Evolution
Erin Lutz
Term Project Summary

Differences between dogs and people are not difficult to notice but this is because we both utilize our senses so greatly to determine what our surroundings are. Because we as humans rely so heavily on our eyesight to figure out our world around us, we find it noticeable when other animals, such as dogs, do not employ the same amount of emphasis to what their eyes tell them. For people, seeing the full range of the color spectrum has become something that is needed in order to understand everything around them, it is their main way of interpreting the world. For dogs however, other senses that are more advanced than our own have been developed which allow them to not need the same color vision that people depend on. This is why dogs only have dichromatic vision while people have trichromatic vision [6].

Mammalian ancestors originally had ultraviolet sensitive and red-sensitive vision but this has since evolved into the kind of sight we have today [6]. The main difference between human vision and that of dogs, comes down to the number of rods and cones in the eye. Rods aid the eye to see more clearly in low light situations. Cones, do the opposite, and help the eye see in bright light [2]. While at one point dogs may have developed the ability to see with the full range of colors, their abilities to interpret everything around them with more than just their eyes have since made it less necessary for them to see the full color spectrum [1]. Dog's dichromatic vision allows them to see in ranges of violets/ blues and greens/ yellows [5]. This means that they struggle to distinguish reds. If presented with a green apple and a red apple, dogs will probably see a slightly duller version of the green apple that is also slightly more yellow. The red apple however, would probably be interpreted as a very dull yellow and no sense of the red would be interpreted.

This idea, that dogs see the world in very different colors than we humans do, is what my project explores. The pictures taken are all at the perspective of a medium sized dog. This allows the viewer to have a full understanding of how a dog interprets their surroundings. There are two sets of images, one unedited version, which is what the human eye sees and one edited version which explores how a dog experiences the surroundings. By providing both of these they audience is given a better understanding and a direct correlation of what the differences are between dog and human sight. The unedited version of the pictures represents the human trichromatic vision and has the full range of visible color in them. The edited images though have the dichromatic colors that dogs see. These are mainly blues, yellows, and greens. All of the reds have been edited out because dogs can not see them.

However because my project is not just exploring the way in which our sight is different, I have also included a mouse in the pictures. In the unedited pictures, I have simply added this mouse in. This is because people use our eyesight to discover where a mouse might be. We might see that it has left droppings near where food is kept or we might actually see it running

across the floor. Either way, we utilize our eyesight to find out that there is a mouse around. Dogs however, do not use just their eyesight to find where the mouse might be. Rather, they would, more often than not, smell the mouse before they saw it. Their sight might aid them in hunting the mouse down but it is not their only way of figuring out where it is. In the edited images I have included the swirling lines in order to represent the idea that smell is another way for dogs to understand their surroundings. The lines also have some opacity to them because this tells the audience that they are not actually part of the scene but have been added in order to convey a meaning.They are also red which indicates to the audience that they are not physically present in the setting (dogs can not see red) but rather are exploring another aspect of the image. The tracks on the floor have also been added to the edited images so that one can see how the mouse traveled but then also how that is tracked by a dog.

This project is trying to reach people who are interested in having a better understanding of their own dog or of dogs in general. I also want it to speak to people that have not understood how sight is not the most important sense all animals. I want it to highlight the other ways in which animals have evolved to best survive in their environments and show that just because people evolved one way does not mean it is the best way for every animal to survive. It will provide people with an understanding of how they interpret their situations and perhaps why people might get frustrated with their dogs. It is designed to give a better understanding of how animals are different from ourselves but this does not make them less advanced. By including the olfactory sensory in the edited images, my hope is that people will understand how we are not better than other animals or more sophisticated because animals have developments that we as humans do not have or necessarily need. It is meant to present the idea that even though other animals do not act the way that we do and perhaps cannot see the way that we see, they have other ways of surviving that are more evolved than our own and therefore we are in no position as humans to look down upon any animal and think that we are better than it.

1. Clark, Carol. 2014. A Clear, Molecular View of how Human Color Vision Evolved. *Science Daily* December.

Five classes of opsin genes encode visual pigments for dim-light and color vision. Some of the opsin genes change and therefore vision adapts as the environment of a species changes. Around 90 million years ago, primitive mammalian human ancestors were nocturnal and had UV-sensitive and red-sensitive color, giving them a bi-chromatic view of the world. But roughly 30 million years ago, they evolved four classes of opsin genes, giving them the ability to see the full-color spectrum of visible light, except for UV.

2. David Falk, Dieter Brill, David Stork. 1986. The Human Eye and Vision-I: Producing the Image. 153-157 in *SEEING THE LIGHT: Optics in Nature, Photography, Color, Vision, and Holography*, First Edition, Edited by Lisa S. Berger, Steven Pisano. New York (NY): Harper & Row Publishers, Inc.

The human retina contains around seven million cones and 120 million rods. The cones help us to see when there is high light levels while the rods help us to see in low light levels. Despite their large numbers, they are not uniform and are not distributed completely evenly across the retina. The number of rods and cones in human eyes differs from those of other mammals like cats and rabbits which are naturally nocturnal. Naturally, these animals have more rods than people because they would need to be able to survive in the dark.

3. Gerald H. Jacobs. 2009. Evolution of Colour Vision in Mammals. *Physiological Transactions of the Royal Society B: Biological Studies*. 364:2957-2967.

Cone pigments are linked to two families of the opsin genes (SWS1 and LWS). Each of the pigments are also put into four groups based off of their spectral location. These four are ultraviolet (UV), short wavelength (S), middle wavelength (M), and long wavelength (L). Despite having these some primates are have more than one of these opsins and therefore are called polymorphic.

4. Huabin Zhao, Stephen J. Rossiter, Emma C. Teeling, Chanjuan Li, James A. Cotton, and Shuyi Zhang. 2009. The Evolution of Color Vision in Nocturnal Mammals. *PNAS*. 106 no. 22:8980-8985.

In an experiment performed with bats, it was tested whether or not the M/LWS1 and the SWS1 gene had an affect on the ability to see easily in the dark. What they found was that the SWS1 gene had a stronger effect than the M/LWS1 gene.This came as a surprise and it showed an alternate topology where bats with laryngeal echolocation formed a single monophyletic clade resembling the traditional grouping of microbats.

5. Jay Neitz, Timothy Geist, Gerald H. Jacobs. 1989. Color Vision in the Dog. *Visual Neuroscience*.:119-125.

In this study three dogs were taken and trained to touch illuminated panels based on light sensitivity and wavelengths. In order to gain a better understanding of which colors and how sensitive dogs' eyes are to light, multiple tests were run. It was determined based off of the three dogs that were studied that they were dichromatically color blind. This means that unlike humans

who have three functioning cone photopigments, dogs only have two. According to their tests the dogs struggled to differentiate color and light as it approached and reached 480 nanometers.

6. Mickey Rowe. 1997. The Evolution of Color Vision. *The Talk Origins Archive*. http://www.talkorigins.org/faqs/vision.html. (Accessed 1 October 2017).

Most mammals do not have well developed color vision systems because after our ancestors evolved color vision it became necessary again and was then lost. It is not because they had never developed it but rather that it had once been there and was then no longer required. The color vision of primates is not strictly homologous to the color vision of fish, birds, and turtles. A lof of the systems that primates utilize for primate color vision came about independently long after similar systems developed (without being lost) in other vertebrate lineages. Mammals were originally nocturnal. This means that as they have evolved, they have developed ways of seeing better in light. Color is one of these ways. However since most animals are color blind at night (meaning it is difficult to make out the differences between color in low light situations).

7. Monica Weymouth. 2017. What Colors do Dogs See? *Pet MD.* http://www.petmd.com/dog/general-health/what-colors-do-dogs-see. (Accessed 30 October 2017).

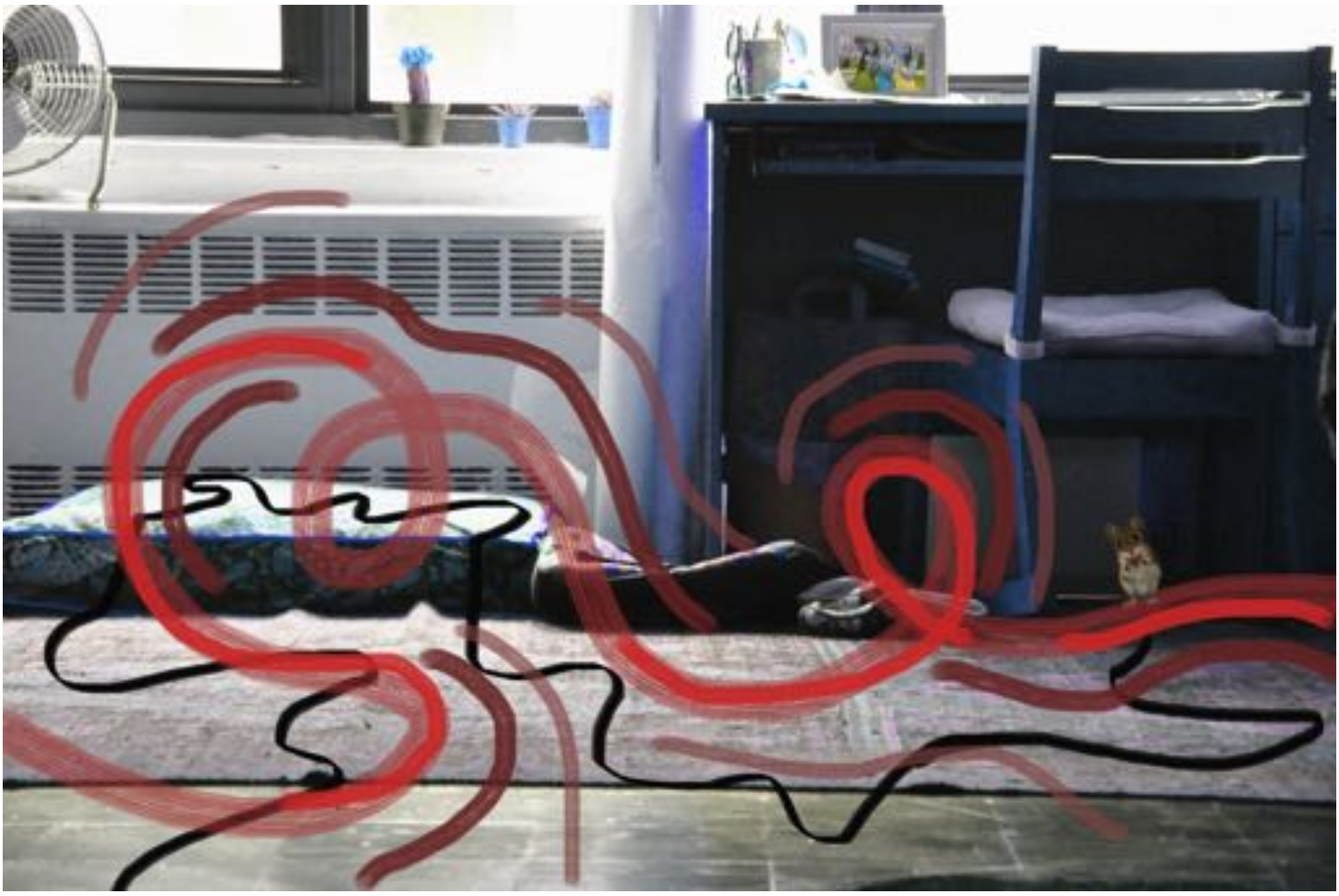
The reason why dogs do not have the developed sense of color that humans have is due to the fact that some of their other senses are more heightened than our own and because some of what we consider "limitations" in their color vision, actually help them to see at night. Like the cones and rods that they have: while they might hurt the dogs in their ability to see color they also allow dogs to see better at night. Also their heightened sense of smell allows them to distinguish what things are lose to them even though their vision close up is as clear as humans.

8. Paul E. Miller, Christopher J. Murphy. 1995. Vision in Dogs. *Scientific Review*. JAVMA 207:1623-1634.

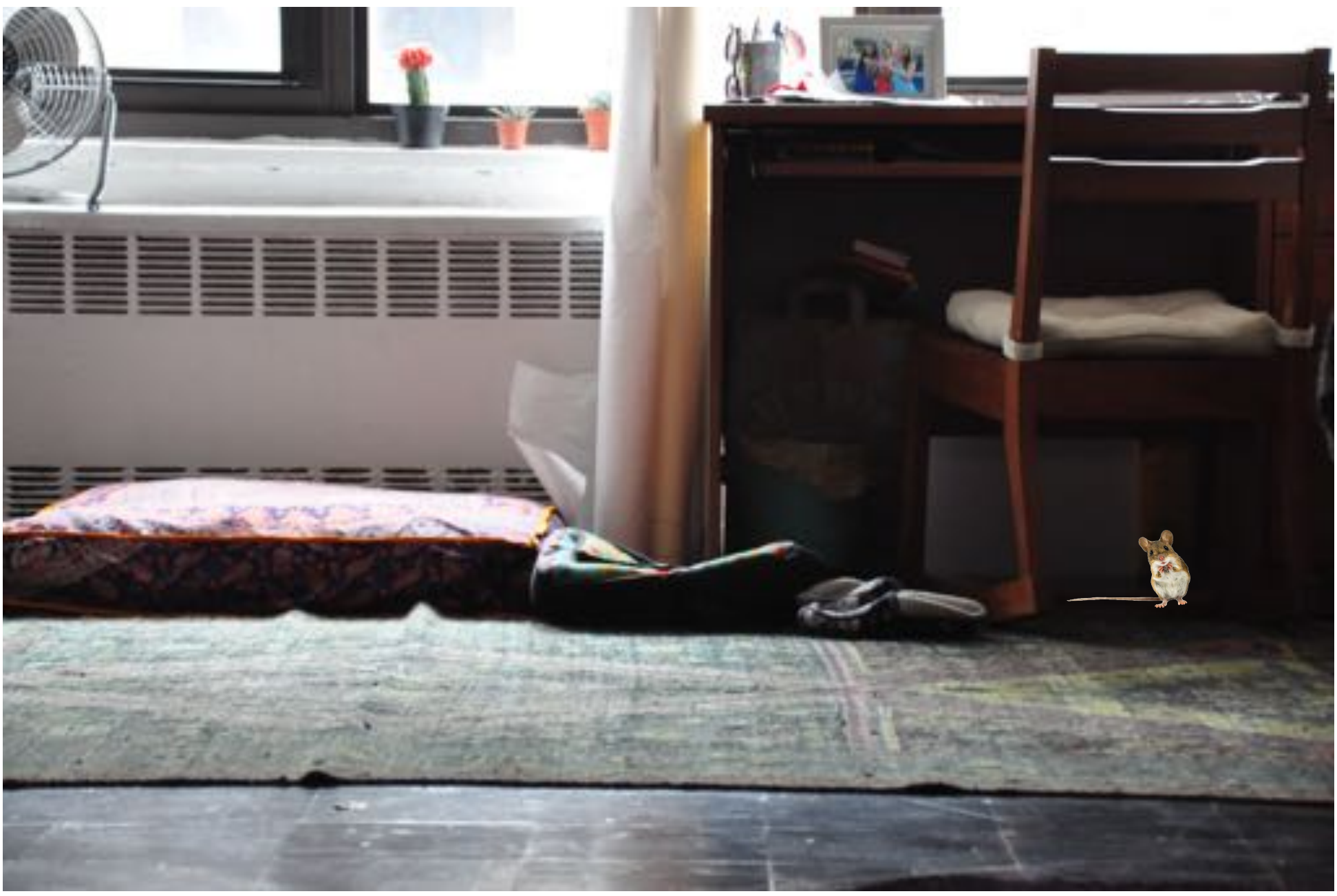
One of the main ways that human eyes are different from a dog's eyes is that they have a different number of rods and cones as the photoreceptors. In a dog's eye the central twenty-five percent of the retina is made up of rods, however, in a human's eye, this area is made up of cones. It is the cone that allows humans to see color more clearly and to be able to see well in bright light. Dogs's rhodopsin levels are also a little different than people's. Dog's levels peak at between 506 and 510, but people's peak around 496. This means that dogs' eyes work better in the dark than people's. However, their eyes also take longer (over an hour) for the rhodopsin to regenerate after extended time in bright light. Typically a person's will regenerate more quickly.

Dog's Experience

Human's View



Dog's Experience

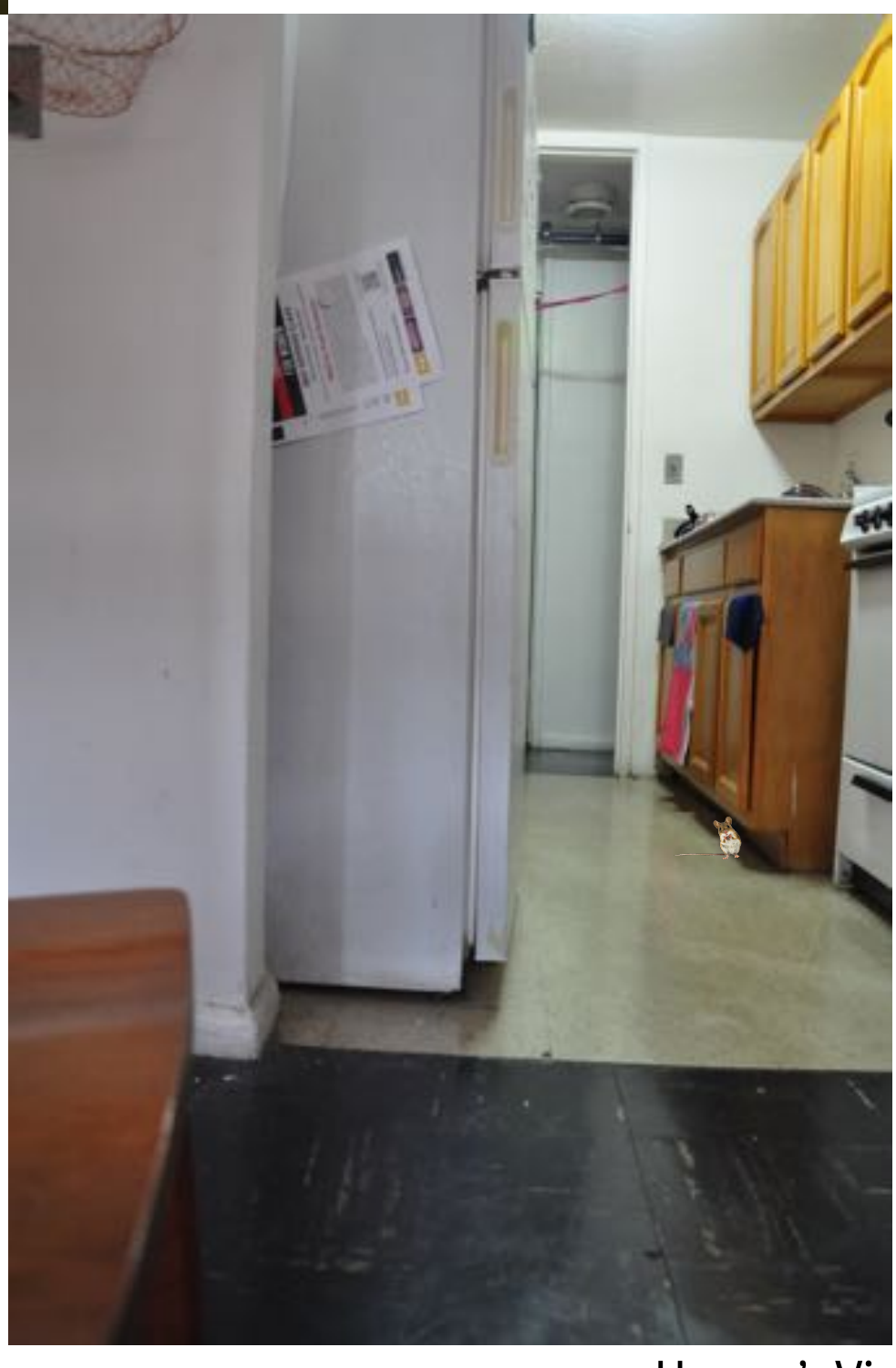


Human's View

Dog's Experience

Human's View

Dog’s Experience



Human’s View

Dog's Experience

Human's View