Behavioral Effects on *Cavia porcellus* in an Environment Manipulated by Color

John Bowne High School

63-25 Main Street

Flushing, NY 11367

Cristina Jerez and Joshua Ibarrondo

Senior Honors Agriscience

Category: Animal Systems

Agriculture Division

Abstract

Guinea pigs have been one of America's favorite small domesticated pet for decades. Very little research has gone into guinea pigs, pertaining to their color preference. Guinea pigs are one of the very few animals that can distinguish the difference between two or more colors. Knowing a guinea pigs color preference can help future pet owners and researchers know what colors they should include in their guinea pig's habitat. Studies show that research behind guinea pig preference has substantial results and play important roles in completing a similar goal, making a guinea pig feel comfortable in its own environment.

Guinea pigs were placed in a large cage filled with bedding, colored food bowls and colored water bottles. Guinea pigs with various ages and sexes showed similar behavioral patterns during three months, preferring the color yellow regardless of age and sex. The theory behind this experiment assumed that guinea pigs favored the color green rather than colors yellow, blue or red. Green is a color guinea pigs are familiar with in the wild as well as the green foods that they consume, but results suggest that guinea pigs prefer a different color than green. Conclusions drawn from the results suggest that guinea pigs do well in an environment surrounded by a food bowl colored yellow and a water bottle colored blue. Further research can study their behavior with the color yellow and blue by studying how the guinea pigs, of all sexes and breeds; react towards a yellow food bowl and a blue water bottle over a period of time.

Introduction

Guinea pigs are one of many animals Americans love to keep as pets. They are commonly mistaken for being rodents, when in fact they are *cavia porcellus* (cavies.) They have a life span of four to seven years. They were domesticated in South America and raised as a food

source. By the 1500s they were selectively bred as pets and laboratory animals. Guinea pigs are commonly used in research as well as in many different laboratory experiments. Few studies have been conducted to their preference and behavioral reaction to color. Guinea pigs can distinguish between certain objects and are in fact not color blind. Guinea pigs also have been known to exhibit personality through behavior and interactions within their environment. Guinea pigs have a variety of different behaviors which mean many different things and can possibly compare that to which colors they prefer or are attracted to. Finding the preference and behavioral reaction of guinea pigs will improve the environment in which guinea pigs are house in research and in the pet trade. It will also show which colors make guinea pigs happier and what colors to include in an environment.

Literature Review

Previous Research

Guinea pigs are biologically similar to humans, which make them useful in many fields of research. In 1882, guinea pigs led to the identification of Mycobacterium tuberculosis which is the cause of tuberculosis. Guinea pigs are used as model animals for immunological studies, auditory research, and respiratory diseases including asthma. Guinea pigs susceptibility to infectious disease makes them a good sentinel animal for tuberculosis, Q fever and Listeria. Guinea pigs also lack the ability to manufacture their own vitamin C and require an outside source of vitamin C in the form of vegetables or fruits. Guinea pigs require a source of vitamin C in their diet and high levels of other nutrients such as folic acid and potassium (as do humans), which makes them a good model for nutritional research. Guinea pigs are one of the easiest animals to use in research because just like all small rodents, they are easy to take care of.

There are many factors that can cause error in an experiment such as, the type of bedding used. An article titled, “Preference of Guinea Pigs for Bedding Materials: Wood Shavings Versus Paper Cutting Sheet” explains that guinea pigs, unlike other small rodents, are more sensitive to how the bedding actually affects them. “During animal breeding and experimentation the bedding material is an important environmental factor, not only for the animal health and welfare, but also because it causes biased experimental results. Many studies have investigated with the effects of raw materials, forms, structure, and bedding on laboratory mice and rats, but few have shown effects of bedding materials on guinea pigs and rabbits.”(Kawakami et al., 2003)

Do to all the previous research, guinea pigs are relatively easy animals to take care of. Guinea pigs are lively, gentle and responsive pets, particularly if handled frequently at a young age. Guinea pigs cannot tolerate sudden changes in their diet or environment. Their food preferences are established early in life. Often guinea pigs refuse to eat if their food has changed in any condition, which can potentially be life threatening. Something as simple as a new bowl or water bottle can upset them, causing the animal to stop eating. Guinea pigs tend to stress out easily and they also have tendency to become extremely attached to their caretakers, so changes in personnel will be noticed. It’s very important to be patient with guinea pigs, in effect; research on guinea pigs must be precise and done very carefully because they are docile and easily startled. When conducting research on guinea pigs you must be patient, precise and able to handle them very carefully.

Statistics show that Guinea pigs have been used in just over 30,000 scientific experiments in the UK in 2006, representing less than 1% of total animal research. Over half of these were studies of the respiratory, nervous and immune system. Guinea pigs are also widely used to

provide tissues and organs for research such as guinea pig blood whose components are widely used, and isolated organ preparations such as guinea pig lung and intestine are extensively used in research to develop new medicines. Such tissue and organ preparations were important in the discovery and early development of beta blockers to treat high blood pressure and drugs to treat stomach ulcers in humans. The structure of a guinea pigs ear is also similar to that of humans, meaning that their hearing range is also similar.

Guinea pigs also are ideal candidates for germ-free research, since their young have a good chance at surviving from birth on solid food. In today's research, guinea pigs continue to be used in significant numbers to investigate many topics such as the impact of cigarette smoke, nutrition, genetics, infectious diseases, reproductive biology, and several types of toxicity/safety tests. In an article titled, "Induction of Preneoplastic Lung Lesions in Guinea Pigs by Cigarette Smoke Inhalation and Their Exacerbation by High Dietary Levels of Vitamins C and E, Carcinogenesis" research has been conducted to then prove that guinea pigs are more suitable in experiments rather than rats or mice. "We have been using the guinea pig to assess the effects of natural antioxidants, such as ascorbic acid (AA), alone and in combination with other antioxidants, on pulmonary damage caused by reactive oxygen and nitrogen species derived from inhaled cigarette smoke and from the consequent inflammatory events. The guinea pig provides a more suitable experimental model for this purpose than other species, such as the mouse, rat, hamster or ferret, which have also been used in the past for studies on effects of cigarette smoke inhalation, because the guinea pig, like the human, requires an exogenous source of AA. Thus, in the guinea pig it is possible to manipulate AA levels in organs through dietary means" (Fiala et al., 2005). This article helps prove guinea pigs are very useful for humans and guinea pigs are very beneficial to human research. Guinea pigs have helped our society advance

in technology and medicine. Since guinea pigs are closely related to humans, a guinea pigs eye sight is a very important factor in figuring out if they have the same color preference as humans do.

Eyes

Another thing guinea pigs are known for are their big oval shape eyes. The position that guinea pigs eyes are located in their head makes guinea pigs able to see a 340 degree range. This is because they are prey animals and their eyesight is important for escaping from predators. However, guinea pigs struggle to see depth. Unlike dogs guinea pigs can see color. Guinea pigs can differentiate between green, blue, red etc. Horst Beilfield describes an experiment using three different colored identical food bowls in his book, *Guinea Pig – A Complete Pet Owner's Manual*. He changed the order from day to day. Eventually he found out that the guinea pig searches out the colored bowl with food. Other research I have found are Guinea pigs come in many different eye colors, but it doesn't affect how their vision. Breeders identify these colors as dark, dark with a ruby cast, and pink. Dark eyes can be further described as blue, black, or brown. Healthy eyes reflect red in a strong light; this is especially noticeable in ruby pigs, whose dark looking eyes have a pronounced red cast to them, especially noticeable when photographed with a flash. Guinea pigs and their eyes have also been researched on over the decades. A guinea pigs vision is relatively poor but guinea pigs can distinguish colors. Guinea pigs normally keep their eyes open all the time, even when sleeping. A very few may sleep with their eyes fully closed. Studies show that the upper eyelid movements in humans are similar to guinea pigs.

According to this article titled "Blinking and Associated Eye Movements in Humans, Guinea Pigs, and Rabbits, Journal of Neurophysiology," studies show that the eye movements in guinea pigs are similar to humans. "Recordings of upper eyelid movements in humans, guinea

pigs, and rabbits demonstrated that all three species displayed qualitatively similar patterns of eyelid movement. The relation between amplitude, duration, and maximum velocity in rabbits and humans was nearly identical. Guinea pig blinks were faster than those of rabbit and man", "Photographs of blinking showed that the motions of the eyelids exhibited some species differences. In humans the upper eyelid traversed a downward and medial trajectory, while in rabbits and guinea pigs the upper eyelid path was downward and lateral. Although this report deals exclusively with upper eyelid movements, it is worthwhile noting that in humans the lower lid moved primarily medially, while in rabbits and guinea pigs it moved primarily upward, with a small medial component" (Evinger et al., 1984). Knowing that guinea pigs and humans have many things in common can be beneficial to finding out if they share the same preferences.

Guinea pigs have always been an extraordinary creature in many eyes and research has proven that guinea pigs have been very useful throughout our lives. They are beneficial in research and have helped America as well as around the world discover cures to diseases, and have made products safe for humans to use.

Methods and Materials

Behavioral data from one White crested, one Abyssinian, one Peruvian, and one American guinea pig was collected using materials the school funded for us for our research on a budget. A cage six feet by two feet with black grids and coroplast was constructed so that all the guinea pigs can roam freely. There were four white grids that separate the cage inside, making each corner a different section the guinea pig can go to with a selected color which was rotated clockwise weekly.

The guinea pigs were loaned for research by John Bowne High School Agriculture Department to use for our research. Three the guinea pigs were female one was a male. Having both sexes represented made this experiment more accurate with result, looking at the color preference in guinea pigs as a whole, as opposed to only specific gender. Having different species as well as both genders made this experiment more promising. All the guinea pigs had unlimited amounts of food and water which was changed three times a week. The food was standard guinea pig pellets ordered by the facility monthly, and the water came from the school's water supply. The food and water was measured and weighed three times weekly. The cage was cleaned twice a week in the mornings. Two cups of guinea pig pellets measured and weighed were placed in the four different colored bowls three times a week. The food weighed approximately 578.0 in grams with the food inside the bowl. The water was weighed approximately 1066.30 in grams with water. 32 ounces of water was filled up in each colored water bottle measured and weighed for the given weight three times a week.

Color	Yellow	Red	Blue	Green

Weight of food in grams				

Table 1 was used to measure the amount of food left in the bowls in grams.

Color	Yellow	Red	Blue	Green
Weight of water in grams				

Table 2 was used to measure the amount of water left in the water bottles in grams.

All data was recorded and analyzed once every other week (see table 1 and 2) using a graph showing results from that week. They were all eating from all the different color bowls and drinking from the different color water bottles. The amount of food and water given to them remained the same throughout the experiment. There were occasions when students were not allowed to enter the school due to vacation or weather therefore, in those occasions; extra food was given to the guinea pigs in a separate black bowl. Data was still collected from the color bowls because it still showed the guinea pigs preferring to eat from the color bowls over black bowl. All the data that was collected relates to our hypothesis because the data recorded showed what the guinea pigs preferred. This made it able to see what color they preferred. My hypothesis was that guinea pigs would prefer the color green because green is a color they see their entire life, in the wild guinea pigs are always around grass or leaves or anything that is nature. It is assumed that that color is their safe color, safe as in the color they feel more comfortable being around with. This experiment will test my hypothesis because the experiment had the guinea pigs open to all four colors during 3 months. Data has been collected to test the hypothesis. The data

was analyzed by seeing how many times a month a color is preferred from both the food bowls and water bottles, using the tables. The color that was eaten out of more or drank out of more frequently would show a possible trend.

Results

Four guinea pigs were placed in a cage with bedding, four different color food bowl, red, blue, green and yellow and four water bottles, the same colors, for this experiment. Three days a week food and water was collected to record data. All results were calculated by measuring the amount of food eaten and amount of water drank in grams. The amount of food left in the bowl had to be subtracted by the amount the bowl weighed with no food in it. The water bottle also had to go through this process. To calculate the total amount all of the bowls and bottles were added up together to get the final amount. During each data collection a trend was noticed. The guinea pigs from time to time would eat out of the yellow bowl the most. As shown in Fig. 1, the color yellow was preferred the most while blue was the least favored color. Data collected from the first month, yellow and red had the same amount of times favored in the recorded day. Data collected from the second month again had similar results. Data collected from the final month also had similar results. Although the data between the colors yellow and red were similar, yellow still had different results.

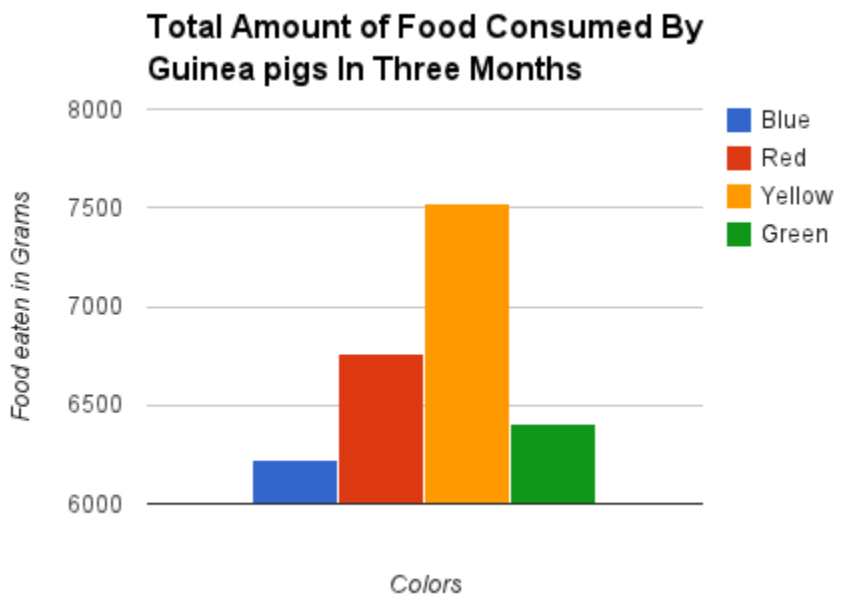

Fig. 1 shows the amount of food eaten in grams by the guinea pigs in three months.

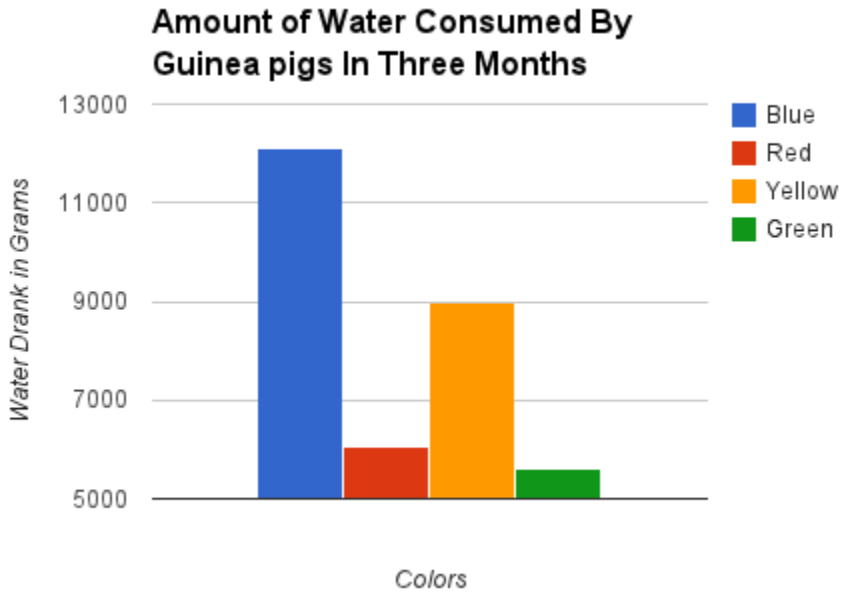

Fig. 2 shows the amount of water drank in grams by the guinea pigs in three months.

A black food bowl was placed with extra food during long vacations and no interest towards the black food bowl was observed.

During the data collection for the water bottles a trend was noticed. The guinea pigs from time to time would have drunk out of the blue water bottles the most. As shown in Fig. 2, the color blue was preferred the most while red and green was the least favored color. Data collected from the first month, blue and yellow had the same amount of times favored in the recorded day. Data collected from the second month again had similar results. Data collected from the final month also had similar results. Although the data between the colors blue and yellow were similar, blue still had different results.

Discussion and Conclusion

Knowing a guinea pigs preference can be very beneficial for the owner. Guinea pigs cannot tolerate sudden changes in their diet or environment. Their food preferences are established early in life, often they refuse to eat if their food has been changed in any condition; which can be life threatening. Something as simple as a new bowl or water bottle can upset them, causing the animal to stop eating. Knowing a color guinea pigs are comfortable being around in can help them live longer and stress free. Our hypothesis was that guinea pigs would prefer the color green over the other colors blue, yellow, or red. We concluded that guinea pigs would prefer the color green because that is a color we believe they are most familiar with. Guinea pigs are familiar with green because they eat lots of green foods such as lettuce, celery, broccoli, etc. A result from our experiment show that green was a color the guinea pigs did not favor at all. They ate more out of the yellow food bowl and drank more out of the blue water bottle. Past research from Horst Bielfeld describes an experiment using three different colored identical food bowls in his book, *Guinea Pigs -- A Complete Pet Owner's Manual*. He placed a food item in the same colored bowl, changing the order from day to day. He eventually found the guinea pig searches out the colored bowl with food. This similar to our experiment only shows the guinea

pigs being aware of colored food bowls. Our experiment went more into seeing if the guinea pigs preferred one color over the other. Our results showed that guinea pigs preferred the yellow food bowl and blue water bottle. As shown in Fig. 1, the yellow food bowl was eaten out of the most over the other colors. As shown in Fig. 2, the blue water bottle was drunk out of the most over the other colors. These results will benefit all guinea pig pet owners and researchers using guinea pigs because more research can be done to prove if guinea pigs of different sexes and different breeds react well or preform well in an environment with yellow food bowls and blue water bottles. To improve this experiment, more guinea pigs should be used to show more accurate results to have a better understanding of guinea pig color preference as well as different breeds of guinea pigs. Guinea pigs of different ages and sexes should also be considered in this research because having more trials done on different sex guinea pigs and different age guinea pigs can create more concise data.

References

Das, A., Dey, N., Ghosh, A., Das, S., Chattopadhyay, D. J., & Chatterjee, I. B. (2012). Molecular and Cellular Mechanisms of Cigarette Smoke-Induced Myocardial Injury: Prevention by Vitamin C. PloS one, 7(9), e44151.

Evinger, C., Shaw, M. D., Peck, C. K., Manning, K. A., & Baker, R. (1984). Blinking and associated eye movements in humans, guinea pigs, and rabbits. Journal of neurophysiology, 52(2), 323-339

Fiala, E. S., Sohn, O. S., Wang, C. X., Seibert, E., Tsurutani, J., Dennis, P. A., ... & Aliaga, C. (2005). Induction of preneoplastic lung lesions in guinea pigs by cigarette smoke inhalation and their exacerbation by high dietary levels of vitamins C and E. Carcinogenesis, 26(3), 605-612

Kawakami, K., Takeuchi, T., Yamaguchi, S., Ago, A., Nomura, M., Gonda, T., and Komemushi, S. (2003). Preference of guinea pigs for bedding materials: wood shavings versus paper cutting sheet. Experimental animals, 52(1), 11-15

Lichtenstein, G., & Cassini, M. H. (2001). Behavioral mechanisms underlaying food aversion in guinea pigs. Etologia, 9, 29-34.

Sharon, D. V. M. (2003). *The guinea pig handbook*. Barron"s Educational Series.

Acknowledgments

This work was supported by John Bowne High School, with the help of Ms. Gottfried, Mr. Perry, Mark Gregory and Shanyce Pierre.