Specific Habituation by Chicks

Certain changes in the sensory input of an animal are immediately followed by a reaction from that animal which is the same for a variety of different changes. This orientation reaction was first described by Pavlov, who referred to observable changes in posture such as turning the head to look or listen in a particular direction. Many other changes within the animal have been found to coincide with such movements and are therefore considered to be part of the orientation reaction. Lynn has summarized the various components of the reaction which have been measured.

Repetition of a change in environment leads to reduction in the duration and extensiveness of the orientation reaction and, as far as present recording techniques can determine, to its final disappearance. After an environmental change has occurred at intervals until the disappearance of the orientation reaction, slight modification of that change may be followed by the reappearance of the reaction. The degree of modification necessary for such a reappearance depends on various factors and is limited by the acuity of the sensory system concerned. Sokolov has described experiments in which animals habituated to a tone of a particular pitch or duration showed a reaction, measured physiologically in various ways, when the pitch or duration was altered. To explain such results, Sokolov has proposed that with repeated presentation of a stimulus a "neuronal modal", related to it, is gradually formed. Responses to subsequent stimuli depend on a comparison between the stimuli and the model. If that further input corresponds exactly with the model, no reaction occurs, but a mismatch of any sort is followed by an orientation reaction and, presumably, by a modification of the model.

This and other theories of the mechanisms of habituation are reviewed by Lynn. The physiological mechanisms suggested by Sokolov to account for his observations have recently been questioned by Horn, who points out that some aspects of habituation can be explained without postulating an active gating process after the matching of model and stimulus. Horn also quotes evidence, for some situations, against Sokolov's statement that the model and matching system are located in the cortex, and that the afferent signal to the reticular formation, where the behavioral change is presumed to be initiated, is controlled by fibers originating in the
cortex. Horn’s proposals do, however, include a model forming system, which in the case of time dependent experiments may be two-stage, and thus do not conflict with Sokolov’s behavioural hypothesis, only with some of the mechanisms he suggests.

The aim of this study was to test Sokolov’s general hypothesis using behavioural measures and to see whether the theory applied also to birds. The reactions shown by young domestic chicks to a regularly repeated light flash and the effects of varying the duration of that flash are described.

Chicks were reared from hatching singly in grey-walled pens with a 6·3 V torch-bulb present on the wall. This bulb could be silently illuminated by an automatic timing mechanism. The observer was never seen or heard by the chicks. The birds were watched individually and their behaviour was recorded continuously using a moving paper event recorder. Every initiation, termination or change of direction of a movement, and the bout length of the fifteen most frequent measures of behaviour, were recorded.

When the seventeen chicks used in the experiment were 2–3 days old, the torch-bulbs were illuminated on a regime of 10 s on, 20 s off. This was the first illumination change seen by the chicks since being placed in the pens. Each bird was watched for 2·5 min before and for 2·5 min after the initial illumination. The regime was maintained for 18–24 h, after which the chicks were watched for a further 2·5 min and then for 15 min while the duration of the bulb-on period was altered at intervals.

The changes in the behaviour of chicks which result from the illumination of a torch-bulb in their home pen have been reported elsewhere. A major change in behaviour during the 3 s after the first bulb illumination was shown by 94 per cent of the chicks watched in this experiment. The exact nature of the change varied from one individual to another, but any call, jump, head-shake, head turn so as to fixate the bulb, or abrupt termination or change in direction of an activity, is referred to here as a major change. The beginning or end of bouts of frequently occurring activities are called minor changes in behaviour. A comparison of the 2·5 min before the initial bulb-on with the 2·5 min after, using two-tailed Wilcoxon matched pairs tests, showed increases in calling loudly and jumping (\(P < 0.01\)), fixing the torch-bulb (\(P < 0.01\)), and moving close to the torch-bulb (\(P < 0.05\)).

When each chick was watched for 2·5 min after the regime had been operating for 18–24 h, no bird showed an important change in behaviour during the first 3 s after any bulb-on, and minor changes occurred in only 2 per cent of these 3 s periods. Thus the reaction to the light flash, as assessed by measurement of overt behaviour, had disappeared.
The illumination regime was then altered in one of two ways (Fig. 1). The 30 s period which included 10 s bulb-on and 20 s bulb-off became: (a) 5 s on, 25 s off \((n=8)\); or (b) 15 s on, 15 s off \((n=9)\). After one such alteration, the previous regime was reinstated for five 30 s periods before another change of the same type. This procedure was repeated so that each bird was subjected to the changed regime five times at 3 min intervals. The only change detectable by the chicks was in flash duration, for the timer controlling the regime was inaudible to them, being in a different room, and the use of a constant voltage supply prevented any change in bulb brightness.

If a model of the regular input were formed and an overt reaction occurred when the subsequent input did not match that model, it would be expected that the behaviour of the chicks would show a change in group \((a)\) at 5 s after bulb-on, that is to say, when the bulb went off too early, and in group \((b)\) at 10 s after bulb-on, that is to say, when the bulb would normally have been extinguished but was not. Such changes should be apparent within 5 s, so that data from the record of continuous observation which are quoted here are for 5–8 s after bulb-on in group \((a)\) and for 10–13 s in group \((b)\).

During the five 30 s periods before the alteration in flash duration, none of the chicks in group \((a)\) showed a major change in behaviour between 5 and 8 s after bulb-on, and none of those in group \((b)\) showed a major change between 10 and 13 s after bulb-on. In the five periods during which the flash duration was altered, however, major behaviour changes were shown by 83 per cent of group \((a)\) birds between 5 and 8 s after bulb-on and by 100 per cent of group \((b)\) birds between 10 and 13 s after bulb-on.

The most obvious changes in behaviour were the fixation of the bulb for at least 2 s and a sudden shake of the head or whole body accompanied by a brief cessation of whatever activity was being performed. Other frequent changes included the initiation of a series of rapid pecks directed at the ground or the wall or sudden isolated pecks, scratches, calls or preening. Some birds walked
Table 1. INCREASE IN BEHAVIOUR CHANGES AFTER ALTERING FLASH DURATION*

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Before altering flash duration</th>
<th>After altering flash duration</th>
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<td></td>
<td></td>
<td>0-3 s</td>
<td>5-8 s</td>
</tr>
<tr>
<td>(a)</td>
<td>8</td>
<td>0</td>
<td>0</td>
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<tr>
<td>(b)</td>
<td>9</td>
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* Each figure is the percentage of major behaviour changes during 3 s observation.

"Before altering flash duration" figures are for the 3 s starting at bulb-on, and 5 and 10 s after. "After altering flash duration" figures are for 5–8 s after in group (a) and 10–13 s in group (b). The total percentages for all five periods and the figures for successive periods are shown.

Towards or away from the bulb. A comparison of the frequency of major changes in behaviour before altering flash duration and in the five successive periods in which the duration was altered is shown in Table 1.

For group (a), a comparison of the behaviour of each bird in the 5–8 s after bulb-on during the five periods before altering flash duration, with the corresponding time during the five periods in which the duration was altered, gave a two-tailed value for $P$ of 0.02 (Wilcoxon matched pairs test). For group (b), in a similar comparison but for the 10–13 s after bulb-on, $P < 0.01$ two-tailed.

In group (a), 75 per cent of the chicks reacted to the early extinction of the bulb when this first occurred, but none reacted to the fifth duration change. This change from a 10 to a 5 s flash is presumably large enough to be readily detected as a discrepancy between previous and present input but, as far as is apparent from behavioural observation, the "model" is modified rapidly. Fewer birds reacted initially to a change from a 10 to a 15 s flash, but the total percentage of reactions over the five changes was almost the same. This change may be less easily detected than that from 10 to 5 s and the "model" is not modified as rapidly.

The recording was continuous, so it was possible to look for behaviour changes during periods other than those in which the flash duration was altered. The chicks often showed changes in behaviour when the bulb was illuminated as usual in the 30 s period following that of altered duration. For both group (a) and group (b), in 28 per cent of the bulb-illuminations following periods in which flash duration had been altered, major changes in behaviour occurred in the first 3 s. Results of Wilcoxon tests comparing these 3 s periods with the corresponding periods before altering the duration for both major changes, and major and minor changes combined are as follows: group (a), major change $P > 0.05$, major or minor change $P = 0.05$; group (b), major change $P = 0.05$, major or minor change $P = 0.01$ (all two-tailed). This effect of an environmental change on subsequent reactivity to a regular change is similar to some of those described for various mammals².

Using entirely behavioural measures, these results support the hypothesis that the mechanisms underlying
such reactions include the formation of a model of the repeated sensory input and some system for comparing subsequent input with that model. This comparison could be active, as required by Sokolov, or passive as suggested by Horn. A mismatch may be followed by an overt reaction, a change in the likelihood that the animal will respond to further input, and modification of the model.

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1 Pavlov, I. P., Lectures on the Work of the Cerebral Hemispheres, No. 2 in Selected Works (edit. by Koshtoyants, Kh. S.), 199 (Moscow, 1924).