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Short communication

Discrimination learning in the white rhinoceros

Joseph C. Daniel [a,*], Peter J. Mikulka [b]

[a] *Department of Biological Sciences, Old Dominion University, Norfolk, VA 23529, USA*
[b] *Department of Psychology, Old Dominion University, Norfolk, VA 23529, USA*

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Abstract

This study examined the ability of two adult white rhinoceroses (*Ceratotherium simum simum*) to develop a visual discrimination between an open circle and a triangle. These stimuli were presented as black symbols on large white cards. The cards were presented 4.6 m apart and a food reward was given if the subject approached the open circle. Ten discrimination choices were given daily until each subject reached the criterion of 80% correct responding over a block of 50 trials. The female reached the criterion over trials 151–200, while the male required considerably longer (trials 501–550). The male's discrimination was dramatically affected by a shift in the food reward. This study demonstrates that these rhinos were able to develop a successful discrimination and this protocol could be used to further examine their visual acuity.

Keywords: Rhinoceros; Learning

1. Introduction

A modest literature exists regarding training of captive rhinoceros: This consists of operant conditioning to voice commands for moving, standing stationary and positioning body parts with respect to a target location, and promoting tolerance to medical procedures such as blood collection, taking rectal temperatures, ultrasonography, and physical examination of skin, eyes, mouth, feet, etc. (e.g., Eyres et al., 1995; Grams and Ziegler, 1995; Michel and Illig, 1995). Also, some circus training has been possible (e.g., Reynolds, 1968; Rookmaaker and Reynolds, 1985), typically involving tricks such as climbing stairs, pulling wagons, retrieving objects or vocalizing on command and permitting a keeper to mount and ride them. Only one report exists, however, involving

* Corresponding author.

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an empirical study of their discrimination learning abilities (McCain and Stepter, 1968). Using a pair of juvenile black rhinoceroses (*Diceros bicornis*) in the Dallas Zoo, these investigators showed that the subjects could gradually learn to discriminate between black and white cards and symbols when the 'correct' choice was reinforced with a food reward. The goal of the present research was to expand the body of knowledge about the learning capacity of rhinos, specifically the ability of the southern African white rhino (*Ceratotherium simum simum*) to develop a visual discrimination.

2. Animals, materials and methods

2.1. Subjects

The subjects for this research were two adult African southern white rhinoceroses housed at the Virginia Zoological Park in Norfolk. The male, Rufus, and the female, Jesse, were in their mid-twenties and had been housed together since arriving at the park as calves in 1974.

2.2. Methods and materials

This research consisted of three phases. Phase One adapted the rhinos to the experimenters and shaped the response of approaching the stimulus card for a food reward. During Phase Two, the animals were trained on a two-choice visual discrimination between a triangle and an open circle until an 80% performance criterion was reached. If the rhinos were successful in Phase Two, then a subsequent discrimination test (Phase Three) was conducted between the 'open' circle, Landolt ring (Landolt, 1889), and a closed circle.

The stimuli were painted on white laminated plastic cards, 61 cm square. The stimuli were painted black; the lines that formed the stimuli were 5 cm wide. One stimulus was an open circle resembling a 'C' with a 15 cm opening and a 35.5 cm diameter. The other stimulus was an isosceles triangle, 40.6 cm on a side.

In Phase One, the animals were introduced to a blank white card, the same dimensions as the test cards. It was presented to each animal at eye level coincidental with the blowing of a whistle to capture the subject's attention. When the subject came to the card, the card was removed as the animal was rewarded with grain pellets (Lee Feeds Herbivore Diet 9034, Stevens Milling, Broadway, NC) or bread. A number of food rewards were tried (e.g., carrots, apples, bread and pellets) and the subjects seemed most responsive to the food pellets. The subjects were tentative at first, but by the sixth day both rhinos were responding reliably to the card and whistle. Each animal was shaped and tested individually.

In Phase Two, the same general protocol was used. Each morning, at least 1 h before the park opened to the public and before being fed, the two rhinos were separated by permitting one to go into the shelter room (8.25 m deep by 11.8 m wide) while leaving the other in the overnight holding room (6.33 m across the front and 6.17 m deep). When either rhino walked to the middle or the far side of its enclosure, the whistle was blown and two assistants placed the cards about 4.6 m apart against the inside of the

heavy metal bars that defined the keepers' walk (Fig. 1). The correct card for both rhinos contained the open circle. The circle was used as the correct stimulus in anticipation of using it as the target in a subsequent discrimination. When the test subject touched the card with their lips or horn or stopped within 12 cm of either card, the trial was terminated. If the correct card was selected, a handful of pellets (6–7) was placed in front of the card.

After each trial, the animal was lured to the back of the enclosure by a similar food treat (3–4 pellets). Once they had consumed that treat, another trial was begun, care being taken that the subject was as close to a center position as possible before the signal whistle was blown. The number of correct responses out of ten trials per day was recorded and this procedure was repeated daily for the duration of this study, or until at least 80% performance was achieved over a 5-day (50 trials) block. The probability of

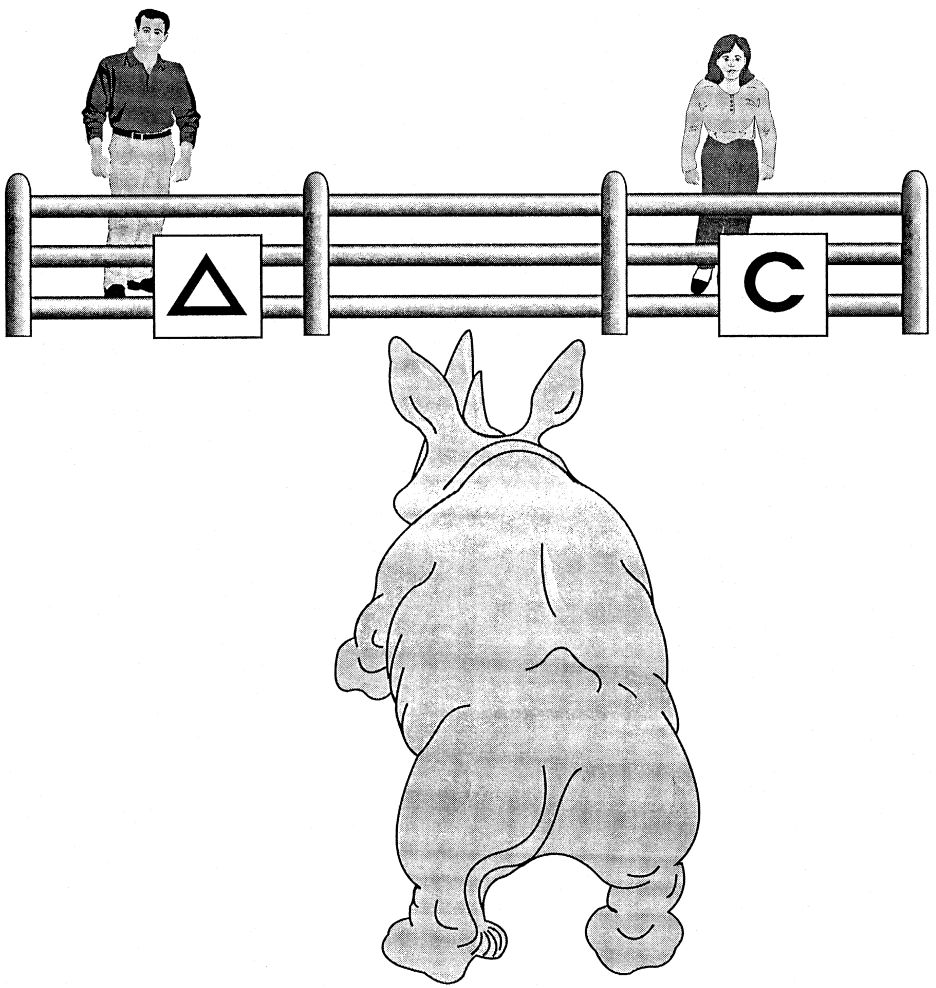

Fig. 1. A diagram of the experimental context.

this criterion performance with respect to chance responding was $p < 0.0001$. Once the criterion was reached, both subjects were continued for an additional 5 days to assess the stability of the performance criterion. Six assistants were used over the course of this study and they varied from day to day. Also, the assistants shifted positions independently of the pattern of correct card location. The location of the cards was changed from side to side in a random manner generated daily by the experimenter. These manipulations assured that the animals were responding to the card and not to one side or to a specific assistant.

Once a successful discrimination (Phase Two) was established, we attempted to define the limits of visual discrimination. For this the same open ring used above was paired with a circle of the same size. If the rhino could successfully discriminate between the two, then the 'gap' in the ring would be made progressively smaller until the subject could no longer see the gap, and thereby provide an assessment of acuity. Due to time constraints and other zoo operations, only Jesse was able to be tested on this subsequent discrimination.

3. Results

The results of the initial experiment are shown in Fig. 2. Jesse reached the 80% performance criterion by the fourth block (trials 151–200). It is clear that she was able

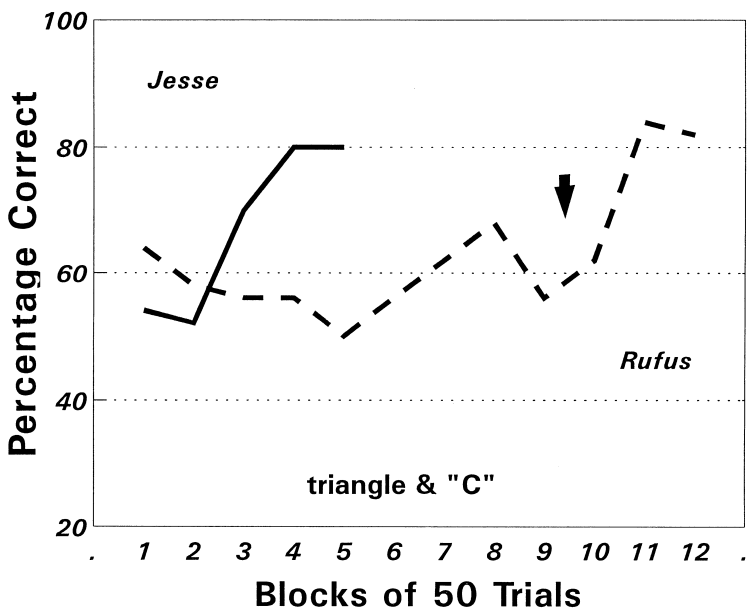

Fig. 2. The figure presents the percentage of correct choices over training blocks. Each training block is composed of 5 days of training (10 trials per day). The solid line represents the performance of Jesse, while the dashed line represents the performance of Rufus. The arrow indicates the point at which the reinforcement was changed for Rufus from food pellets to bread.

to discriminate between the stimuli, responding between 70% and 90% correct each day over the last 2 blocks or 100 trials (mean = 80%) in comparison to her performance over the first 100 trials (mean = 53%). In contrast, Rufus showed little evidence of any learning over the first 250 trials. He was far less cooperative than Jesse. In an attempt to simplify the discrimination, the isosceles triangle was filled in (a solid black form) and he was tested again for an additional four blocks (200 trials) using the solid triangle against the open ring. His performance still remained below criterion and he responded sluggishly to the rewards. Earlier, he had readily accepted the pellets, but at this point, the reward was changed from the pellets to bread (indicated by the arrow in Fig. 2). Thereafter, his performance quickly improved and he reached the criterion within 100 trials of the reward shift. His daily performance over the last 2 blocks (100 trials) ranged from 70% to 100% with a mean of 83%.

Following her mastery of the first symbol discrimination exercise, Jesse was given the second discrimination between the open and closed circles. After 25 days (250 trials), she continued to perform around chance and this test was abandoned.

4. Discussion

In the recently published Rhinoceros Husbandry Resource Manual (Fouraker and Wagener, 1996), the authors indicate that three to five months of 10–30 min sessions/day was required to train a rhinoceros for daily blood collection and up to nine weeks for one to remain stationary on command. The results reported here with white rhinos and those of McCain and Stepter (1968) with black rhinos suggest that rhinos are more amenable to training. In both of these studies, the animals reached a performance criterion within a few weeks. The success of training depends on the choice of task, the intensity of the trial sessions, and clearly the need for the appropriate incentive. This latter is evidenced by the rapid improvement of Rufus contingent upon an incentive shift.

Our results compare favorably with the findings of McCain and Stepter (1968). They found a discrimination between black and white cards formed within 165 trials (15 per day) and a follow-up discrimination between a circle and triangle took 270 trials. Their asymptotic levels ranged from 77% to 91% for these two discriminations. These similarities were found despite the difference in genera, the juvenile black rhinos used by McCain and Stepter, other differences in experimental protocols and sizes of the stimuli.

While conducting this research, several conditions were identified that disrupted the animals' performance. Low-frequency noise, such as produced while an arc welder was used to repair an access door, caused the animals to become agitated, moving constantly around the room and failing to respond to the whistle signals. Similarly, when Jesse was in estrus both animals were hyperactive. However, despite these difficulties, the present findings indicate that these animals are tractable and can be profitably used to examine perceptual abilities.

The task posed by the Landolt ring may have been beyond Jesse's visual acuity or she was not attending to this dimension. The gap in the Landolt Ring card was 15 cm

and it is hard to believe that a rhino cannot distinguish this difference. In earlier visual acuity studies, Daniel (1994) showed that rhinos could see and respond to a life-sized image of another rhinoceros at least 100 ft away. At that distance such an image would occupy about 15 cm in the visual field. It is more likely that one or more of the other test conditions impaired performance. One difficulty was the low level of illumination present inside the facility. The issue of rhino visual acuity is important and further research should begin with a much larger gap and vary the orientation of the opening rather than always in the 'C' position. If evidence of a discrimination can be established, then an acuity threshold can be established by varying the sizes of the gap.

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