Ability to Discriminate between Similar Colors in Sheep

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Abstract An experiment was carried out in order to clarify the color perception in sheep. Twin Corridale lambs were trained using an operant conditioning technique to press a switch under the positive stimulus color card in order to receive feed as a reward. They were tested to discriminate between green and seven kinds of color, which were created by gradating blue and yellow into green. The luminosity of all colors was the same. The lambs succeeded in all discrimination tests but the most similar color combination.

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Key words : sheep, color perception, similar color, operant conditioning

In recent years, it has been clarified that cattle can discriminate between different colors using the methods of experimental psychology^{1,2)}. MANDA *et al.* confirmed that cattle had the ability to discriminate between colors³⁾, and they also studied the response of cattle to various colored electric fences in order to apply this sensory capability to animal management⁴⁾. According to these reports, it is important to study the ability of the sense of sight in farm animals and utilize their ability for the management.

In our previous report⁵⁾, sheep was also found to be able to discriminate between three colors (red, blue and green) and gray, and between opposite colors with the same luminosity. However, the limit of the visual capability to discriminate between similar colors was not known.

In the present research, an experiment was carried out in order to clarify the ability of sheep to discriminate between similar colors.

Materials and Methods

Twin Corridale female lambs, aged 5 months, were trained using an operant conditioning method in which they pressed a switch with their muzzles or heads in order to obtain hay cube, to discriminate between simultaneously presented two cards. The apparatus was the same as that of our previous report⁵⁾. The lambs were forced to press the switch for 13 days, 30 min each, in order to learn how to eat the feed before the beginning of the experiment. The card combinations were green (5 G 6/8)

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vs. seven kinds of color, which were created by gradating blue (5 PB 6/8, 5 B 6/8, 5 BG 6/8, 5 G 6/10) and yellow (5 Y 6/8, 5 GY 6/8, 5 G 6/6) into green, respectively. The luminosity of all colors was the same (Table 1). The arrangement of the cards in each combination was changed randomly according to the GELLERMANN series⁶⁾. Each test consisted of 20 sessions and each session consisted of 30 trials, according to the results of our previous study⁵⁾ in which the lambs reached the criterion until the 20th session in all tests after the establishment of associative learning. The lambs were tested for one or two sessions per day. The criterion of successful discrimination was three consecutive sessions with a correct score above 21 (70%, $P < 0.05$, by a Chi-square test)⁷⁾.

Results

The results of the tests are given in Fig. 1. In the first test, in which blue (5 PB 6/8) was contrasted with green (5 G 6/8), one lamb reached the criterion after 16 sessions. The other lamb selected the correct card above 70% in the 11th session, but she could not reach the criterion until the 20th session. In the green vs. yellow (5 Y 6/8) test, the two lambs reached the criterion after 3 and 9 sessions, respectively. In the green vs. 5 B 6/8 test, the two lambs reached the criterion after 3 and 7 sessions, respectively. In the green vs. 5 GY 6/8 and 5 BG 6/8 tests, both lambs reached the criterion until the 3rd session. In the test of green vs. 5 G 6/6 which was the most similar to green among the four colors gradated from blue, one lamb reached the criterion after 12 sessions. The other lamb, however, selected the correct card above 70% in only two consecutive sessions which were the 4-5th and 10-11th session, and she could not reach the criterion through the entire test period. In the last test, in which the most similar to green among the three colors gradated from yellow (5 G 6/10) was contrasted with green, it was determined that both lambs were not able to discriminate between these two colors.

Table 1. The color of positive and negative stimuli

	Hue	Luminosity	Saturation
Positive stimuli			
5G6/8	5.0 Green	6.0	8.0
Negative stimuli			
Blue→Green			
5PB6/8	5.0 Purple Blue	6.0	8.0
5B6/8	5.0 Blue	6.0	8.0
5BG6/8	5.0 Blue Green	6.0	8.0
5G6/10	5.0 Green	6.0	10.0
Yellow→Green			
5Y6/8	5.0 Yellow	6.0	8.0
5GY6/8	5.0 Green Yellow	6.0	8.0
5G6/6	5.0 Green	6.0	6.0

Fig. 1. Correct responses of lambs in tests with green as correct choice. I, 5 G 6/8 vs. 5 PB 6/8; II, 5 G 6/8 vs. 5 Y 6/8; III, 5 G 6/8 vs. 5 B 6/8; IV, 5 G 6/8 vs. 5 GY 6/8; V, 5 G 6/8 vs. 5 BG 6/8; VI, 5 G 6/8 vs. 5 G 6/6; VII, 5 G 6/8 vs. 5 G 6/10
 —●—, Sessions with correct score above 70%

Discussion

The results obtained in this experiments indicate that sheep can discriminate between green and its similar colors. This means that sheep have a relatively high ability for color discrimination.

One lamb did not reach the criterion until the 20th session in the first test of green vs. blue. This may be due to the fact that she was not accustomed to the experimental procedures. The training period before the first test must be too short for this lamb to learn the subject. This is supported by the fact that she could distinguish between green and 5 B 6/8, which is more similar color to green in the third test.

In the tests green vs. most similar colors to green gradated from yellow and blue, one lamb in the former and both lambs in the later decided not to be able distinguish. But they selected the correct card above 70% in some sessions in these tests. The

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differences between these colors were small and it is usually difficult for us to discriminate between them although the factors such as light and distance from the object might affect on the visibility. Therefore, it may be difficult for lambs to discriminate between them in a instant.

Throughout the experiments, one lamb (No. 2) tended to reach the criterion slower than the others (No. 1). ZITO *et al.* suggested that the rearing conditions affect on the behavioral development of lambs⁸⁾. The lamb No. 2 was reared in flock with her mother before the experiment, and became timid by isolating from the flock. The lamb No. 1, on the other hand, was reared artificially and tamed with people. The degree of adaptation to the environmental condition seems to be connected with the temperament of animals¹⁾. The lamb No. 2 might have not been well adapted to the experimental condition and not reacted quickly to a new situation.

The fact that sheep can discriminate between similar colors suggests that color plays an important role in the life of sheep, and it is possible to apply the technique of conditioning animals by color to management.

References

- 1) DABROWSKA, B., W. HARMATA, Z. LENKIEWICZ, Z. SCHIFFER and R.J. WOJTUSIAK, *Behav. Processes.*, **6** : 1-10.1981.
- 2) GILBERT, B.J. and C.W. ARAVE, *J. Dairy Sci.*, **69** : 825-832.1986.
- 3) MANDA, M., Y. OKU, A. ASHIDACHI, M. KUBO and I. KUROIHIJI, *Jpn. J. Zootech. Sci.*, **60** : 521-528. 1989. (in Japanese)
- 4) MANDA, M., M. SATOU and I. KUROIHIJI, *Jpn. J. Zootech. Sci.*, **60** : 236-239. 1989. (in Japanese)
- 5) TANAKA, T., K. ASAKAWA, Y. KAWAHARA, H. TANIDA and T. YOSHIMOTO, *Jap. J. Livest. Management*, **24** : 89-95.1989.
- 6) GELLERMANN, L.W., *J. genet. Psychol.*, **42** : 207-208. 1933.
- 7) SNEDECOR, G.W. and W.G. COCHRAN, *Statistical methods*. 7th ed., The Iowa State University Press. Ames. 1980.
- 8) ZITO, C.A., L.L. WILSON and H.B. GRAVES, *Appl. Anim. Ethol.*, **3** : 367-377.1977.

緬羊における類似色の識別能力

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緬羊における色の識別能力のうち、特に類似色をどの程度まで識別できるかを明らかにすることを目的とした。供試羊は双子のコリデール種去勢羊を用い、正刺激側のスイッチを押すと飼料が与えられるスキナー箱を自作して2色の同時弁別実験を行なった。草の色を想定して緑を正刺激とし、黄および青から徐々に緑に近付けた計7色を負刺激としてそれぞれ識別させた。各課題とも1セッション30試行とし、20セッションまで行なった。各試行ごとにおける左右のカードの交換は乱数表に基づいて行なった。 χ^2 検定により1セッション21試行以上の

正解 ($P < 0.05$) を基準とし、その基準に3回連続到達した時点でその色を識別したとみなした。結果は、黄から近付けた緑に最も近い色との対比において1頭が、また、青から近付けた緑に最も近い色との対比において2頭ともが、それぞれ識別不能と判断された他は、全ての組合せにおいて識別できるものと判断できた。以上から緬羊の色覚はかなり発達しているものと思われ、色による条件付け学習を利用した管理技術の開発の可能性が示唆された。

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