videos, individual female trainers were shown engaging in various chores and training sessions throughout the day. The elephant documentary, narrated by a male voice, focused on a group of elephants as they traversed a desert habitat, occasionally showing brief periods of high activity behaviors by the elephants. In contrast, the whale and dolphin documentaries, also narrated by male voices, depicted cetaceans in the wild engaging in very active behaviors. Perhaps these documentaries were more biologically relevant to the killer whale, even though neither documentary focused on a killer whale as the subject. However, it is possible that the higher levels of behavioral activity in the cetacean documentaries may have been of greater interest to the killer whale as compared to the other slower-paced video options. The differences in the types of behaviors and environments depicted in the videos could help explain the differences in behaviors displayed by the killer whale while viewing the visual media. These differences in videos could also provide an explanation for differences in the lengths of bouts. The familiar human A video may change scenes more frequently than the dolphin documentary, creating a longer bout duration even though the killer whale watched the dolphin documentary longer overall.

The current results are similar to some research with chimpanzees in which preferences for certain video programs were displayed (Bloomsmith et al., 1990, but see Bloomsmith & Lambeth, 2000). Singly-housed chimpanzees spent more time watching the television when viewing video recordings of conspecifics engaging in agonistic behaviors or video recordings of chimpanzees interacting with human caretakers (Bloomsmith et al., 1990). Additionally, rhesus monkeys preferred to watch videos of unfamiliar monkeys and humans as opposed to those videos of familiar individuals (Platt & Novak, 1997). Further analysis is needed to determine if the behavior of the killer whale in the current study directly related to the content presented in the video at the time of a given behavior. If she can discriminate between the video content and the content produces different behavioral responses, the efficacy of this means of enrichment could be increased.

One potential indicator of the killer whale's ability to discriminate content was her eye preference when viewing the visual media. Previous research has indicated that cetaceans, primarily bottlenose dolphins display lateralized preferences when viewing visual stimuli, typically using the left eye to process social information and often using the right eye to process unfamiliar or novel information (for a recent review, see MacNeilage, 2014). In general, the killer whale spent more time engaged in monocular (left or right eye) viewing than binocular viewing. A similar spontaneous preference for monocular vision was observed in bottlenose dolphins processing visual stimuli for a complex cognitive task (Delfour & Marten, 2006) and may be indicative of a cognitive processing lateralization. However, the monocular preference may have also been elicited by the experimental set-up as she typically watched the television while positioning herself as close as

possible to the viewing window to observe the visual content on the television located outside her pool, which were limited in size and proximity (Figure 2). It may have been easier for the killer whale to get closer to the television when she positioned her body laterally in relation to the television instead of in a vertical, nasoventral direction. This lateral positioning would favor monocular vision.

The killer whale did not display a consistent, specific eye preference (right eye vs left eye) across the study. However, when viewing a video for the first time, a right eye preference did appear. Previous studies in dolphins have found a right eye preference for visual processing and visual discrimination (Kilian, von Fersen, & Güntürkün., 2000; 2005; von Fersen, Schall, & Güntürkün, 2000; Yaman, von Fersen, Dehnhardt, & Güntürkün, 2003). For example, Delfour and Marten (2006) found a right eye and left hemisphere advantage for information processing, as the dolphins were more likely to make the correct visual discriminations with their right eye than their left eye. Interestingly, the bottlenose dolphins in this study did not display a clear preference for the using the right eye to complete the task (Delfour & Marten, 2006). This study along with several others suggest that bottlenose dolphins might have greater visual acuity with the right eye and a left hemisphere dominance for visual discrimination and processing (Delfour & Marten, 2006; Kilian et al., 2000, 2005; von Fersen et al., 2000; Yaman et al., 2003). It is therefore possible that using the eye with greater visual acuity was more important for this killer whale the first time she watched a video. Once she had seen the visual stimuli once, it is possible that she was not inhibited by needing to use the eye with the greatest visual acuity and increased her flexibility in orienting towards the television screen. This hypothesized function of lateralized visual processing has implications for the cognitive processing of novel stimuli and additional research with more killer whales should be conducted to examine how killer whales process visual information.

Although this experimental study was conducted with a single subject, the results demonstrate that audio/visual media are an effective means of environmental enrichment for an individually-housed killer whale. Moreover, the modes of presentation, including the presence of sound, and the content of the presentation likely contribute to the overall efficacy of this enrichment option. Future studies should further examine the role sound and content have in the efficacy of video enrichment. Specifically, including conditions in which sound is presented without the associated video would allow for the independent effects of sound to be evaluated. Additionally, future studies should continue to examine the content of visual media to determine if the increased interest is related to the specific subjects of the program (e.g., conspecifics or ecologically familiar subjects) or the activity of the subjects (e.g., high levels of movement or social interactions). Future studies may want to consider the responses to the first presentation of a video compared to subsequent viewings. Finally, similarly to previous studies with primates (Bloomsmith et al., 1990; Bloomsmith & Lambeth, 2000), future research should examine the effectiveness of this form of enrichment in various social grouping of killer whales as well as with other individuals. Not all enrichment is equally enriching for individual animals (Delfour & Beyer, 2012; Eskelinen et al., 2015), and the effectiveness of this form of enrichment should be replicated with other individual killer whales as well as other cetaceans. Perhaps visual media could be used to promote social interactions between animals, to model new behaviors that the killer whales might attempt to replicate, or simply provide an option to investigate within their environment.

Conclusions

1. The use of video enrichment appears to be a valuable tool to enrich the environment of a solitary killer whale.
2. The presence of visual stimuli combined with auditory stimuli appeared to be more engaging than visual stimuli alone.

3. Visual stimuli on a television elicited more attention from the killer whale than just the TV alone.
4. The killer whale showed a right eye preference when viewing videos for the first time and tended to view the videos monocularly.
5. The highest rates of behavioral responses occurred during videos of cetaceans, which needs to be examined with other killer whales and cetaceans in general.

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