

**Application of positive reinforcement training to assist in voluntary dental evaluation for Southern white rhinoceros (*Ceratotherium simum*)**

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Disney's Animal Kingdom®

**Abstract**

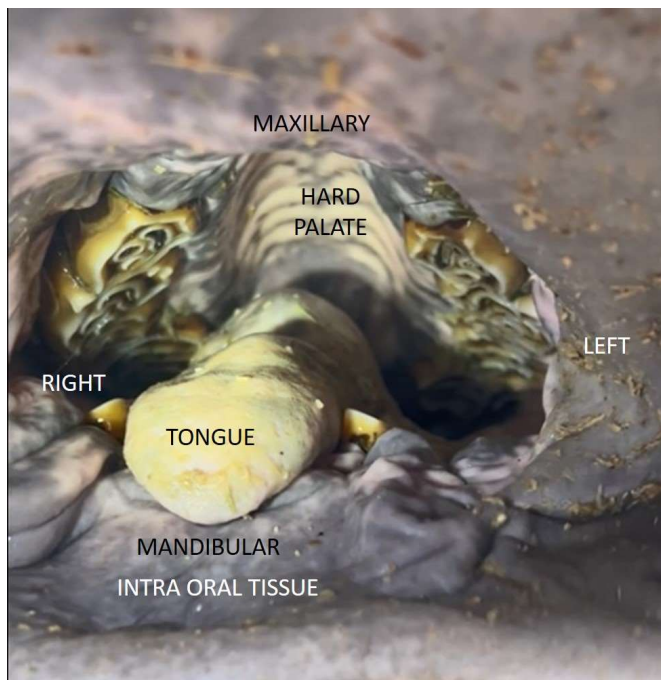
Voluntary dental evaluation on Southern white rhinoceros (*Ceratotherium simum simum*) in managed care can be difficult due to white rhino physiology. White rhino dental evaluation and treatment is typically performed during anesthesia, which carries high costs for the facility as well as risks for the animal. These costs and risks are balanced with the critical nature of dental care, as uneven wear or pathology of the teeth and calculus accumulation could result in numerous health issues. Following the introduction of positive reinforcement training and novel tools, a white rhino at Disney's Animal Kingdom® (DAK) voluntarily participated in thorough oral examinations including oral rinsing. Keepers were able to develop a basis for a practical procedure for expanding the view of white rhino mouths and rinsing teeth, as well as allowing for the possibility of voluntary dental work in the future. The improved visual access to white rhino dentition has led to multiple avenues of possible research, learning, and dental care. Opportunities to explore include the reduction of tooth-related immobilizations because of voluntary dental work, the effect of an abrasive diet on the teeth of managed care rhino, tooth wear patterns in these rhinos, and the long-term effects of proactive dental work (including brushing, prescription rinses, etc.).

*Keywords:* operant learning, dental care, zoo animals, oral exam

### Application of positive reinforcement training to assist in voluntary dental evaluation for White rhinoceros (*Ceratotherium simum*)

Dental health is critically important for animals in human care. According to Jurado and colleagues (2008), “Dental health in captive animals could be considered an indicator of the ecologic care status, reflecting housing, enrichment, diet, and correct species management, and should receive appropriate attention” (p. 74). This is a particular concern for white rhinos because of their dental structure and diet. White rhinos have plagiolophodont vertically elongated hypsodont teeth, which they use to graze on high abrasion diets (Taylor, 2013). Taylor (2013) also concluded that inadequate tooth wear could negatively impact animal health and suggested dental health checks should be part of routine preventive health care for rhinos. White rhino dental care is uniquely challenging due to their anatomy. Due to the small jaw gaping size and intra-oral tissues, it is difficult to see all 24 teeth in an ordinary oral examination (Figure 1).

**Figure 1** Image of oral examination



An ordinary oral examination is usually comprised of the white rhino opening the mouth after a cue from a trainer, and the veterinarian inspecting the resulting visible area, sometimes further made challenging by the presence of hay (Figure 2). Because this is typically not adequate for a full examination, dental care in this species most often requires immobilizations, which entail other complications. “Anesthesia of rhinoceros species requires specialized

equipment, planning, and expertise. Rhinoceros species are prone to complications such as myopathy and neuropathy in addition to the general risks associated with chemical immobilization” (Miller pp. 539).

**Figure 2** *Oral Exam View Prior to Training*



Developing practices to train voluntary medical behaviors can provide opportunities for dental care to be delivered while bypassing the risks of anesthesia. In addition, large scale immobilizations are costly due to the price of potent opioids as well as the resources needed, including increased staffing, specialized equipment, and specialists. Successful implementation of husbandry training, including voluntary hoof trims and phlebotomy, has reduced the need for immobilizations in numerous zoo-housed species. At Cheyenne Mountain Zoo, in reference to voluntary hoof trims on giraffe, Dadone (2017) noted that, “With training, fewer giraffe anesthetic procedures needed to be performed, which improved follow-up care to the patient and minimized the risk for preventable anesthetic mortality...” (p. 235). Training with large mammals for voluntary dental care in particular has been successful for killer whales, allowing the removal of food causing gingiva inflammation via a large toothbrush resulting in no further medical attention being required (Graham, 1990). Animals in managed care are living longer, and age-related dental issues are emerging more and more, making dental care all the more critical (Glatt, 2008). Husbandry training with positive reinforcement has been used with white rhinos previously to obtain weights and to perform ultrasonography (Pill, 200; Shaffstall, 2000), but there is not yet a standard of care for voluntary dental examination of this species (Pill, 200;

Shaffstall, 2000). In this case study we describe an application of positive reinforcement training to obtain better visual access to the teeth. This is a prerequisite for voluntary dental care, which could lead to a decrease in the need for dental related immobilizations, avoiding the risks associated with anesthetic events.

## **Method**

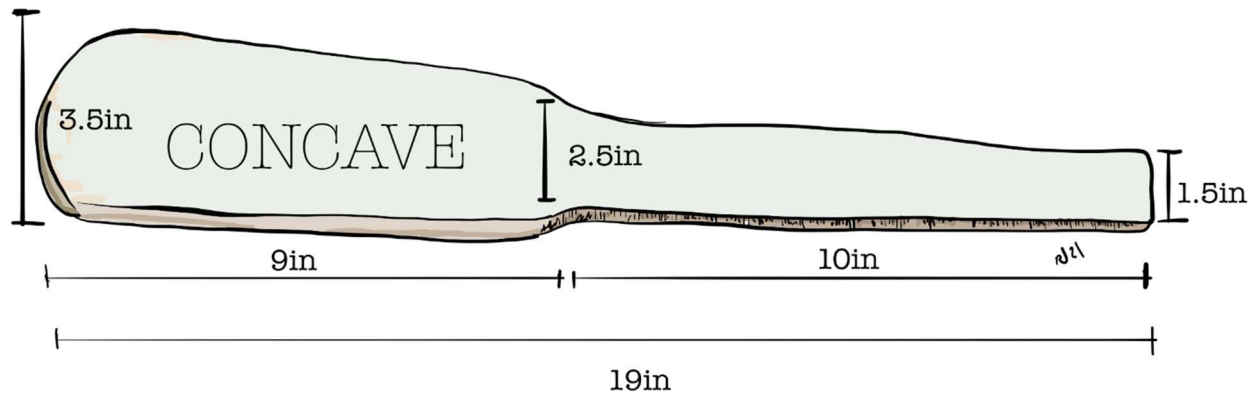
### **Subject**

“Jao”, an approximately 23-year-old female white rhino, came to Disney’s Animal Kingdom® (DAK) in 2007. Jao participates in a Positive Reinforcement Training (PRT) program. Previously trained behaviors include, for example, the use of a target to aid in positioning for visual examinations, and a chute to aid in positioning for voluntary enemas in preparation for voluntary rectal ultrasounds. PRT had been used to train ten behaviors with Jao prior to the oral exam with mouth rinse behavior. Prior to the oral exam training, veterinarians would use an extended flashlight to look in the oral cavity of the rhino while the trainer gave the cue for an open mouth behavior (Figure 1). The unobstructed space between the oral tissues on the left and the oral tissues on the right is approximately four inches. The intraoral tissues obstruct the buccal side of all of the teeth. With regards to Jao, she has been observed holding food on the right side of her mouth and the intraoral tissues on that obstruct more of the view of her teeth. Training is conducted daily for husbandry and medical behaviors by all approved trainers. This training fell within normal animal care practices approved by Disney’s Animal Care and Welfare Committee.

### **Materials**

To expand oral visibility, a specially designed PVC cheek retractor was made from large diameter PVC cut into a paddle-like shape measuring a total of 19 in. The paddle at its widest is 3.5 in. tapered down to 2.5 in. The paddle-like part is 9 in. with a handle that is 10 in. long at a width of 1.5 in (Figure 3). Materials for mouth rinsing include a 500 mL spout wash bottle and a 2-gal handheld pressure sprayer.

**Figure 3**  
*Cheek Retractor*



### Training/Protocol

The final criterion for completing this behavior was to have Jao remain stationary while voluntarily holding her mouth open with the retractor inserted, as shown in steps 5 and 6 in Table 1, in order to agitate debris from the rhino's teeth and gingiva with water, as shown in steps 11-12 in Table 1 (see below). A final training plan of successive approximations with criterion for advancing to the next step in the plan, as shown in Table 1, was followed by trainers noting any changes needed during the process in a local training binder. One trainer performed the PVC pipe acclimation and then performed sessions for the left side of the mouth followed by the right; the left side has more dates and data points than the right side for both the retractor sessions. All quadrants were run concurrently while acclimating to the spout wash bottle and the pressure sprayer. Training sessions lasted approximately five minutes when Jao entered the session voluntarily, (stepping up to the small bollard designated for mouth training and responding to cues given by trainers). If, at any point, Jao left the vicinity of the training area three times and did not return, the session was ended. Jao was offered two stalls (353 square feet each) for the duration of the session. A visual cue (the retractor held in front of the rhino's head) signaled the availability of reinforcement for the rhino opening her mouth and allowing the retractor to be placed inside. Alfalfa hay was considered a high value reinforcement during the shaping process based on previous learned behaviors, but sometimes contributed to food packing in the mouth. Mazuri® Petting Zoo pellets were eventually used as the predominant reinforcement, as it helped keep the mouth cleaner during visual examinations. Reinforcers were delivered directly after the clicker bridge and all oral exam devices were removed. Once the initial step of holding the mouth open for ten seconds with the retractor in the mouth was completed, a verbal signal of "rinse" was given before rinsing the mouth. A spout wash bottle was used as an intermediary

step to introduce oral rinsing before moving on to a pressure sprayer. The behavior was considered complete when the rhino opened her mouth above the small vertical bollard, voluntarily accepted the cheek retractor to be placed in the mouth, and remained stationary with her mouth open while a pressure sprayer sprayed the teeth/gingiva for ten seconds (rinsing both upper and lower molars on both the buccal and lingual sides of the teeth).

### Data Collection

Data collection began on December 7, 2019 and ended on December 5, 2020. Jao was trained up to two times daily, up to 7 days a week. Duration of tool use (water, retractor, etc.) was recorded for each session.

### Results

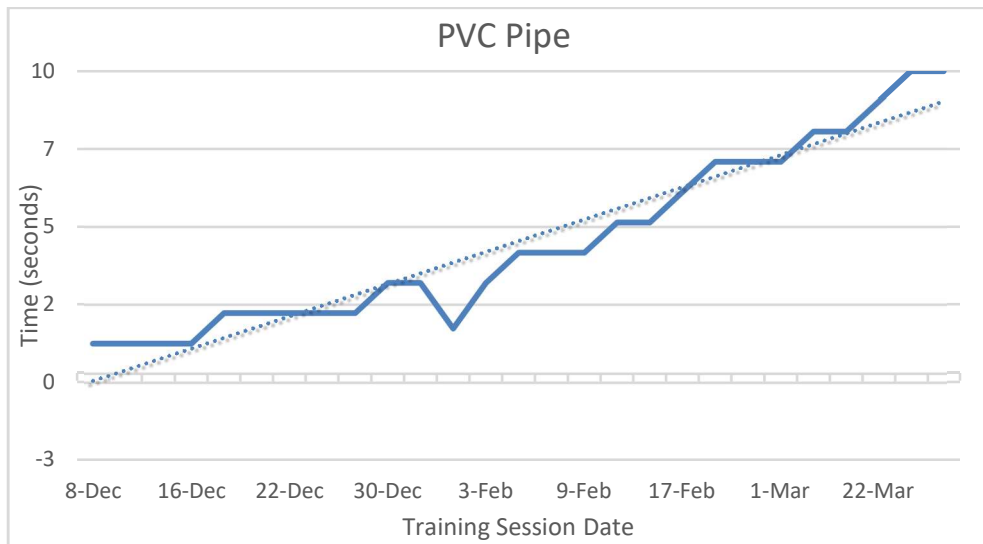
At the conclusion of her training, Jao voluntarily participated in a thorough oral examination at her 2020 dental health evaluation, giving the veterinarian substantial visual access to the teeth (Figure 4).

**Figure 4** *Comprehensive Oral Exam View Post Training*



Pressing the retractor against the intraoral tissues allowed an additional 1.5-2 in. of unobstructed space between the intraoral tissue and the buccal side of the teeth. The buccal side of the first two premolars in each of the quadrants were able to be observed with the addition of the observation of calculus on the upper right premolars. Jao met the criteria for steps 1-3, per Table 1, for five straight sessions for each step before moving on to step 4. Per step four of Table 1, Jao was acclimated to the PVC pipe through daily training sessions over the course of four months, as shown in Figure 5.

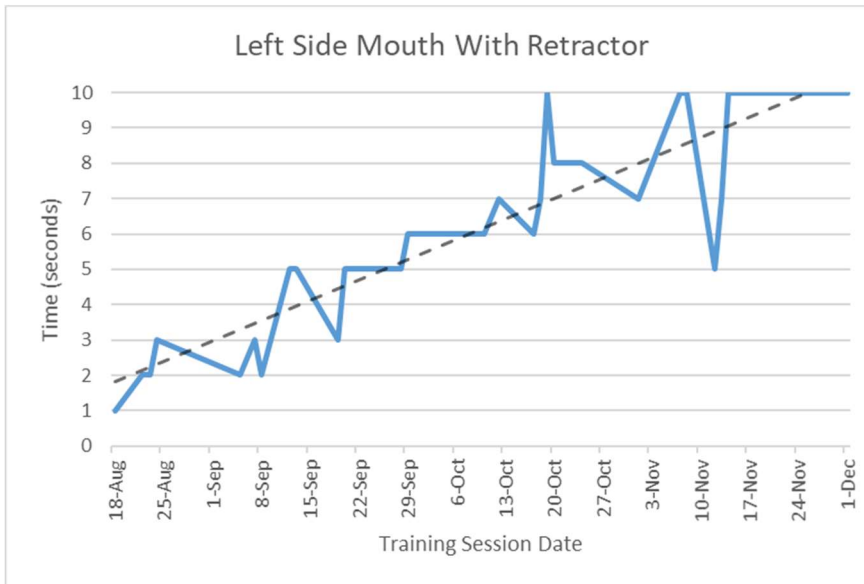
**Figure 5:** *Step 4: PVC Pipe Acclimation Shaping*



Per step five, Jao was acclimated to the PVC retractor on the left side through daily training sessions over the course of four months, as shown in Figure 6.

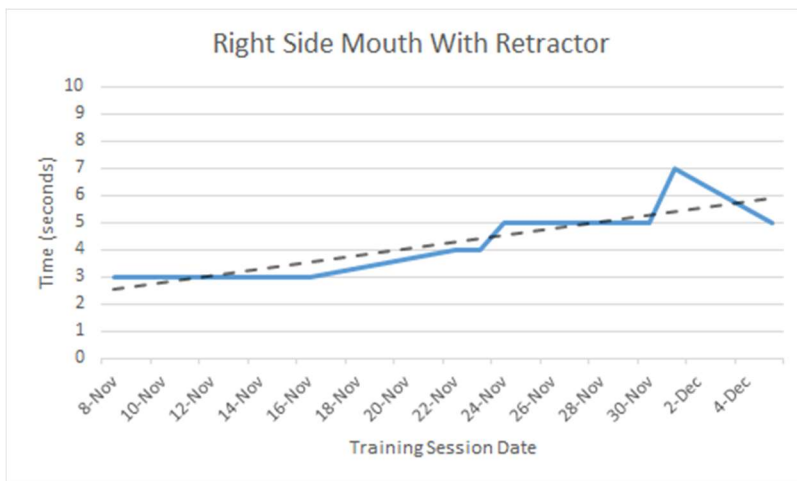


**Figure 6:** *Step 5: Left Side Retractor Shaping*



The right-side retractor was shaped after the left side and has fewer data points (step 6, Figure 7); never reaching the end criteria of ten seconds.

**Figure 7:** *Step Six: Right-side Retractor-Shaping*

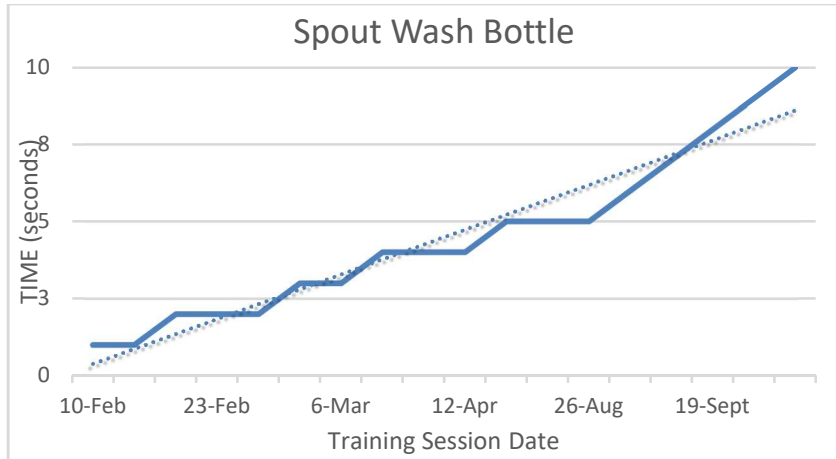


*Note.* The time is the number of seconds that the rhino’s mouth is open. The right side was shaped after the left side and has fewer data points; never reaching the end goal of ten seconds.



Over a seven-month period, all quadrants of Jao’s mouth were acclimated to the spout wash bottle, as shown in Figure 8.

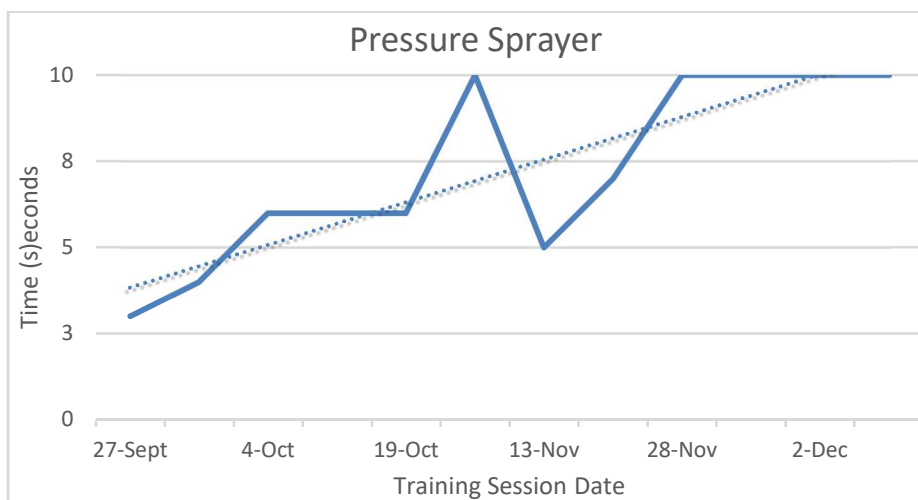
**Figure 8:** Steps 7-10: Spout Wash Bottle Acclimation Shaping



*Note.* All quadrants of the mouth were trained concurrently, only the bottom left quadrant is shown here.

Figure 9 demonstrates the three-month acclimation period in which Jao met the criteria for the pressure sprayer in steps 11-12.

**Figure 9:** Steps 11-12: Pressure Sprayer Acclimation Shaping



*Note.* All quadrants of the mouth were trained concurrently; only the upper right quadrant is shown here.

Each date's data point represents the longest duration per session that Jao met the criteria for each step. The longest duration for each session is represented on the y-axis for each step. Each step was not graphed based on the similarity of the overall graphed representation of the data. As shown in Figure 5 on 15 November, Jao only reached five seconds then closed her mouth instead of the end criteria of ten seconds but continued to participate through the rest of the sessions documented. The training plan was not completed to a duration of ten seconds for the right side of the mouth by the time of the oral examination by the veterinarian, but Jao held her mouth open with the retractor inserted for seven seconds.

## **Discussion**

White rhino annual exams at DAK generally occur in fall and include collecting blood samples, a general physical examination (including the mouth, eyes, etc.), and vaccinations. After training the oral exam and mouth rinse behavior, trainers were able to take pictures of the teeth prior to the exam so veterinarians could focus on specific areas of concern during the exam itself. Trainers were also able to utilize the mouth rinse behavior to rinse the teeth of any debris prior to the exam and then utilized the mouth retractor to give the veterinarian a clear view of all but the three molars on the buccal sides of the teeth.

The dental health of white rhinoceros in managed care has yet to be well described in the literature despite the number of immobilizations due to dental concerns. The process of applying PRT to oral exams has widespread future implications for the dental health of managed white rhinoceros. Based on the improved visual access to rhino teeth, multiple other avenues of training and treatment are open for future exploration.

### **Mouth Flush**

Oral exams can be complicated, as Bermuda grass hay tends to stick to the teeth, significantly altering visibility. A mouth flush will allow a large burst of water into the mouth, ideally with the animal's head in a downward position, to quickly and effectively remove any hay and allow for the best-unobstructed view possible. The trained mouth rinse behavior makes the mouth flush behavior possible.

### **Brushing Teeth**

With an enhanced visual of the teeth of the white rhinoceros now possible, both plaque and calculus/tartar have been observed in multiple rhinos at DAK. Plaque is the colorless film of bacteria and sugars constantly forming on teeth that can be brushed away. Animal care professionals are looking into tools that can be used to brush and rinse away plaque daily to prevent calculus. Calculus/tartar is the hardened plaque that cannot be brushed away requiring dental tools and most likely immobilization. A proactive approach to dental care might assist in preventing the formation of calculus and subsequent periodontal disease.

### **Discussion**

This research has shown that greater visual access to the oral cavity is possible through positive reinforcement training. While preventive oral care in white rhinos is largely unexplored, the successful training of this behavior is a prerequisite for voluntary oral exams with mouth rinsing, and sets the stage for future advancement in the overall healthcare of white rhinos. The increased visual access, using specially designed tools, can help determine individual needs as a diagnostic tool and allow dental tools to aid in the prevention of tooth related issues and decreased frequency of immobilizations needed to resolve these issues. Through the exploration of voluntary dental care in white rhinos, keepers have been able to explore other avenues of care, including measurements of elongated premolars.

### **Acknowledgements**



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**Table 1**




*Oral Exam and Mouth Rinse Approximation Process*

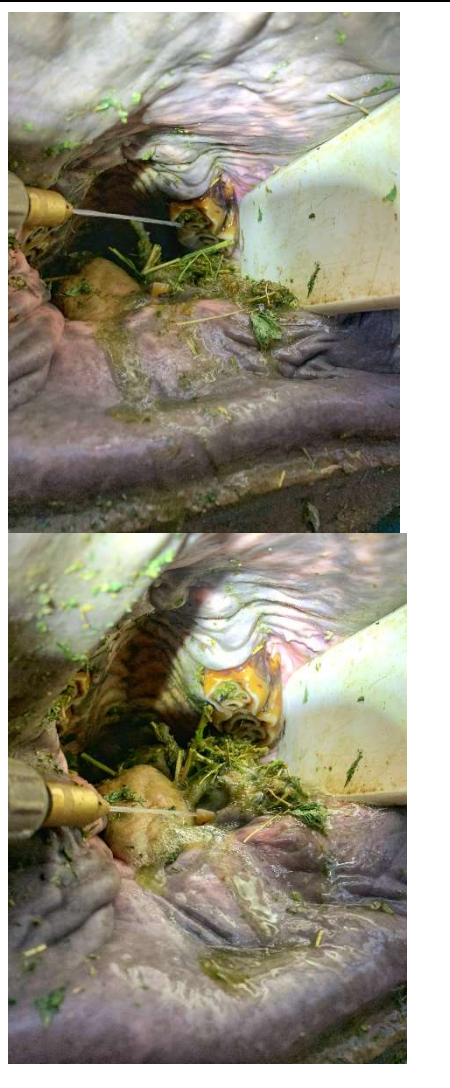
<b>Step</b>	<b>Dental Tools and Procedures</b>	<b>Behavior Criteria</b>	<b>Criterion for Advancing</b>	<b>Photo Reference</b> <i>Images and Video Property of the Walt Disney Company. Cannot be repurposed without permission.</i> <i>Note: Photos taken in off – exhibit holding.</i>
1	Bait rhino to place head between vertical bollards, facing trainer, and on top of the short vertical bollard (36.5in. tall, 3in. wide closed pipe) located at the front of each stall	Places chin on top of small vertical bollard and between long vertical bollards	Places head in proper location when keeper stands in front of the rhino for five straight sessions	
2	Place food in front of the rhino's mouth so that they open and remain open for 10 seconds; eventually remove the bait	Mouth open for 10 seconds	Advance in increments of one second; should complete previous time goal for five straight sessions before increasing time	

3	Touch retractor to muzzle to elicit mouth open behavior	Mouth open for 10 seconds when retractor is held in front of face	Rhino opens mouth as soon as the retractor is shown (without muzzle tactile) for five straight sessions	
4	Place PVC pipe into the open mouth; touching all parts of mouth	Mouth remains open for 10 seconds with tactile inside of the mouth	Advance in increments of one second; should complete previous time goal for five straight sessions before increasing time	




<p>5</p>	<p>Place retractor in quadrants 1 and 2 of the mouth between cheek and buccal surface of teeth</p>	<p>Retractor remains in place for 10 seconds pressing against the cheek to view molars on left side</p>	<p>Advance in increments of one second; should complete previous time goal for five straight sessions before increasing time</p>	
<p>6</p>	<p>Place retractor in quadrants 3 and 4 of the mouth between cheek and buccal surface of teeth</p>	<p>Retractor remains in place for 10 seconds pressing against the cheek to view molars on right side</p>	<p>Advance in increments of one second; should complete previous time goal for five straight sessions before increasing time</p>	
<p>7</p>	<p>Utilize spout wash bottle to rinse teeth in quadrant 1 with retractor in place on right side; requires a secondary trainer for rinsing; add in verbal "rinse"</p>	<p>Teeth rinse for 5 seconds in quadrant 1</p>	<p>Advance in increments of one second; should complete previous time goal for five straight sessions before increasing time</p>	

<p>8</p>	<p>Utilize spout wash bottle to rinse teeth in quadrant 2 with retractor in place on right side; requires a secondary trainer for rinsing</p>	<p>Teeth rinse for 5 seconds in quadrant 2</p>	<p>Advance in increments of one second; should complete previous time goal for five straight sessions before increasing time</p>	
<p>9</p>	<p>Utilize spout wash bottle to rinse teeth in quadrant 3 with retractor in place on left side; requires a secondary trainer for rinsing</p>	<p>Teeth rinse for 5 seconds in quadrant 3</p>	<p>Advance in increments of one second; should complete previous time goal for five straight sessions before increasing time</p>	
<p>10</p>	<p>Utilize spout wash bottle to rinse teeth in quadrant 4 with retractor in place on left side; requires a secondary trainer for rinsing</p>	<p>Teeth rinse for 5 seconds in quadrant 4</p>	<p>Advance in increments of one second; should complete previous time goal for five straight sessions before increasing time</p>	

<p>11</p>	<p>A secondary trainer should use the pressure sprayer to rinse the teeth in quadrant 1 for 5 seconds then quadrant 2 for 5 seconds while the primary trainer has the cheeks retracted</p>	<p>Pressure sprayer rinse for 5 seconds in quadrant 1 and 5 seconds in quadrant 2 while the cheek is retracted for a total of 10 seconds on the left side</p>	<p>Advance in increments of one second; should complete previous time goal for five straight sessions before increasing time</p>	 The image contains two photographs stacked vertically. Both show a close-up of a horse's mouth during a dental procedure. A dental sprayer nozzle is directed at the teeth, which are covered in a greenish-brown dental paste. The horse's lips are held back by a retractor. The top photo shows the sprayer being used on the upper teeth, while the bottom photo shows it being used on the lower teeth.
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12	<p>A secondary trainer should use the pressure sprayer to rinse the teeth in quadrant 3 for 5 seconds then quadrant 4 for 5 seconds while the primary trainer has the cheeks retracted. Reinforcement should be lessened to the use of Petting Zoo (instead of hay) to increase visibility.</p>	<p>Pressure sprayer rinse for 5 seconds in quadrant 3 and 5seconds in quadrant 4 while the cheek is retracted for a total of 10 seconds on the left side</p>	<p>Advance in increments of one second; should complete previous time goal for five straight sessions before increasing time</p>	 The image consists of two vertically stacked photographs. Both show a close-up of a horse's mouth, specifically the area around the teeth and gums. A person's hand is visible on the left, holding a dental mirror to inspect the teeth. A blue pressure sprayer nozzle is directed towards the mouth. The horse's mouth is held open, and there is some green material (possibly hay or a specific feed) visible inside. The background is a blue metal structure, likely part of a horse restraint or stall.
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