2 Sensibility in Pigeons: Do Pigeons See "Beauty"?

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Summary

We investigated whether pigeons could discriminate beauty in paintings in a way similar to humans. We classified children's paintings into good (beautiful) and bad (ugly) categories according to the evaluation of adults. We trained pigeons to discriminate these good and bad paintings using food rewards. When we tested them with new paintings, they could discriminate these novel good and bad paintings. Their discrimination was maintained in a test with paintings of reduced size, but decreased when black and white paintings were presented. The pigeons showed a decrement in discrimination depending on the degree of mosaic processing of the image. Thus, the pigeons used both color and pattern cues for their discrimination. Pigeons learned to discriminate watercolor from pastel paintings. These results show that the pigeons could learn a sensory category similar to the human category of beauty, and have a discriminative ability for complex visual stimuli such as paintings.

Producing art is a basic human activity, which has been documented since the cave drawings of human ancestors more than 30,000 years ago (Lewis-Williams, 2002). A sense of "beauty" is considered to be a uniquely human ability. People judge some products of animals, such as the nests of bowerbirds, to be beautiful; we do not know whether the birds have a similar impression. Aesthetics has been studied from evolutionary (Voland & Grammer, 2003), neuroscientific (Zaidel, 2006 ; Zeki, 1999) and cognitive perspectives (Solso, 2003). Looking at good art causes pleasure in humans; in other words, art has reinforcing properties for humans. People can discriminate good or beautiful paintings from bad or ugly paintings; they have a sensory concept or category of "good" painting. Behavioral experiments have demonstrated that birds have good visual ability not only in terms of visual acuity and color vision but also in terms of cognitive processing. For example, pigeons can be trained to discriminate many symmetrical patterns from asymmetrical patterns (Delius & Habers, 1978) . They also discriminated paintings of Monet from those of Picasso (Watanabe et al., 1995), or Chagall from Van Gogh (Watanabe, 2001). In tests after the discrimination training with paintings, pigeons successfully discriminated paintings never shown during the training. They seemed to have learned a category of artists. Do pigeons also discriminate good and bad paintings?

Experiment 1: Discrimination of "beauty" in pigeons

Here I trained pigeons on discrimination between good and bad pictures drawn by elementary school pupils. The good and bad pictures were defined by a school teacher and human observers.

Methods

Subjects

Twelve experimentally naïve pigeons were obtained from the Japanese Society for Racing Pigeons. They lived in cages individually under a 12L:12D lighting cycle and their weights were maintained at 80% of their free feeding weight. Water was freely available in the cages. They were treated in accordance with the guidelines of the Japanese Society of Animal Psychology.

Stimuli

To teach pigeons about good and bad paintings, we obtained examples of paintings by children from an elementary school in Tokyo. Watercolor and pastel paintings drawn by pupils were divided into good and bad paintings according the evaluation of the school art teacher. 57 paintings by children (age 9-11 years) that were graded A or C or D by the classroom art teacher were obtained. They were photographed using a digital camera under natural lighting. Adobe Photoshop (version 8.1) was used to modify the brightness of pictures that looked too dark or too bright, but no other processing, like control of contrast or color, was applied. Then, printed pictures (16 x 24 cm) were made. 10 adults (Students and professors in Keio University, age from 20-57 years, normal color vision) were individually asked to classify them to good and bad. There was no time limit of classification. We then selected 15 good paintings and 15 bad paintings that were classified as good or bad by the art teacher and all of the adult participants. We used 10 good and 10 bad paintings for training and used the remaining five of each group as the novel paintings. The pictures were edited using Power Point software so that the size of the painting on the monitor was 23.5 x 17.5 cm.

Apparatus

Standard operant chambers with a modified pecking window were used (30 x 25 x 30 cm, MED). The birds could see a liquid crystal display monitor of a computer (Power PCG4, iMac2.1, 800 MHz) through the rectangular transparent key (10 x 7 cm). The distance between the window and the monitor was 20cm. There was a liquid crystal shutter between the key and the monitor.

Procedure

Discriminative training: During discrimination training, 10 good (S+) and 10 bad (S-) paintings were presented 2 times each in a pseudo-random sequence. Pecking at the good pictures (S+) was rewarded by a 4 s period of access to a feeder after a variable interval with a mean of 20 s (Variable Interval 20 s schedule), whereas pecking at the bad pictures was not rewarded. After the 20 s presentation of a painting, the monitor was darkened for 5 s by a liquid crystal shutter and then the next trial began. This training continued until the birds emitted more than 90% of their total responses to the good paintings (the discrimination ratio) for 2 successive sessions. After the discrimination

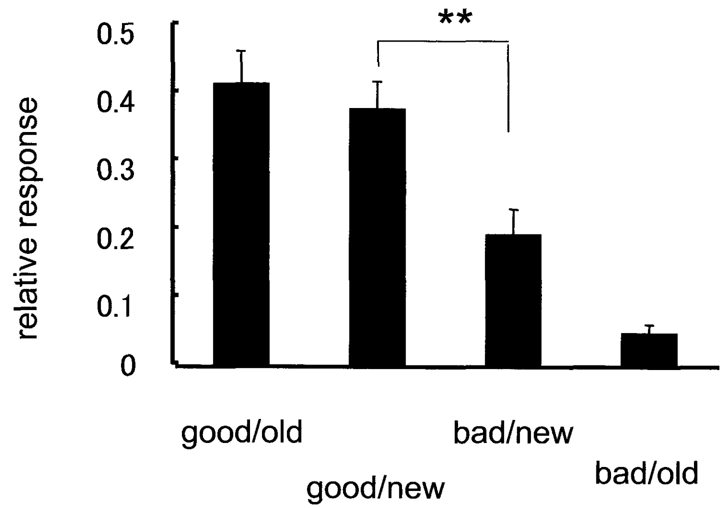

Figure 1. Generalization test. The vertical axis shows the average of relative responses to the four types of paintings, calculated by dividing the number of responses to each type by the total number of responses. a. Test after good vs. bad paintings discrimination training. The pigeons discriminated good and bad even for paintings never shown during the training. **P<0.01, paired t-test. Small bars indicate standard deviations.

training, the subjects received 4 different types of tests. Between the tests, discrimination training was carried out to maintain the discrimination. If the birds showed less than a 90% discrimination ratio, the training continued until they reached the criterion again.

Generalization test: First subjects were tested with 20 paintings consisting of 5 good and 5 bad paintings used in the discrimination training and another 5 new good and 5 new bad paintings. Each stimulus was presented 2 times for 20 sec separated by a 5 sec dark period. Pecking to any stimuli was reinforced on a Variable Interval 20 s schedule to avoid extinction.

Size reduction test: The procedures of the test were identical to the initial training procedures but size of each stimulus was reduced to 6.0 x 4.5 cm.

Gray scale picture test: This test was a black and white pictures test in which the paintings were displayed using the gray scale mode of the computer. Other procedures were identical to the size reduction test.

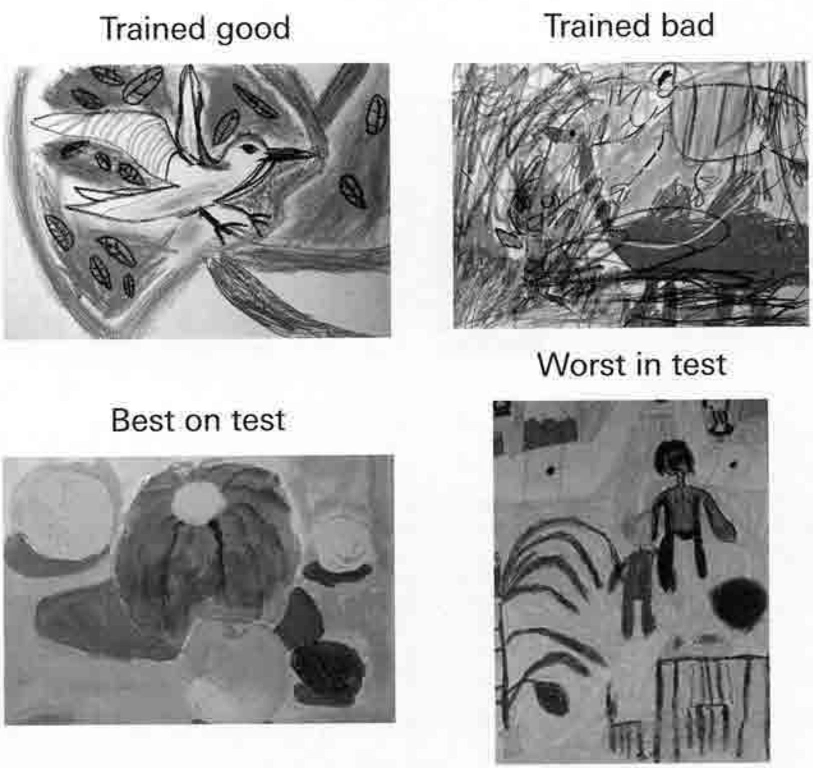

Figure 2. Examples of good and bad paintings. Paintings used in the discriminative training (upper two panels) and the novel paintings (lower two panels) to which the birds responded most often (best: left panel) and least often (worst: right panel) during the test.

Mosaic stimuli test: The forth test was a mosaic test. The original paintings were modified to consist of 10, 20, 40 and 80 pixels per mosaic unit. Thus, the third test consisted of 4 separated subtests. Other procedures were identical to the size reduction test.

Results

All of the birds learned the discrimination (average 22.5 sessions; range 18 to 32 sessions). Then, we tested the pigeons' responses to 10 paintings used for the training and 10 new paintings. These paintings were presented in random order 2 times in the test. As shown in Figure 1, the subjects responded often to the old and to the new good paintings, and less often to the old and

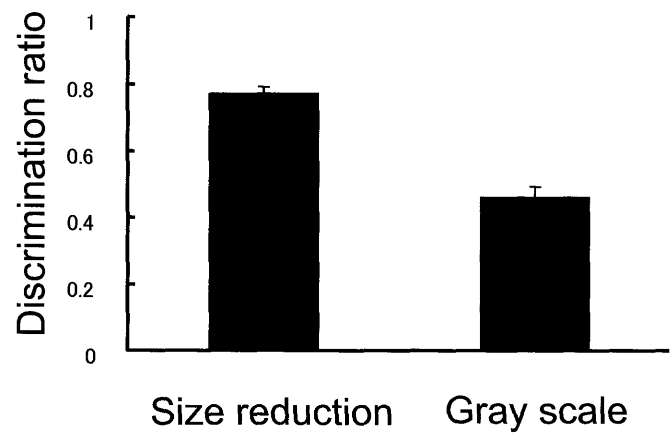

Figure 3. Results of size reduction and gray scale pictures tests. The size reduction did not affect the discrimination but the removal of color cue disturbed the discrimination. Small bars indicate standard deviations.

new bad paintings. There was no statistically significant difference in responding between the old and new good paintings, or between the old and new bad paintings. There was a significant difference in responding between new good and new bad paintings (two-tailed t-test, $t(3)=6.22$, $P<0.008$). Thus, the pigeons responded to new good and bad paintings differentially, suggesting a classification of good and bad paintings. The pecking rate for the new paintings varied individual by individual; some paintings were pecked quite often and some less often. Fig. 2 shows the best and worst of the novel paintings.

When we reduced the size of paintings (6.0 x 4.5 cm), the birds discriminated them as well as the original size (Figure 3). On the other hand, when we presented black and white paintings, their discrimination was reduced to almost chance level (Figure 3). There was a significant difference in the discrimination ratio between the monochromatic test and the training session just before the test ($t(3)=6.48$, $P<0.007$). Thus, color must be one cue for their discrimination. As shown in Figure 4, when mosaic processing was varied among 10, 20, 40 and 80 pixels per mosaic unit, their accuracy of discrimination was reduced depending on the spatial frequencies of the processing ($F(3/12)=5.74$, $P<0.05$). The discrimination ratio for 80 pixels

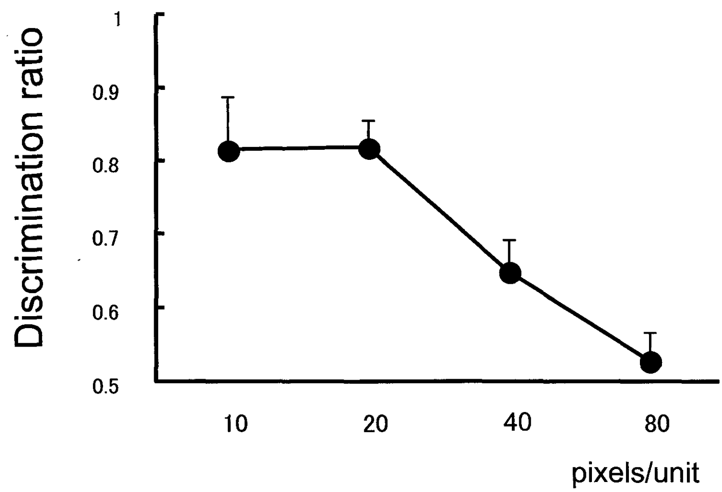

Figure 4. Results of mosaic test. Accuracy of discrimination was reduced depending on the spatial frequencies of the processing. Small bars indicate standard deviations.

was at chance level (mean =0.52, s.d.=0.07). Because the change of spatial frequency modified the shape while maintaining the global color information, these results indicate that the birds used the pattern as a cue for their discrimination.

Experiment 2: Discrimination between pastel and watercolor paintings.

Several experimental studies have demonstrated fine visual discrimination of texture in pigeons (Cook, 1992) . Using the children's painting, we trained pigeons to discriminate watercolor from pastel paintings to examine their fine visual discrimination ability.

Methods

Subjects

We trained 8 new pigeons on the watercolor vs. pastel discrimination using a procedure similar to the beauty discrimination. Four pigeons were trained

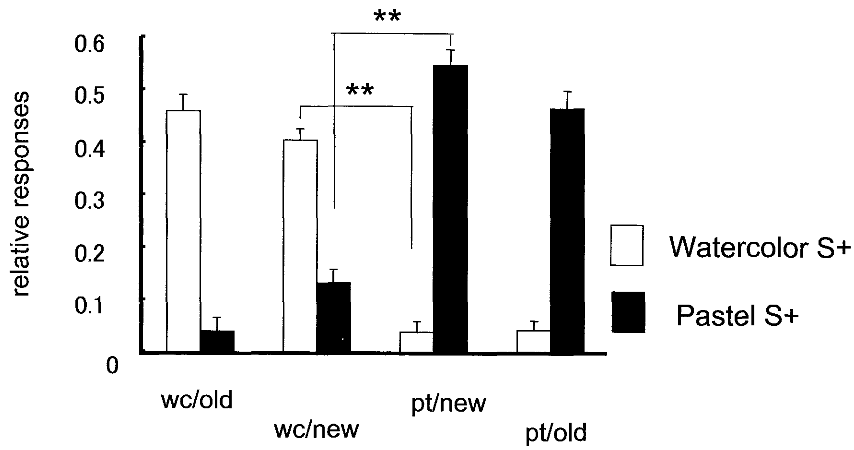

Figure 5. Test after watercolor vs. pastel discrimination training. Both the watercolor group (open bars) and the pastel group (solid bars) showed discrimination for paintings never shown during the training. **P<0.01, paired t-test. Small bars indicate standard deviations. wc: watercolor, pt: pastel.

to peck the watercolors while the remaining 4 were trained to peck the pastel paintings.

Stimuli

We selected paintings that were correctly classified as watercolor or pastel by all of the 10 adult participants. The paintings contained good and bad paintings.

Apparatus and procedures

Apparatus and procedures were identical to Experiment 1. All subjects were trained on the discrimination, then tested with generalization, size reduction, gray scale pictures and mosaic tests.

Results

Figure 5 shows results of the tests with new paintings. The pigeons clearly discriminated the new paintings ($t(3)=9.19$, $P<0.003$ for water-color group and 6.44, $P<0.008$ for the pastel group). Watercolor and pastel provided

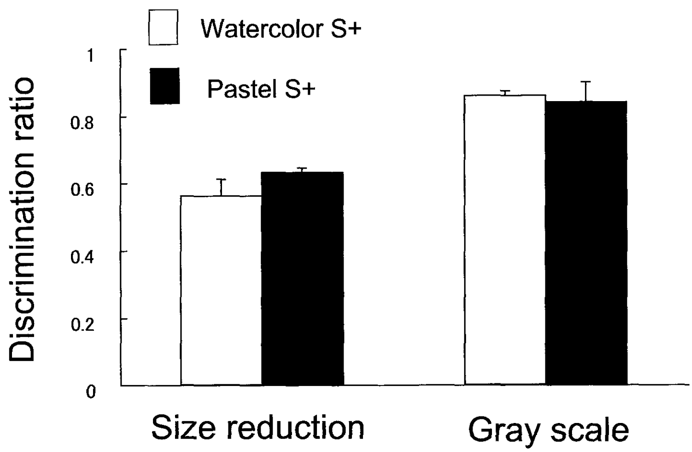

Figure 6. Results of size reduction and gray scale pictures tests. The size reduction did not affect the discrimination but the removal of color cue disturbed the discrimination. Small bars indicate standard deviations.

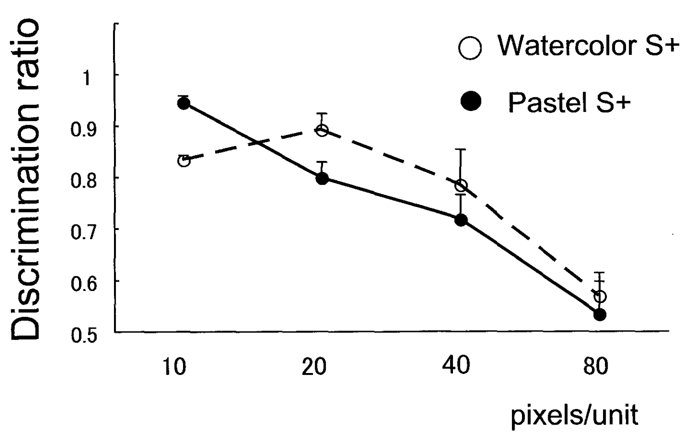

Figure 7. Results of mosaic test. Accuracy of discrimination was reduced depending on the spatial frequencies of the processing. Small bars indicate standard deviations.

sufficient information for discriminating paintings. Interestingly, reduction in size did not affect their discrimination but monochromatic test stimuli showed lower discrimination performance (Figure 6). Thus, color is an important cue for watercolor vs. pastel discrimination. Figure 7 shows results of the mosaic test. Because the mosaic processing of the 4 test levels affected the discrimination, pattern cues also played a role in the discrimination (two-way ANOVA, $F(1/24)=0.32, P=0.57$ for groups; $F(3/24)=16.27, P<0.0000005$ for mosaic processing; $F(3/24)=1.51, P=0.23$ for the interaction). The discrimination for the 80 pixel stimuli was at chance level (mean=4.34, s.d.=0.008).

Discussion

The present results demonstrate that pigeons can be trained to perform human-based discrimination of "beauty." In other words, beauty is a kind of sensory category that can be shared by humans and birds. We interviewed the teacher of the art class and the human participants on their criteria for good and bad paintings. Defining good and bad pictures was not simple even for the teacher. He pointed out technical qualities, such of using different types of brushes for watercolor and the variety of colors, but also explained that technical goodness is not the only criteria. Most of the participants said that they easily identified objects in the picture when it was good. These interviews suggested that the category of beauty is a polymorphous concept comprised of several different aspects (Lea & Harrison, 1978).

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