EFFECTS OF STIMULUS PREEXPOSURE UPON SEXUAL IMPRINTING IN THE JAPANESE QUAIL*1*2

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INTRODUCTION

It has been suggested that sexual preference is determined by the imprinting process differing from filial behaviour at an early stage, even though the processes of filial and sexual behaviour might partly overlap in the period of formation (Schutz, 1965; Klinghammer, 1967; Immelmann, 1972).

The sensitive period for sexual imprinting is significantly longer and of greater variation than is that for filial behaviour (Nicolai, 1956; Schutz, 1965). Imprintability is generally lower in sexual behaviour. Subjects raised with brood mates are less prone to imprinting on different species than are those reared in isolation (Nicolai, 1956; Gray, 1963). The intensity and maintenance of sexually imprinted preference also vary with different conditions and species (Schein, 1963; Schutz, 1969; Immelmann, 1972; Gallagher, 1978).

Among those studies on rearing conditions affecting sexual preference, the influence of siblings is still not unequivocal. As Immelmann (1972) pointed out, findings indicate that the effect may differ among different species of aves. It is necessary to accumulate data in various conditions.

The present study examines effects of preexposure to the albino adult female upon sexual preference in connection with preexposure to brood mates and with preexposure duration. The Japanese quail (*Coturnix coturnix japonica*) was chosen for the present study because this species has favourable qualities for the purpose of the study. It reaches sexual maturation at 6 weeks from hatching, which favours control of rearing condition. Its sexual behaviour is easily activated; mature males are highly motivated and show mating behaviour without being disturbed in the test situation. In addition, this species has been domesticated for both laboratory and commercial purposes, but not for a long time. The domesticated birds, therefore, have still preserved many behavioural characteristics of the wild birds.

Gallagher (1965, 1976, 1977, 1978) has found that the subjects show sexual preference for an albino adult female after having been exposed to an albino peer for 20-25 days from hatching. When the exposure period is brief, say less than 5 days, they do not prefer the albino in a choice test between pigmented and albino adult females, while they mate with albino after having been exposed to an albino peer alone. The sensitive period peaks at 6-15 days in age, ending at about 20 days. Thus, Gallagher's findings suggest that early experience with brood mates possibly acts as a factor in determining sexual preference at a later stage. However, it remains uncertain how relatively important the influence of brood mates is, since subjects were deprived of early exposure to an adult. In the present study, early rearing condition is made more natural by giving subjects experiences with both an adult and brood mates.

EXPERIMENT I

PURPOSE

Experiment I was conducted to examine effects of the experience with brood mates upon the sexual preference for an adult female.

METHOD

Subjects Male chicks (N=24) of a breed with wild-colour plumage were transferred from a poultry farm to our animal laboratory on the first day of hatching. They were reared and were tested at 50-60 days of age.

Stimulus birds Adult females (N=10) of the albino breed were used as a stimulus bird for imprinting and testing. Pigmented adult females (N=6) of the same breed as subjects were presented only in the preference test.

Rearing conditions for preexposure Same number of subjects (N=8) were randomly assigned into one of the following three groups of different conditions for the first 15 days.

1) Group S (individual): Subjects were individually reared, while being continuously exposed to an albino adult female with a Plexiglas wall in-between.

2) Group G (grouped): Subjects were reared in a group, while being exposed to an albino adult female with a Plexiglas wall in-between.

3) Group C (isolated): Subjects were reared in isolation, with exposure to neither adult female nor brood mates.

The rearing cage for Groups S and C was a small-sized box (32 x 22 x 13.5 cm) of Plexiglas with wire-meshed top. Temperature was kept at 30-40° C by a heating lamp on a side wall. The adult female for Group S was kept in a same-sized box without heating (under the room temperature of 23.5° C). The subject's cage was attached to the adult's cage side by side.

The rearing cage for Group G was a large-sized stainless-steel box (46 x 34 x 18 cm). It was bisectioned by the area ratio of 10.7 with a Plexiglas. Subjects were kept in the larger compartment heated to 30-40° C, while the adult female was kept in the smaller one without heating (23.5° C). Lighting was given from above to the cage continuously (for 24 hours) in order to equalize the visual experience of each group.

When the preexposure period was over, subjects were moved to a small-sized cage (35 x 25 x 15 cm) and were kept there individually until the day of preference test.

Preference test Figure 1 illustrates the testing situation.

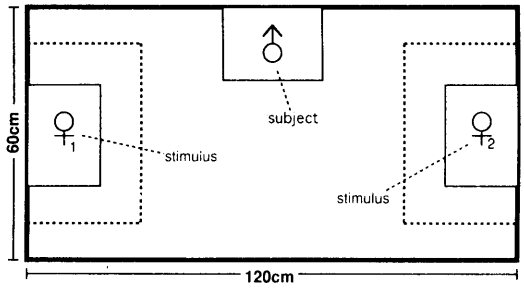

Figure 1 Ground plan of the preference test situation.

The floor of the test field was made of polystyrene to prevent subjects from slipping. The top and front wall were of Plexiglas for observation, and the other walls were of gray polyvinyl chloride.

Three bottomless boxes (17.5 x 24.5 x 12.5 cm) of Plexiglas were placed in fixed positions on the floor. Each subject was placed in the middle box between the other two which contained stimulus females for the prescribed time. The time duration of staying in the area indicated by broken lines in Figure 1 was measured.

Preference was tested between albino and pigmented adult females. Each subject was visually exposed for 120 seconds to the two females confined in the box. Then, he was released to move about for 90 seconds while the females were still confined. This procedure allowed observation of approaching behaviour. Finally, the females were also set free to

observe mating behaviour.

Each trial was finished when mounting occurred to either of the females, but the trial was ceased if mounting did not occur during the observation period of 10 minutes. Testing was run at one trial per day for 10 days starting on the 51st day after hatching. By inspection, all subjects were normal in sexual maturation.

Data were collected for choice in mounting as well as for total time of staying in the approach area during the 90-second exploration period.

RESULTS

Figure 2 shows the mean time of staying in each approach area. Group S stayed longer in the albino area than in the pigmented area, while Groups G and C stayed longer with the pigmented female. A binominal distribution tests showed significant differences between the two staying times for all three groups (CR=10.85, $p<.01$ for Group S; CR=15.15, $p<.01$ for Group G; CR=7.29, $p<.01$ for Group C). It was demonstrated that only Group S was affected by preexposure to the albino.

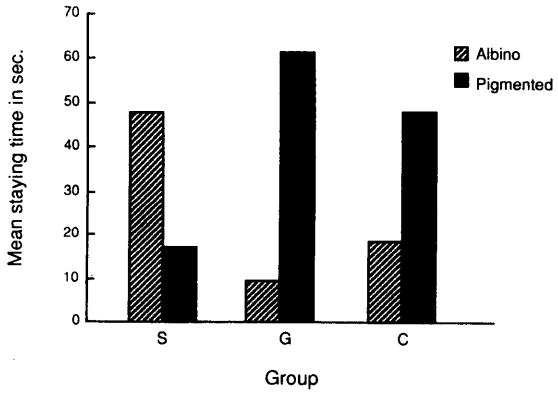

Figure 2 The mean staying time in the preference test (Experiment I).

Figure 3 shows the mean frequency of mounting to each stimulus female in a total of 10 trials. Group S mounted the albino female more frequently, while the remaining two groups preferred the pigmented female for mounting. The data indicated significant differences for the choice ratio of mounting in each group (CR=1.91, $p<.05$ for Group S; CR=2.64, $p<.01$ for Group G; CR=2.10, $P<.05$ for Group C). The similar effect of preexposure was found here on mounting.

These results suggest that separation from brood mates during a sensitive period is a prerequisite for sexual imprinting to a substitute stimulus in this species.

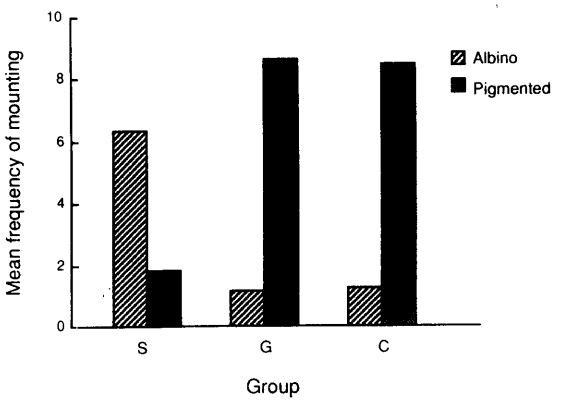

Figure 3 The mean frequency of mounting in the preference test (Experiment I).

EXPERIMENT II

PURPOSE

This experiment was conducted to examine whether the age period of preexposure to a substitute stimulus has an impact on sexual preference at a later stage.

METHOD

Subjects Male chicks (N=21) of a breed with wild-colour plumage were transferred to our laboratory on the first day of hatching. They were artificially reared and were tested later at 50-60 days of age.

Stimulus birds Adult females (N=8) of the albino breed were used as the stimulus for imprinting and testing. Pigmented adult females (N=8) of the same breed were presented only in the preference test, as in Experiment I.

Rearing conditions for preexposure All the subjects were reared in separation from brood mates starting at a few hours after hatching and throughout the experiment.[*3] They were randomly assigned into one of three groups differing in the age period exposed to an adult female; subjects exposed to the albino from the 1st through 5th day after hatching (Group I), from the 6th through 10th day (Group II), and from the 11th through 15th day (Group III). Detailed rearing conditions were completely identical to those of Group S in Experiment I except for the duration and age of preexposure.

Preference test The test box was the same as for Experiment I. The same testing procedure was adopted.

RESULTS

Figure 4 shows the mean time of staying in each approach area. Group II spent longer in the albino area than in the pigmented area. Groups I and III, on the other hand, stayed longer within the pigmented area. However, differences in staying time between two groups were not statistically significant in either of the three groups.

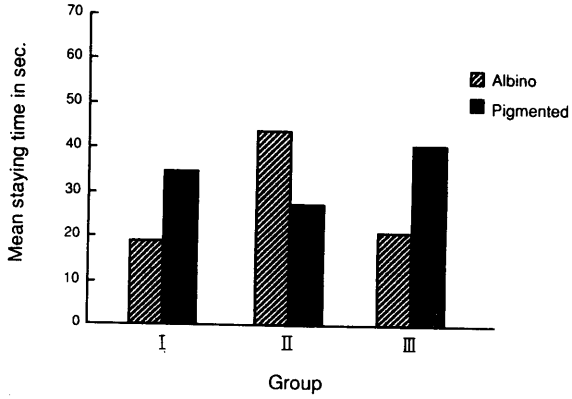

Figure 4 The mean staying time in the preference test (Experiment II).

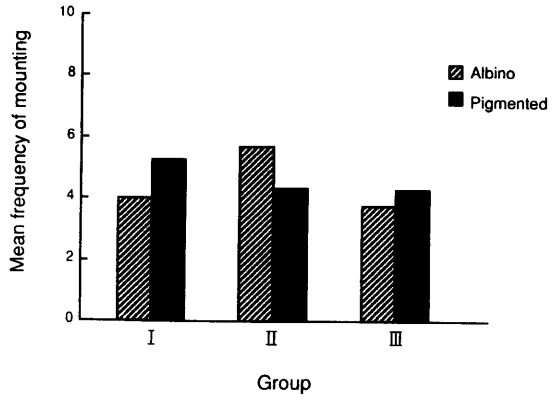

Figure 5 The mean frequency of mounting in the preference test (Experiment II).

Figure 5 shows the mean frequency of mounting to each stimulus female. Statistical test failed to find significant differences in this measure between any two of the groups,

although mounting to the albino occurred more frequently only in Group II.

Closer examination of the data proved that there were some subjects which preferred the albino to the pigmented in three groups. The percentage of albino-preferring subjects was 43, 50, 43, and the relative frequency of mounting to the albino (the frequency ratio of the albino female to the total frequency) was 0.43, 0.59, 0.47, for Group I, II, III, respectively. It is interesting to compare these values with the value for Group C of Experiment I who were deprived of both adult female and brood mates during the preexposure period. In Group C, all the subjects preferred the pigmented female, and their frequency ratio of mounting to the albino (0.13) was significantly lower than the ratio for all of the groups of Experiment II ($\chi^2=16.962$, df=3, $p<.001$), while the ratio for Group S of Experiment I (0.78) was remarkably higher than the ratio for Group II.

Therefore, it could be inferred that sexual imprinting might have occurred to some extent by the 5-day preexposure, but the amount was not so much as to surpass the innately built-in preference.

DISCUSSION

The subjects who were exposed to the albino adult female for the first 15 days were strongly imprinted, as was seen in Group S of Experiment I. However, rearing with brood mates made the experience of preexposure ineffective, as was demonstrated by the fact that the subjects of Group G preferred the pigmented female. When subjects were deprived of the experience with both adult female and brood mates, they showed sexual preference for the conspecific female (the same breed, in this case), as was seen in Group C. This suggests that an innately built-in mechanism for sexual preference works, unless an early experience can affect to change its manifestation.

When the preexposure period to the albino female was reduced to 5 days, its effect was not significantly marked. Such a brief preexposure, however, tended to affect the preference, even if the effect was not able to exceed the innately determined tendency.

It is suggested that sexual imprinting on the substituted stimulus is limited to the condition in which a subject is exposed to it while being deprived of his mother and brood mates. However, the results did not directly imply that brood mates were more influential than the mother, since both effects were not matched in the present experiments. Subjects in Group G could contact physically as well as visually and auditorily with brood mates, while they had only visual and auditory experience with the albino adult female. This

holds true of the comparison of imprintability with Gallagher's results. The possible effect of auditory cues upon preference can probably be discounted. Stimulus females scarcely uttered any vocalizations in the test situation, and subjects did not respond to vocalization even if the female made it on rare occasions.

It might be questioned whether the experience with brood mates affects the imprinting process as such, or only activates the innate mechanism to cope with an anomalous situation. If the former is what happens, the process cannot be initiated at the earliest stage, say at least in the first week, since chicks at this stage have no common appearance to the adult in their plumage. Gallagher (1976), having exposed subjects to albino chicks of the same age for the first 5 days, failed to find sexual preference for an albino female in a free-choice test, although his data were not unequivocal because the subjects mounted the albino in the single-stimulus test.

Sexual dimorphism in appearance is not so typical in this species, but sexual difference in plumage on the chest is distinguishable from the second week. Chicks at 13-15 days look like adults in their plumage. It would be biologically adaptive, if any characteristic in the chick at this age is imprinted. The preexposure period should be sectioned to examine it further.

Males of this species are sexually active; sexual behaviour shows a rapid sequence with a lack of elegant display to the reluctant mate. Male-male mounting is frequently observed, when males are kept in separation from females. It is worth noting that males did not mate with the albino female but tried to pair with a male of their own breed, even after they had been placed in a unisexual group for a long period while deprived of females. One possible inference would be that males had difficulty in detecting a signal to release sexual behaviour when they met an albino female with featureless plumage. Any preference for the albino female in the present experiments is more noteworthy, when this fact is taken into consideration. It is a task for further investigation to compare the imprintability among various breeds including variations of plumage colour.

Attempts to elaborated the basic conditions determining sexual preference would contribute to correcting a misleading emphasis upon the possibility of imprinting on an artificially substituted stimulus.

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ABSTRACT

Effects of preexposure to an albino adult female upon sexual imprinting were examined in relation to an early experience with brood mates (Experiment I) and with the age period of preexposure (Experiment II), by using the Japanese quail (*Coturnix coturnix japonica*). Male chicks of a breed with wild-coloured plumage were reared in each of three different conditions for the first 15 days. The birds with preexposure to the albino adult female in separation from brood mates showed sexual preference for the albino female, while the birds with preexposure in a group of brood mates and those with complete deprivation of other birds showed no preference for the albino. When the preexposure duration was reduced to 5 days, imprinting on the albino was not significantly large.

Such brief pre-exposure, however, tended to affect the preference, even if the effect failed to exceed the innate tendency. It is thus suggested that sexual imprinting on the substitute stimulus is limited to the condition in which a subject is reared in separation both from brood mates and real mother.

[FOOTNOTES]

*1 Data of this study were collected by Naomi Mizuno for her graduation thesis under the guidance of the present authors.

*2 Requests for reprints should be addressed to the first author: Keiichiro Tsuji, Department of Psychology, School of Letters, Nagoya University, Furocho, Chikusaku, Nagoya, Japan 464-01.

*3 Before sex-checking, newly hatched chicks were kept in an incubator for 1-3 hours, inside which they had both sensory and physical contact with brood mates under dim light.