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# Utilizing Scents as Environmental Enrichment: Preference Assessment and Application with Rothschild Giraffe

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**Abstract** - Zoological institutions use environmental enrichment to increase opportunities for animals to engage in species-appropriate behavior. In these facilities, enrichment for giraffe typically consists of different types of feeders to increase the percentage of time spent foraging. The current study explored the use of scent enrichment as a way to increase exploration, activity levels and space use in zoo-housed Rothschild giraffe. Study one investigated the preferences of individual giraffe to six scents while study two investigated how scent enrichment affected behavior when applied in their main exhibit. Results suggest that there are individual differences in scent preference in giraffe and that scents can be used to decrease inactivity and alter exhibit utilization in the short-term. If provided in appropriate areas, depending on the species, scent enrichment may promote a better experience for zoo visitors by bringing the animals closer to the viewing areas while benefiting the animals. Future research is still needed to better understand the effects of olfactory enrichment on zoo animals.

**Keywords** – Animal management, Visitor experience, Exhibit use, Olfactory, Behavior, *Giraffa camelopardalis rothschildi*

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Environmental enrichment is utilized within zoological institutions to provide opportunities for animals to engage in species-appropriate behaviors. The goal is to provide an animal with opportunities to exhibit behaviors that they are naturally motivated to perform (Carlstead & Shepherdson, 2000). This in turn can improve the welfare of the animal by ensuring we are meeting their behavioral needs (Friend, 1989). Research in a variety of situations has shown that the inability to perform certain behaviors can compromise an individual's welfare (Dawkins, 1990; Friend, 1989). Environmental enrichment is commonly used to try and reduce abnormal behavior (Swaisgood & Shepherdson, 2005). However, reviews of available literature have demonstrated that enrichment targeting one specific problem has never been shown to completely eliminate abnormal behavior (Mason, Club, Latham, & Vickery, 2007).

Sensory stimulation has been increasingly investigated for its potential as enrichment for species exhibited in zoos (Clark & King, 2008; Wells, 2009). Examples include using different scents to increase exploration (e.g., Wells & Egli, 2004) or playing natural sounds to decrease stereotypic behavior (e.g., Clark & Melfi, 2012). Olfactory enrichment has been recognized as an effective way to promote exploration and increase activity levels in primates, wild cats, and deer found in zoos (Clark & King, 2008). Many zoo environments are sterile or predictable which highlights the importance of increasing sensory stimulation (Marriner & Drickamer, 1994). Introduction of a novel scent can reduce the predictability of a zoo exhibit and lead to opportunities for exploration. Studies suggest that increased quantity and variety of stimulation in zoo environments also impact the behavior of species exhibited in

zoos. For example, giraffe and okapi were less likely to exhibit stereotypic behaviors if they had experienced an environmental change in the previous year (Bashaw, Tarou, Maki, & Maple, 2001).

The most common stereotypic behaviors performed by giraffe in zoo environments include tongue rolling and repetitive licking of nonfood objects (Bashaw et al., 2001). In the past, research on giraffes has primarily focused on decreasing oral stereotypic behaviors by providing foraging enrichment (Bashaw et al., 2001). For example, complex puzzle feeders are used to elicit foraging behavior observed in wild giraffe, which requires complex tongue manipulations to gain access to resources (Fernandez, Bashaw, Sartor, Bouwens, & Maki, 2008). However, the puzzle feeders simply focus on foraging behavior and do not address other species-appropriate behaviors that could be important for giraffe.

Preference assessments have been utilized primarily in the field of applied behavior focused on children with severe behavior or autism (e.g., Piazza, Fisher, Hagopian, Bowman, & Toole, 1996). However, within the field of animal welfare, preference assessments are becoming more common to help determine the value of different aspects of an animal's environment (e.g., Mehrkam & Dorey, 2014). Environmental enrichment can lead to higher levels of welfare for animals and even increase reproductive success (Meagher et al., 2014). Understanding individual preferences regarding enrichment can then provide a greater opportunity to ensure each individual animal is thriving. The current study examined scent preferences in Rothschild giraffe at the San Diego Zoo Safari Park and the effect of preferred versus non-preferred scents on behavior. The goal was to examine the short-term impact of scents on giraffe behavior and exhibit use as potential indicators of animal welfare.

## Experiment 1

### Method

Preference tests were conducted on 4 female and 1 male Rothschild giraffe (Table 1). All subjects were at least 7 years old at the time of data collection. Preference assessments were conducted in the giraffe boma where the animals remained for the duration of the trials (Figure 1). This area was chosen in order to examine the individual preferences of giraffe in a controlled environment without social influence from other individuals. In a hierarchical system, animals that are more dominant could gain access to preferred areas during data collection impacting the results (Young & Isbell, 1991). Subjects were each allowed a minimum of two days in the experimental area with the preference test set-up to habituate to the testing system before data collection began.

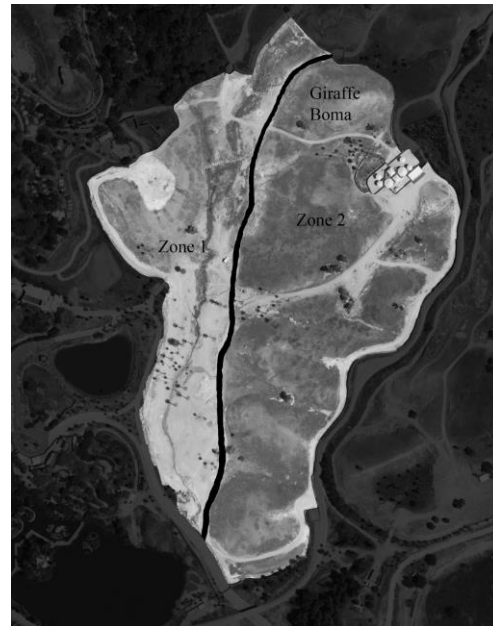


Figure 1. Map detailing the location of the giraffe boma and two different zones for the study.

Table 1

*Subjects for the Study Examining Scent Preferences and Effects on Behavior*

Subject	Age	Sex	Experiment 1	Experiment 2
G1	16	F		X
G2	13	M	X	X
G3	12	F		X
G4	10	F		X
G5	4	F	X	X
G6	4	F	X	
G7	3	F		X
G8	3	F	X	
G9	3	F	X	
G10	1	F		X
G11	1	F		X
G12	1	M		X
G13	1	F		X
G14	1	M		X

The scents used for the preference assessment included rose oil Bulgarian and ginger oil (Essential Oil Company, Portland, OR), and vanilla, orange, mint, and banana extracts (McCormick & Company, Inc. Sparks, MD). All extracts and oils were diluted at 1 ml of extract or oil to 31 ml of distilled water. Two empty, round plastic containers each with a radius of about 7 cm were attached securely to the outside fencing of the enclosure about 4 m off the ground and approximately 1 m apart. Containers that fit snugly into the ones already attached were filled with 30 ml of the approved scent and water mixture. During the trials, each scent was covered with a screw-on lid with small holes in the top to allow for scent dispersion without allowing the subject direct access to the liquid in the container.

Preference tests were conducted on weekdays from June 14, 2010 to July 8, 2010, between 12:00 and 13:00 with each trial lasting 10 min and 5 min intervals between trials. Scents were randomized using a counterbalanced design. Two scents were presented per trial with each scent appearing in the left and right containers an approximately equal number of times. This resulted in 15 trials that were randomized over 8 days per subject with a maximum of two trials per day (Table 2). Each subject's behavior was observed from a nearby location to minimize observer effects. Observations were made from a different location within the boma approximately 10 m away from the subject and with visual obstruction by large wood panels. The duration of time spent interacting with the left or right container was recorded for each approach, as well as the total number of times a subject approached either container. Interacting with a scent was defined as standing unmoving and extending the nose less than one meter from the scent, flehmen or flaring the nostrils less than one meter from the scent, or licking the container. Preference data were examined using descriptive statistics due to the small sample size. Results are summarized in terms of number of bouts and total duration of time interacting with each of the scents. Binomial test was used to determine if any bias was observed between the left and right containers.

Table 2

*Randomized Scent Distribution for Preference Assessment*

Trial	Left Scent	Right Scent
1	Vanilla	Rose
2	Mint	Rose
3	Vanilla	Banana
4	Ginger	Banana
5	Ginger	Mint
6	Mint	Orange
7	Ginger	Vanilla
8	Mint	Banana
9	Banana	Orange
10	Banana	Rose
11	Orange	Ginger
12	Rose	Orange
13	Rose	Ginger
14	Vanilla	Mint
15	Orange	Vanilla

## Results

Subjects showed no bias toward the right or left container based on a binomial test ( $p = 0.55$ ). In general, the giraffe spent the most time ( $M = 79.2 \text{ s} \pm 61.4 \text{ SD}$ ) and greatest number of bouts ( $M = 7.2 \pm 3.4 \text{ SD}$ ) investigating the rose scent (Figure 2). Individual differences were observed with three individuals spending the most time with the rose scent, one with the orange scent, and one with the banana scent (Figure 3).

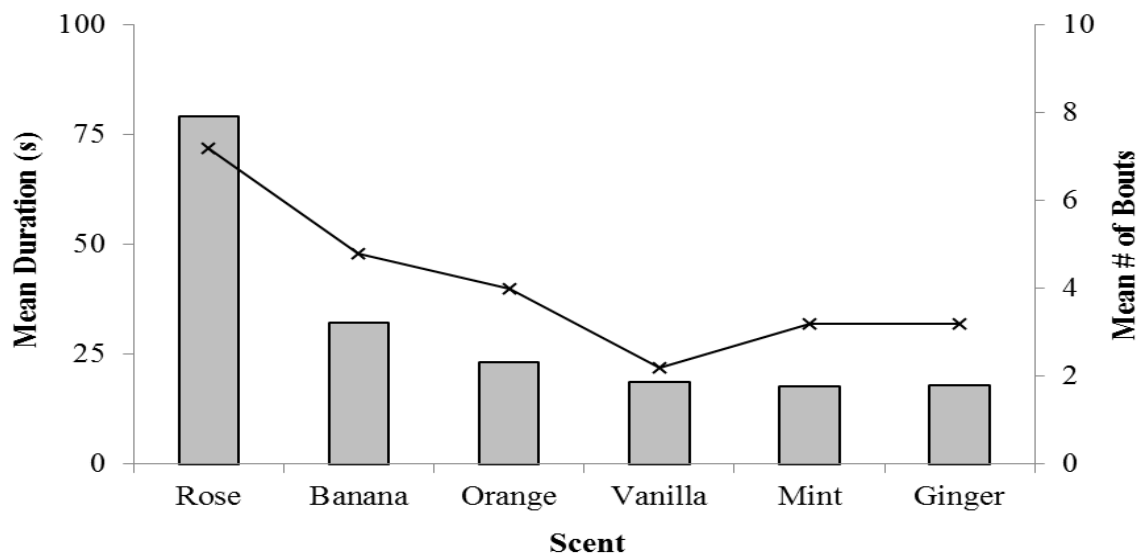


Figure 2. Differences in duration and number of bouts spent with each of the different scents.

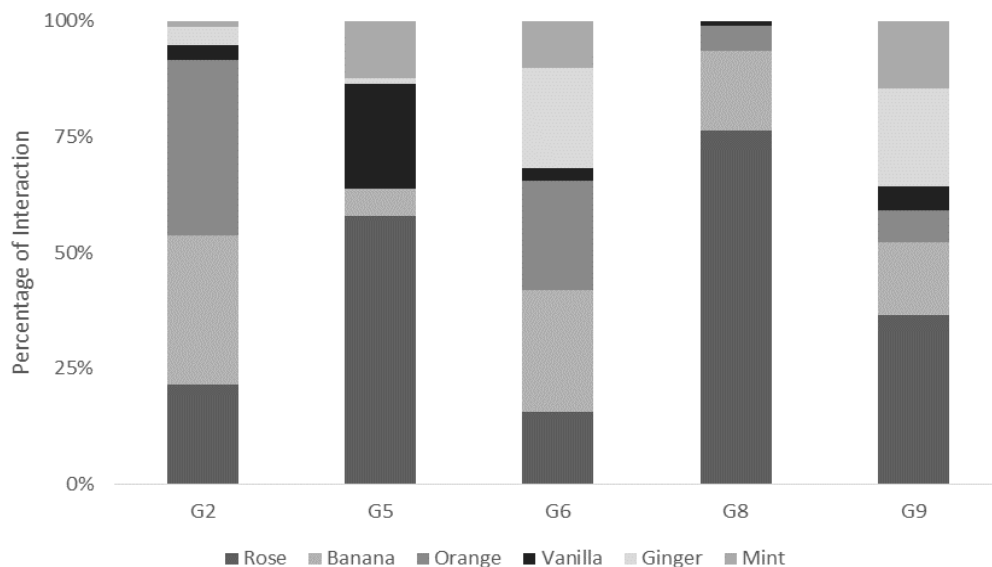


Figure 3. Differences in duration and number of bouts spent with each of the different scents.

## Experiment 2

### Method

The subjects included eight female and three male Rothschild giraffe (Table 1). The giraffe share a 4050 m<sup>2</sup> exhibit with cape buffalo (*Syncerus caffer*), Defassa waterbuck (*Kobus ellipsiprymnus defassa*), East African sitatunga (*Tragelaphus speki*), fringe-eared oryx (*Oryx beisa callotis*), Grant's gazelle (*Nanger granti*), Kenya impala (*Aepyceros melampus melampus*), Nile lechwe (*Kobus megaceros*), southern white rhinoceros (*Ceratotherium simum simum*), Thomson's gazelle (*Eudorcas thomsonii*), Uganda kob (*Kobus kob thomasi*) and East African crowned cranes (*Balearica regulorum gibbericeps*). The enrichment offered to the herd on a regular basis consisted of feeders made of mesh wire, acacia browse hung in two locations, carrots, and herbivore pellets scattered throughout the exhibit in feeding troughs and fake tree stumps. Diet and enrichment provided to subjects was consistent throughout the study.

Giraffe were observed on weekdays from June 14 through August 6, 2010 in their outdoor exhibit from a raised observation platform that allows a view of the entire enclosure. Data were collected in two-hour sessions from 10:00 and 12:00 and from 15:00 to 17:00. These observation times were chosen to maximize observed activity, as preliminary observations showed the giraffe to be most active in the morning and late afternoon. Behavioral states of each subject were recorded using instantaneous sampling at one-minute intervals, while specific behavioral events were recorded using all occurrence sampling (Table 3). Each subject was observed for five minutes during the 2-hour observation, and the location of the subject was recorded at each minute. The exhibit was divided into two sections to examine space use (Figure 1). The order in which subjects were selected for observation was randomly selected each day.

Baseline data were collected for four weeks before the introduction of scents from June 14 to July 9. Data collection methods were identical before and after scent introduction. Scents were applied to the exhibit using a 95 ml spray bottle to spray approximately 4 ml of diluted extracts into the air and onto the ground around the observation point. From July 12 through August 6, the scents were introduced at 8:30 every other morning with observation sessions beginning 30 min after scent introduction. A distilled water control was sprayed into the enclosure using the same method on days when scents were not

introduced to ensure animals were responding to the scent as opposed to the spraying process. Neither scents nor water was introduced on non-observation days.

All data were examined to look for normal distributions. In order to decrease the number of variables, the behavioral events were clumped based on *a priori* categories. Due to small sample size and a skew in the data, a Friedman's test was used to look for significant differences in location and behavior between baseline, scent, and control (distilled water) periods. Wilcoxon's signed-ranks test was used to follow up on significant differences from the Friedman's test to determine where differences exist. Spearman's correlation coefficient was used to examine relationships between duration of time spent interacting with scents in Experiment 1 and behavior in Experiment 2. For all statistical tests alpha level was set at  $p < 0.05$ .

Table 3

*Ethogram used for the Study*

Behavioral Events	
Self Maintenance	
Groom Self	scratching of the body using any limb or teeth, licking of the body with tongue
Rub against object	rubbing of any body part against a vertical object
Urinate	urinating in a standing position with tail extended away from the body for females, legs spread apart for males
Defecate	defecate with tail extended away from the body while stationary or walking
Social Behavior	
Groom other	licking or cleaning another giraffe using tongue or teeth
Rub against other	rubbing of any body part against another giraffe
Greet	using the nose to touch the nose of another giraffe
Olfactory Communication	
Test urine/feces	smelling or tasting the urine or feces of another giraffe
Flehmen	curling of the upper lip to expose gums as part of an olfactory investigation
Stereotypic Behavior	
Tonguing	expelling tongue from mouth and moving it side to side in the air
Licking non-food	licking of inanimate objects, such as gates, walls or doors
Behavioral States	
Rest/stand	subject is standing or lying down
Locomote	subject travels in a direct route from one location to another by walking or galloping
Social	subject is engaged in any affiliative behavior listed on the ethogram
Play	subject is chasing or interacting playfully with other animals in the area
Explore	traveling from one location to another while smelling or tasting the air or ground
Other	subject is engaged in a behavior not listed on the ethogram
Not visible	subject is out of sight

## Results

The majority of the behavioral states of the giraffe were not affected by the addition of scents. This included social ( $\chi^2 = 2.364$ ,  $df = 2$ ,  $p = 0.307$ ), play ( $\chi^2 = 0.452$ ,  $df = 2$ ,  $p = 0.798$ ), explore ( $\chi^2 = 2.513$ ,  $df = 2$ ,  $p = 0.285$ ), and locomotion ( $\chi^2 = 0.182$ ,  $df = 2$ ,  $p = 0.913$ ). In addition, none of the behavioral event categories were significant between the conditions (social:  $\chi^2 = 1.442$ ,  $df = 2$ ,  $p = 0.486$ ; self maintenance:  $\chi^2 = 2.205$ ,  $df = 2$ ,  $p = 0.332$ ; olfactory:  $\chi^2 = 1.167$ ,  $df = 2$ ,  $p = 0.558$ ; stereotypic/abnormal:  $\chi^2 = 0.000$ ,  $df = 2$ ,  $p = 1.000$ ). There was a significant difference observed for the

behavioral state of rest/stand ( $\chi^2 = 7.818$ ,  $df = 2$ ,  $p < 0.05$ ) and time spent in Zone 1 ( $\chi^2 = 8.512$ ,  $df = 2$ ,  $p < 0.05$ ). Follow-up analysis revealed that the giraffe spent significantly less time standing in both the scent condition ( $z = -2.578$ ,  $n = 11$ ,  $p < 0.05$ ) and control condition ( $z = -2.134$ ,  $n = 11$ ,  $p < 0.05$ ) and more time in Zone 1 in the scent condition ( $z = -2.667$ ,  $n = 11$ ,  $p < 0.01$ ) when compared to the baseline condition.

There was also a correlation between percentage of time spent in Zone 1 with the specific scents and the duration of time spent with each scent from Experiment 1 for subject G3 ( $r_s = 0.845$ ,  $n = 6$  scents,  $p < 0.05$ ). The percentage of time spent in the behavioral state of rest/stand with specific scents was not correlated with the duration of time spent with each scent from Experiment 1 for subject G3 ( $r_s = 0.314$ ,  $n = 6$  scents,  $p = 0.899$ ). Subject G5 showed no significant relationships between percentage of time in the behavioral state of rest/stand for specific scents compared with duration of time spent with each scent during Experiment 1 ( $r_s = 0.075$ ,  $n = 6$  scents,  $p = 0.888$ ) and spent no time in zone 1 during the scent treatments.

## Discussion

The goal of environmental enrichment is to provide animals with opportunities to engage in species-appropriate behavior. In the current study, the addition of different scents resulted in an increase in time spent in the location closest to scent dispersal and decreased the amount of time animals were standing and resting. While no changes were found in behaviors indicative of exploration (e.g., sniff) there was a significant increase in time spent in the location closest to the scent. In this case, perhaps location could be used as a proxy for exploration as there was a significant change in exhibit utilization. This suggests that olfactory enrichment in the form of scents might be an appropriate animal management technique to decrease predictability and introduce novelty into a zoo environment. While there are currently no published studies of the effect of olfactory enrichment on giraffe behavior, similar studies have been carried out on other species within zoos. Olfactory enrichment has been shown to successfully increase exploration of the immediate environment and decrease inactivity (Wells, 2009). For example, nutmeg, catnip and body odor of prey were all found to increase activity levels and exploration in black-footed cats (Wells & Egli, 2004). The results from this study support the success of olfactory enrichment to promote exploration for animals within a zoological exhibit.

The current study also demonstrated differences in individual responses to scents both in the preference test and when the scents were introduced into the exhibit. The preference assessments were able to predict which scents would have the largest impact on one individual. Different individuals within the same species often respond differently to olfactory enrichment, possibly due to gender or age differences (Clark & King, 2008). Occasionally the introduction of a novel scent can induce stereotypic or anxiety-related behaviors, for example, stress and jumpiness in tapirs exposed to jaguar urine (Clark & King, 2008). The introduction of scents to the giraffe exhibit did not result in adverse behaviors; there was no change in the amount of time spent performing self-maintenance or stereotypic/abnormal behaviors. More information is needed to better understand individual differences in response to scent enrichment and the ability for preference assessments to predict which will be most effective in impacting behavior in a positive fashion. In addition, future research should explore the long-term impacts of scent enrichment on behavior as effects could change over time. The experimental design would also be changed in the future to improve the accuracy of the study by placing the two testing cups for the preference assessment further apart to avoid ambiguous behavior. However, during the preference tests, the subjects did not approach the center location between the two scent containers or display ambiguous preference behaviors, suggesting that the results from the current study are valid.

The effects found in the current study may also have larger implications outside of determining the effectiveness of scents as enrichment. Introduction of novel scents near a main observation point resulted in the giraffe spending more time in areas where they were visible to visitors and less time standing/resting. This more intimate experience for zoo visitors, combined with opportunities to observe the animals engaged in species-appropriate behavior would likely lead to a more positive experience and

possibly result in repeat visitorship or recommending the exhibit to others (Miller, 2012). This could help ensure a continued source of revenue for zoological institutions, which can be used to fund further conservation efforts.

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