Color Discrimination in Dogs

Toshio TANAKA, Tamiko WATANABE, Yusuke EGUCHI[a] and Tadashi YOSHIMOTO

School of Veterinary Medicine, Azabu University, Sagamihara-shi 229-8501, Japan

(Received February 15, 2000 ; Accepted March 24, 2000)

Abstract In this study, an experiment was carried out to clarify the color perception in dogs. Two female Shiba breed dogs were trained using an operant conditioning method in which they pressed a switch with their muzzles in order to obtain some food, to discriminate between simultaneously presented colored and gray cards. The left and right positions of the two cards were shifted at random. After the dogs were fully trained, their color perception ability was tested on three primary colors, red, blue and green. The dogs were subjected daily to one or two sessions which consisted of 20 trials each. The criterion of successful discrimination was 3 consecutive sessions with more than 15 correct choices ($P < 0.05$, Chi-square test). In the red vs. gray discrimination test, the dogs respectively took 3 and 12 sessions to reach the criterion. In the blue vs. gray and green vs. gray tests, both dogs were able to attain the criterion by the 13th session. The results of this study suggest that the color vision of dogs is relatively developed and dogs are able to discriminate between all three primary colors and gray.

Animal Science Journal 71 (3) : 300-304, 2000

Key words : Color vision, Dog, Operant conditioning

In general, livestock, with the exception of poultry, have been believed to live in a colorless world. In recent years, however, it has been clarified that some ruminant, cattle and sheep, can discriminate between three primary colors and gray, and between opposite colors with the same luminosity[1,2,4,6,8,11,13]. We have shown that the color vision of sheep is well developed and they have an ability to distinguish between green and its similar colors[14]. Our previous studies have shown that pigs and wild boars were also capable of recognizing bluish colors[3,15].

On the other hand, it is known that the dog retina contains two classes of cone photopigment[9]. It is also concluded that dogs have color vision by Neitz *et al.*[9]. However, there is relatively little information regarding color vision in dogs, and the results of them are quite different from each other. Rosengren[12] reported that three female cocker spaniels were well capable of discriminating red, blue, green and yellow of different degrees of brightness, but he quoted some reports which showed different results.

In the present research, an experiment was carried out to clarify the color perception in dogs using the methods of experimental psychology.

Materials and Methods

The experiment was carried out from April to August in 1996. Two female Shiba breed dogs named Sakura (Dog 1) and Fubuki (Dog 2), 3 years of age, were used. They were trained using an operant conditioning method in which they pressed a switch with their muzzles in order to obtain some food, to discriminate between simultaneously presented colored and gray cards with the same luminosity. The left and right positions of the two cards were shifted according to the Gellermann series[5]. The experimental apparatus (T-maze) was the same as that in our previous report of wild boars[3].

Present address : Chugoku National Agricultural Experimental Station, Oda-shi 694-0013, Japan
Corresponding : Toshio TANAKA (fax : +81 (0) 42-769-1692, e-mail : tanakat@azabu-u.ac.jp)

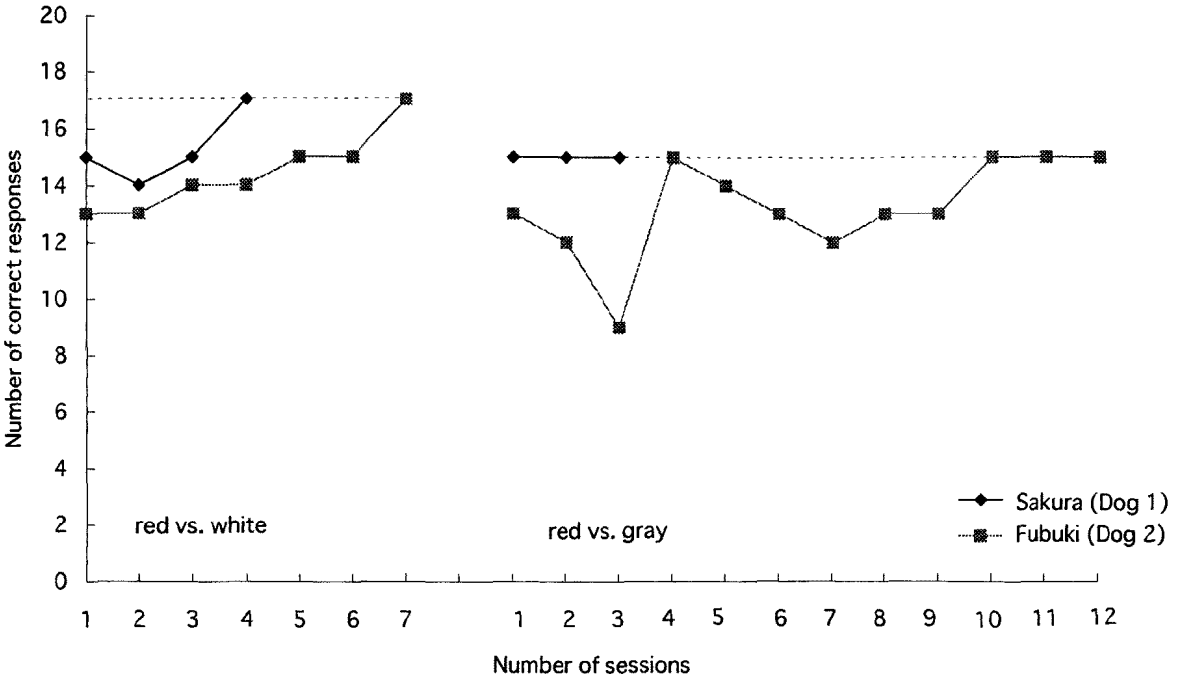

Fig. 1. Correct responses of dogs in tests with red as correct choice.

Before the beginning of the experiment, the dogs were tamed by an experimenter for 2 months in a pen. After that, they were left in the experimental apparatus for 7 days, 30 min/day, to get accustomed to the T-maze and to learn how to operate the switch for a reward. In the following training sessions, the dogs were trained to learn the relationship between a positive target (colored card) and a reward (feed), and to discriminate between colored and white cards. This training was finished when the dogs exceeded more than 17 correct choices during 20 trials ($P<0.01$, Chi-square test).

After the dogs were fully trained, their color perception ability was tested on three primary colors, red (10PR 5/10), blue (10B 5/10) and green (10G 5/10). Before the color vs. gray (N5) test, the color vs. white test was done for relearning. Light intensity on the cards was 450–500 lux. The dogs were subjected daily to one or two sessions which consisted of 20 trials each. The criterion of a successful discrimination test was 3 consecutive sessions with more than 15 correct choices ($P<0.05$, Chi-square test).

Results

Red vs. gray

The results of the discrimination tests between red vs. white and red vs. gray for Sakura and Fubuki are shown in Fig. 1. Both dogs took 4 and 7 sessions respectively to exceed 17/20 correct choices in the red vs. white training. In the red vs. gray discrimination test, Sakura exceeded the criterion in the first 3 sessions. On the other hand, Fubuki took 12 sessions to reach the criterion.

Blue vs. gray

The results of the discrimination tests between blue vs. white and blue vs. gray for the two dogs are shown in Fig. 2. In the blue vs. white training, both dogs were able to attain the criterion by the 3rd or 4th session. In the blue vs. gray discrimination test, Sakura and Fubuki took 9 and 11 sessions to reach the criterion, respectively.

Green vs. gray

The results of the discrimination tests between green vs. white and green vs. gray for the two dogs are shown in Fig. 3. Both dogs showed 17/20 correct

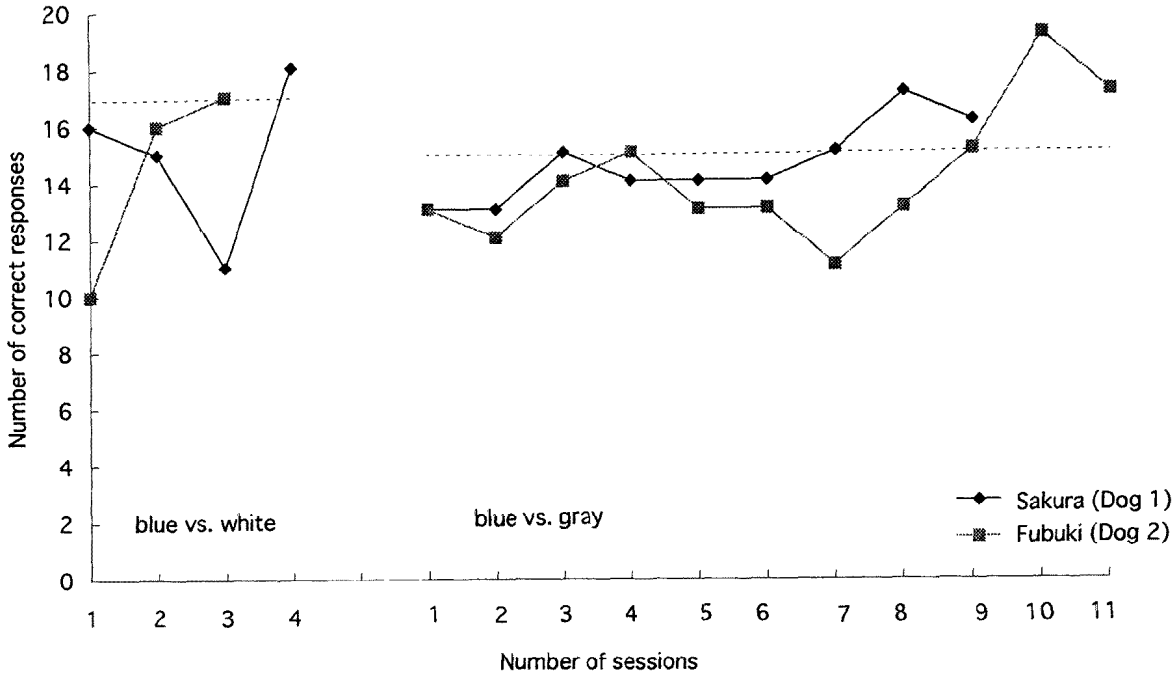

Fig. 2. Correct responses of dogs in tests with blue as correct choice.

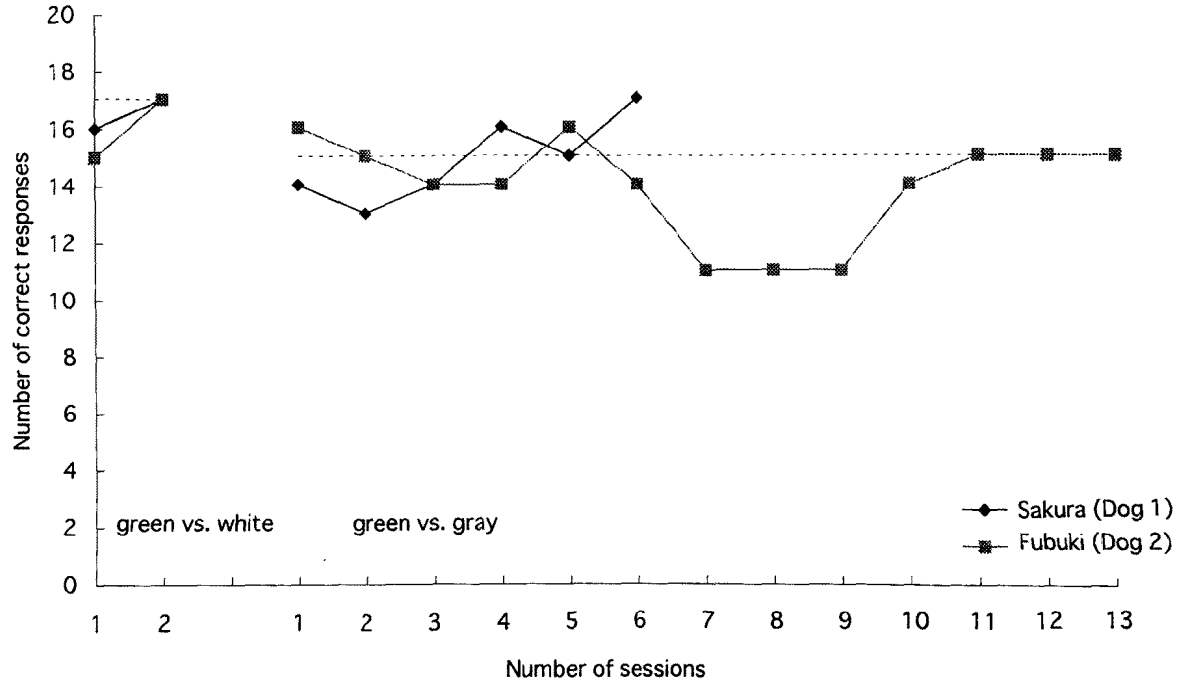

Fig. 3. Correct responses of dogs in tests with green as correct choice.

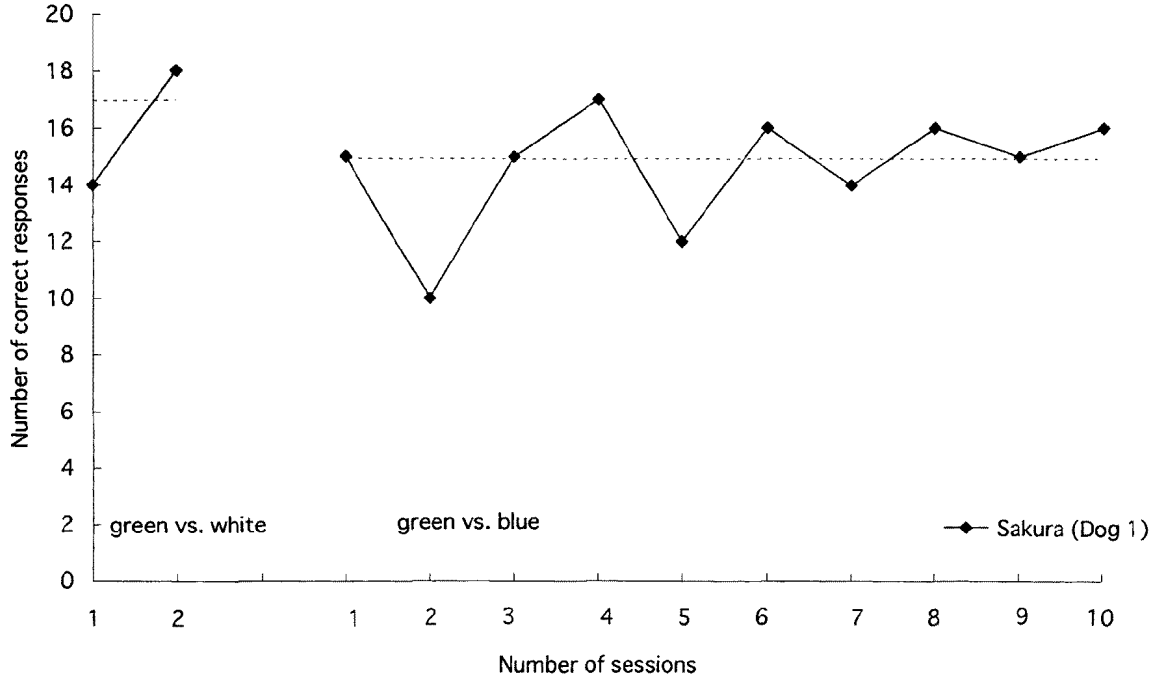

Fig. 4. Correct responses of Dog 1 in tests of green vs. blue discrimination.

choices on the 2nd session in the green vs. white training sessions. In the green vs. gray test, Sakura took only 6 sessions, but Fubuki took 13 sessions to reach the criterion.

Green vs. blue

In addition, the green vs. blue discrimination test was done only for Sakura. The results of this test are shown in Fig. 4. The rate of correct choices were around 75% (15/20) in all sessions. Sakura could then discriminate them more than 75% in the 8th to 10th consecutive session.

Discussion

According to Rosengren[12], dog color vision has been studied since the end of the 19 century. He quoted 28 reports in total, 16 for dogs, eight for cats, two for the wash-bear and two for the red fox. Almost half of these results on the capacity of color perception were positive, and the other half were negative.

In recent years, it has been reported that the dog retina contains two classes of cone photopigment, and those two pigments were computed to have spectral peaks of about 429 nm and 555 nm[9]. Jacobs *et al.*[7] showed four genera of Canid, domestic dog (*Canis familiaris*), Island gray fox (*Urocyon littoralis*), red fox (*Vulpes vulpes*) and Arctic fox (*Alopex lagopus*) to have almost the same photopigment as each other.

These findings suggest that the color perception of dogs is poorer than some species which have trichromatic color vision like a human. However, the results of this study show that the color vision of dogs is relatively developed and that dogs are able to discriminate between all three primary colors and gray. This means our results support the interpretations of Neits, *et al.*[9] on the color vision of dogs.

Guide dogs for the blind have not been trained to watch the traffic signals, because, in general, it was believed that the dogs did not have color vision. However, it might be easy for dogs to discriminate between red and green lights. If guide dogs are trained to judge the signals, it would become more safe for blind people to cross the road.

In addition, it is known that the color surroundings affect us physiologically and psychologically[10]. Therefore, additional research will be necessary to

clarify the physiological and psychological effect of environmental color on dogs. These results will improve the welfare of all dogs.

References

1) Bazely DR, Ensor CV. Discrimination learning in sheep with cues varying in brightness and hue. *Applied Animal Behaviour Science,* 23 : 293-299. 1989.
2) Dabrowska B, Harmata W, Lenkiewicz Z, Schiffer Z, Wojtusiak RJ. Color perception in cows. *Behavioural Process,* 6 : 1-10. 1985.
3) Eguchi Y, Tanida H, Tanaka T, Yoshimoto T. Color discrimination in wild boars. *Journal of Ethology,* 15 : 1-7. 1997.
4) Entsu S. Discrimination between a chromatic color and an achromatic color in Japanese Black cattle. *Japanese Journal of Zootechnical Science,* 60 : 632-638. 1989.
5) Gellermann LW. Chance orders of alternating stimuli in visual discrimination experiments. *Journal of Genetical Psychology,* 42 : 206-208. 1933.
6) Gilbert BJJr, Arave CW. Ability of cattle to distinguish among different wavelength of light. *Journal of Dairy Science,* 69 : 825-832. 1986.
7) Jacobs GH, Deegan II JF, Crognale MA, Fenwick JA. Photopigments of dogs and foxes and their implications for canid vision. *Visual Neuroscience,* 10 : 173-180. 1993.
8) Manda M, Oku Y, Adachi A, Kubo M, Kurohiji I. Behavioral evidence for color discrimination in cattle. *Japanese Journal of Zootechnical Science,* 60 : 521-528. 1989.
9) Neitz J, Geist T, Jacobs GH. Color vision in the dog. *Visual Neuroscience,* 3 : 119-125. 1989.
10) Nomura J. Color Marketing. 309-351. Chikura Shobo. Tokyo. 1991.
11) Roil JA, Sanchez JM, Eguren VG, Gandioso VR. Colour perception in fighting cattle. *Applied Animal Behaviour Science,* 23 : 199-206. 1989.
12) Rosengren A. Experiments in colour discrimination in dogs. *Acta Zoologica Fennica,* 121 : 1-19. 1969.
13) Tanaka T, Asakawa K, Kawahara Y, Tanida H, Yoshimoto T. Color discrimination in sheep. *Japanese Journal of Livestock Management,* 24 : 89-95. 1989.
14) Tanaka T, Sekino M, Tanida H, Yoshimoto T. Ability to discriminate between similar colors in sheep. *Japanese Journal of Zootechnical Science,* 60 : 880-884. 1989.
15) Tanida H, Senda K, Suzuki S, Tanaka T, Yoshimoto T. Color discrimination in weanling pigs. *Animal Science and Technology,* 62 : 1029-1034. 1991.