

THE PEEP VOCALIZATION IN GROUP REARED CHICKS (*GALLUS DOMESTICUS*): ITS RELATION TO FEAR

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Abstract. The relation of fear and arousal to peeping in socially-reared chicks was investigated in a series of four experiments. Pre-test exposure to loud noise or shock resulted in decreased peeping in chicks tested in isolation, while in the presence of a mirror, pre-test exposure to loud noise reduced peeping, but pre-test shock had no effect. It was also shown that neither tranquilizer (Pacitran) ingestion nor experimenter proximity had any significant influence on peeping. An inverse relationship between peeping and activity latency was also revealed in these experiments, and peeping was usually found to precede the initiation of activity. The relationship between fear and the peep vocalization of socially-reared chicks is discussed.

The vocalization patterns of domestic fowl consist of simple call note signals (Lanyon 1960). Numerous attempts have been made to classify the vocalization patterns of the chick into different categories (Andrew 1963; Guyomarc'h 1966; Guhl & Fisher 1969). The vast bulk of chick vocalizations, however, can be classed as either twitters or peeps. Collias (1952) referred to the twitter and peep calls as 'pleasure notes' and 'distress calls', respectively.

Many investigators (Collias & Joos 1953; Hess 1959a, 1959b, 1959c; Hess & Schafer 1959; Kaufman & Hinde 1961; Salzen 1962; Salzen & Tomlin 1963; Rubel 1970; Sluckin, Fullerton & Guiton 1970) have either referred to the peep vocalization of the domestic chick or other precocial nidifugous young as a fear response and/or have employed the call as a measure of fear. Phillips & Seigel (1966) suggested that the peep vocalization may represent a reflexive response that becomes conditioned to fear stimuli. Andrew (1963, 1964, 1969) has proposed that chick call patterns form a unitary response system and are elicited by stimulus contrast in the environment. The present series of experiments examined the assumed relationship between peeping and fear.

The tonic immobility response in domestic chicks has also been interpreted as a fear response (Ratner & Thompson 1960; Salzen 1963). Recent evidence has been gathered in support of this hypothesis (Gallup, Creekmore & Hill 1970a; Gallup et al. 1970b; Gallup, Cummings & Nash 1972); and four of the experi-

mental manipulations that were found effective in enhancing the immobility reaction were employed in the following experiments to determine to what extent peeps represent a fear response in group-reared domestic chicks.

Methods

Subjects

One hundred and sixty-five Production Red chicks (*Gallus domesticus*) obtained from a local hatchery at 1-day post-hatch were housed in commercial brooders equipped with thermostatic temperature devices. Chick chow and water were available ad libitum, and the photoperiod consisted of approximately 14 hr of natural and artificial light per day.

Apparatus

A Lafayette Activity Platform (A501) wired to an electric counter was used to record activity. Stopwatches were used to record latencies and test duration, and a hand counter was used to record peeps.

Chicks were fitted with plastic leg bands 2 days prior to testing, and testing began at 15-days post-hatch. The subjects were randomly divided into two groups; one group was tested in the presence of a mirror, the other in the empty activity box. On day 1 each bird was tested individually for 3 min in the activity box. On day 2 the same procedure was followed, but half of the birds in the mirror and no-mirror groups were randomly assigned to experimental conditions, while the others served as controls. The experimenter was out of sight during all testing

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except for experiment 1. The dependent measures recorded in all tests were peeps, jumps, activity, and latencies of first peep and first recorded activity.

Procedure

Experiment 1. Chicks manually restrained in the presence of experimenter remained immobile significantly longer than those separated from the experimenter by a plywood barrier (Gallup et al. 1972). This experiment investigated the effects of experimenter proximity on the peeping and activity of chicks. Forty chicks were tested according to the procedure described above. On day 2 the subjects in the experimental groups were tested in full view of the experimenter who stared into the activity box from a distance of 0.5 m for the duration of the test.

Experiment 2. Chicks given brief pre-induction exposure to loud noise remained immobile significantly longer than those not given such exposure (Gallup et al. 1970b). This experiment investigated the effects of pre-test exposure to loud noise on peeping and activity. Forty chicks were tested in the manner previously described. On day 2 prior to the start of testing, the subjects were exposed to a 2-s blare from a portable signal horn (Hamilton Power Pack) held over the activity box. The horn generated a low frequency sound of approximately 120 db. The control chicks were treated similarly but were not exposed to the sound.

Experiment 3. The administration of pre-induction shock has also been shown to produce an enhancement of the immobility response (Gallup et al. 1970a), and there is an ample precedent for using shock as a fear stimulus. To investigate the effects of pre-test shock on peeping and activity forty chicks were tested in accordance with the previously described procedure. Prior to testing on day 2 the experimental subjects' legs were dipped in a mild saline solution and wrapped with leads from a Foringer shock generator (A-615 AR); each chick received a 2 mA shock of 3-s duration. The controls were treated similarly but received no shock.

Experiment 4. The first three experiments investigated the effects of stimulus manipulations designed to increase arousal; a fourth experiment was added to study the effects of reduced arousal on peeping and activity. It has been shown that the administration of metoserpate hydrochloride (Pacitran) to pullets

10 weeks of age and the cockerels 7 weeks of age resulted in docile, non-excitabile behaviour (Bell-off & Hsu 1963). On day 1, forty-five subjects were tested in the standard manner except that all chicks were tested without a mirror. Following testing fifteen subjects were randomly assigned to each of three different brooders. On the morning of day 2 all birds were deprived of water for 3½ hr and then allowed to drink from troughs containing either ordinary tap water or water containing a 0.00375 per cent or a 0.015 per cent concentration of metoserpate hydrochloride. These drug concentrations result in approximate individual dosages of 1 mg per kg and 4 mg per kg of body weight. Tranquilization is well established by 90 min and lasts for 24 hr. All subjects were tested from 2 to 5 hr following drug ingestion.

Results

Control Data

The peep data of the control groups from experiments 1, 2 and 3 were combined and subjected to a repeated measures analysis of variance in which experiments (1, 2 or 3) and mirror (mirror or no-mirror) were between-subjects variables and days was a within-subjects variable. This analysis was computed in order to establish base line trends with which to evaluate the experimental treatments. The peep latency and activity latency data were analysed similarly. For the most part the data on jumps and activity were found to be insensitive to test procedures and were not analysed. The scarcity of reliable data from these measures was probably due to the brief test (3 min). Activity latency, however, was used as an indicator of activity level.

Figure 1 shows that the mirror controls peeped less than the no-mirror controls in all experiments ($F=43.16$, $df=1/54$, $P<0.001$). This main effect of mirror was consistent over experiments as indicated by the non-significant experiments \times mirror interaction. The mean number of peeps emitted by each control group increased from day 1 to day 2, resulting in a significant main effect of days ($F=29.58$, $df=1/54$, $P<0.001$). This peep increase across days was consistent over experiments as indicated by the non-significant experiments \times days interaction. There was also a reliable trend over experiments for the no-mirror controls to show greater increases in peep frequency from day 1 to day 2 than did the mirror controls. This resulted in a significant mirror \times days

interaction ($F=11.02$, $df=1/54$, $P<0.005$) and a non-significant experiments \times mirror \times days interaction. These trends are also evident in the no-mirror control data of experiment 4.

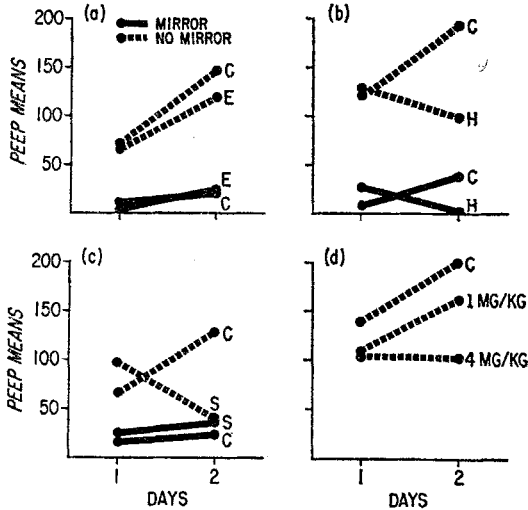


Fig. 1. Mean number of peeps emitted in 3 min over day 1 and day 2 for all four experiments. C=control groups; E=experimenter groups; H=horn groups; S=shock groups.

Table I shows that the mean peep latencies (latency of first peep vocalization) of the mirror controls were greater than those of the no-mirror controls in all experiments ($F=22.95$, $df=1/54$, $P<0.001$). Again, the experiments \times mirror interaction was not significant. All control groups showed a decrease in mean peep latency over days. The days effect was significant ($F=33.36$, $df=1/54$, $P<0.001$), while the experiments \times days interaction did not reach statistical significance.

Table I also shows that the mirror controls exhibited longer activity latencies than the no-mirror controls in all experiments ($F=25.86$, $df=1/54$, $P<0.001$). The experiments \times days interaction was non-significant. The activity latencies of all control groups decreased from day 1 to day 2, resulting in a significant effect of days ($F=11.43$, $df=1/54$, $P<0.005$) and a non-significant experiments \times days interaction. There was also a consistent trend for the no-mirror controls to show greater decreases in activity latency over days than the mirror controls. This yielded a significant mirror \times days interaction ($F=6.80$, $df=1/54$, $P<0.05$) and a non-significant experiments \times mirror \times days interaction.

Table I. Mean Peep Latency and Activity Latency in Seconds Over Days 1 and 2

| Treatment conditions | Peep latency | | Activity latency | |
|----------------------|--------------|-------|------------------|-------|
| | Day 1 | Day 2 | Day 1 | Day 2 |
| Experiment 1 | | | | |
| Mirror-control | 152.8 | 101.5 | 148.4 | 139.8 |
| Mirror-E | 147.4 | 106.8 | 138.6 | 159.3 |
| No-mirror-control | 66.6 | 20.0 | 128.1 | 84.0 |
| No-mirror-E | 73.4 | 22.8 | 146.3 | 73.3 |
| Experiment 2 | | | | |
| Mirror-control | 134.2 | 50.5 | 180.0 | 171.8 |
| Mirror-horn | 130.1 | 158.7 | 151.4 | 162.2 |
| No-mirror-control | 62.1 | 2.0 | 112.4 | 84.4 |
| No-mirror-horn | 69.8 | 83.1 | 108.8 | 125.2 |
| Experiment 3 | | | | |
| Mirror-control | 137.0 | 119.4 | 180.0 | 180.0 |
| Mirror-shock | 132.7 | 38.6 | 168.9 | 126.6 |
| No-mirror-control | 81.1 | 35.4 | 141.6 | 85.4 |
| No-mirror-shock | 59.2 | 76.4 | 109.1 | 141.7 |
| Experiment 4 | | | | |
| Control | 56.8 | 15.5 | 123.7 | 98.2 |
| 1 mg/kg | 49.0 | 16.5 | 125.0 | 110.2 |
| 4 mg/kg | 71.0 | 45.9 | 124.6 | 133.5 |

For the most part, peeping and activity latency appeared to vary inversely with one another. Significant negative correlations between the peeping and activity latency data of the combined control subjects (pooled over mirror and no-mirror treatments) were obtained on day 1 ($r=-0.7543$, $df=73$, $P<0.005$) and on day 2 ($r=-0.5793$, $df=73$, $P<0.005$).

Experimental Treatments

In general the effect of treatments was to inhibit the normal increase in peep rate from day 1 to day 2 (Fig. 1). For convenience in examining the results, the data of the mirror and no-mirror conditions were analysed separately for each experiment. Experiment 4 contained only no-mirror data. A repeated measures analysis in which treatments was the between-

subjects variable and days, the within-subjects variable, was run on all data of each experiment.

Experiment 1. As Fig. 1a shows, the mean number of peeps emitted by mirror-experimenter and mirror-control groups increased over days ($F=8.95$, $df=1/18$, $P<0.01$), whereas the mean peep latencies of both mirror groups decreased over days (Table I), resulting in significant days effect ($F=9.21$, $df=1/18$, $P<0.01$). There was no clear relationship between the peeping and activity latency measures of the mirror-experimenter birds on either day 1 or day 2.

Figure 1a also shows that the peep means of the no-mirror groups increased from day 1 to day 2 ($F=9.85$, $df=1/18$, $P<0.01$). Although the no-mirror-experimenter group appeared to increase less than the mirror-control group over days, the interaction of treatments \times days was not significant. Table I shows that the mean peep latencies of the no-mirror-experimenter and no-mirror-control groups decreased over days ($F=11.43$, $df=1/18$, $P<0.005$). Table I also shows that both mirror groups exhibited shorter activity latencies on day 2 than on day 1 ($F=12.80$, $df=1/18$, $P<0.005$). The peeping and activity latency measures of the no-mirror-experimenter group were inversely related on day 1 ($r=-0.9592$, $df=8$, $P<0.005$), while the negative correlation between these data on day 2 did not attain statistical significance.

Experiment 2. Figure 1b shows that the mean number of peeps emitted by the mirror-horn group decreased sharply over days, while the mirror-control group peeped more on day 2 than on day 1. This yielded a significant horn \times days interaction ($F=5.17$, $df=1/18$, $P<0.05$). Table I shows that the sound of the horn produced an increase in the mean peep latency of the mirror-horn group as indicated by the significant effect of horn ($F=5.33$, $df=1/18$, $P<0.05$). The mirror-control group, moreover, showed a decrease in mean peep latency, and this resulted in a significant interaction of horn \times days ($F=10.19$, $df=1/18$, $P<0.01$). The longer the activity latencies mirror-horn subjects exhibited the less they peeped on day 1 ($r=-0.7950$, $df=8$, $P<0.005$), while no clear relationship was found between these measures on day 2.

Figure 1b also shows that the mean number of peeps of the no-mirror-horn group decreased over days, while those of the no-mirror controls increased. This yielded a significant horn \times days interaction ($F=5.10$, $df=1/18$, $P<0.05$). The peep latencies of the no-mirror-horn group

increased over days, while those of the no-mirror controls decreased (Table I), resulting in a significant horn \times days interaction ($F=5.67$, $df=1/18$, $P<0.05$). Table I also shows the no-mirror-horn group showed longer activity latencies on day 2 than on day 1, while the mean activity latency of the no-mirror-control decreased over days. However the horn \times days interaction of these data was non-significant. The longer the no-mirror-horn chicks delayed before moving, the less they peeped on day 1 ($r=-0.9973$, $df=8$, $P<0.005$) and day 2 ($r=-0.7336$, $df=8$, $P<0.01$).

Experiment 3. The peep means of both mirror groups increased over days (Fig. 1c), but not significantly. Table I shows that the mean peep latencies of both mirror groups decreased from day 1 to day 2, and a significant days effect was obtained ($F=7.74$, $df=1/18$, $P<0.05$). The mirror-shock group showed lower mean activity latency than the mirror control group (Table I), this yielded a significant effect of shock ($F=5.90$, $df=1/18$, $P<0.05$). The mirror-shock group also appeared to exhibit an inverse relation between peeping and activity latency. Significant negative correlations were yielded in the analysis of these data on day 1 ($r=-0.9942$, $df=8$, $P<0.005$) and on day 2 ($r=-0.6484$, $df=8$, $P<0.025$).

Figure 1c also shows that the mean number of peeps emitted by the no-mirror-shock group decreased over days, while the no-mirror controls exhibited an increase. The shock \times days interaction was significant ($F=6.78$, $df=1/18$, $P<0.05$). The no-mirror-shock subjects exhibited longer activity latencies on day 2 than on day 1, while those of the no-mirror-controls decreased (Table I), and the shock \times days interaction for these data was significant ($F=9.94$, $df=1/18$, $P<0.05$). The peeping and activity latencies of the no-mirror-shock group were inversely related on day 1 ($r=-0.9338$, $df=8$, $P<0.005$), although on day 2 no clear relationship was apparent, and the correlation of these data did not attain statistical significance.

Experiment 4. Figure 1d shows that the peep means of the control and 1 mg per kg groups increased over days, while the 4 mg per kg group showed no increase. However, neither the main effect of drug nor the drug \times days interaction reached significance, while the days effect was significant ($F=5.39$, $df=1/42$, $P<0.05$). The analysis of the peep latency data yielded a significant days effect ($F=9.69$,

$df=1/42$, $P<0.005$) with all groups showing decreases over days (Table I). Although there appeared to be a trend for the drug groups to exhibit longer activity latencies than the control group on day 2 (Table I) and lower mean activity counts (8.8 for the control, 6.0 for the 1 mg per kg and 2.3 for 4 mg per kg group) on day 2, the drug \times days interaction of these analyses were not significant.

The drug groups appeared to exhibit an inverse relationship between their peeping and activity latency performances. These data yielded significant negative correlations for the 1 mg per kg group on day 1 ($r=-0.8157$, $df=13$, $P<0.005$) and on day 2 ($r=-0.5985$, $df=13$, $P<0.01$) and for 4 mg per kg group on day 1 ($r=-0.8183$, $df=13$, $P<0.005$) and on day 2 ($r=-0.8722$, $df=13$, $P<0.005$).

A correlation between the peeping and activity latency measures of the combined mirror and no-mirror experimental data was run to establish how the relationship held up across treatments; significant negative correlations were yielded for day 1 ($r=-0.7946$, $df=88$, $P<0.005$) and for day 2 ($r=-0.5604$, $df=88$, $P<0.005$). It was also apparent that throughout this series of experiments chicks tended to peep before they moved, and as can be seen in Table I the mean peep latencies were shorter than their corresponding activity latency values in twenty-eight of thirty cases. A two-tailed sign test (Hays 1963) run on these data showed this trend to be significant at the 0.001 level.

Discussion

The control chicks exhibited a consistent increase in peeping over days. They also showed shorter delays before first peep vocalization and shorter delays before initial activity on day 2 than on day 1. These findings are interesting in view of evidence which shows that experience in an unfamiliar or novel environment acts to reduce fear responses associated with the test situation and to increase other behaviours incompatible with fear reactions (Salzen 1963; Tolman & Wellman 1968; Compton & Scott 1971). Inactivity following placement in a strange environment has been reported to be a viable indicator of emotionality in the chicken (Candland & Nagy 1969). The present data lend additional support to the contention that such behaviour is a characteristic response of the chick to placement in a novel environment and that this response wanes with experience in that situation. The peep vocalizations, on the other

hand, increased with subsequent test exposure in a manner characteristic of other non-fear behaviours. These findings stand in contrast with the view that the peep vocalizations of socially-reared domestic chicks can be used as reliable indicators of fear.

Peeping and activity latency were found for the most part to be inversely related. Consistent with this is the finding that no-mirror chicks peeped much more frequently than mirror chicks and also exhibited much shorter activity latencies. It should be noted that there may be underlying qualitative differences between the inactivity of the mirror and no-mirror chicks. Whereas the no-mirror chicks were confronted with isolation in a small cubicle during the test, the chicks tested in the presence of a mirror were usually confronted with the visual image of an inactive conspecific. In general, however, the longer chicks delayed before first activity, the less peeping they exhibited during a test. Sluckin et al. (1970) using isolation-reared domestic chicks 1 and 4 days post-hatch found longer activity latencies in an unfamiliar environment to be associated with increased peeping. This discrepancy with the present findings may be attributable in part to differences between the testing situations, ages and rearing conditions of the chicks.

Chicks appeared to vocalize less frequently while they were inactive. Other investigators have noted that vocalizing in precocial chicks tends to be associated with alert upright posture, activity and ambulation (Guiton 1959; Hess 1969a; Beer 1969; Candland & Nagy 1969). It was also found that peeping tends to precede the initiation of activity in a strange environment, and this is in agreement with the observations of Guiton (1959).

Experiment 2 showed that exposure to a loud noise prior to testing reduced the peeping of chicks tested either with or without a mirror. Experiment 3 demonstrated that pretest shock resulted in peeping decrements for chicks tested without the mirror, while it did not influence the low level of peeping in the presence of a mirror. The overall influence of effective pretest manipulations which apparently act to increase arousal, was to sharply reduce peeping of no-mirror chicks, while peeping in the presence of a mirror was either uninfluenced or reduced. The peep decreases which resulted from these experimental treatments were accompanied with longer activity latencies, again demonstrating the inverse relationship between

peeping and activity latency. If peeping was a fear response, it might be argued that stimulus manipulations which increase arousal and other fear reactions should also result in an elevation of peeping. The present findings show this not to be the case.

Fullerton, Berryman & Sluckin (1970) found that handling differences and environmental changes did not influence the peeping of socially-reared domestic chicks and reported that "when there is a high level of 'distress', as at social bond disruption, differences in the amount of handling and in the physical environment do not have enough impact to be reflected in a rise in peeping". If peeping did reflect levels of 'distress' or arousal, it might be postulated that socially-reared chicks in isolation are responding at a ceiling level and further increases in arousal would result in peep reduction, suggestive of an inverted U-shaped function between peeping and arousal. This type of explanation would also assume that the low peep rates of chicks tested in the presence of a mirror were indicative of low levels of arousal, thus, more susceptible to increments produced by fear. Since it has been demonstrated in the present study that the peeping of chicks tested in the presence of a mirror were either uninfluenced or reduced in response to fear provoking stimuli, an explanation such as this does not appear tenable.

Experiment 4 revealed that peeping did not show significant decrements following metoserpate hydrochloride ingestion, as would be expected if peeping were a response to fear or arousal. Although the 4 mg per kg dosage appeared to suppress the normal peep increase from day 1 to day 2, this suppression, as indicated by the decrements in activity measures, was probably due to motoric involvements induced by such a high drug dosage.

One might speculate that it would be functionally maladaptive for chicks to call loudly when confronted with alarming stimulation or the possible threat of predation. The sharp increase in duration of initial freezing and accompanying longer delays before first vocalization following fear provoking stimulation lend some support to such speculation, although greater overall reductions in calling might have been expected for this to be the case. The process of domestication may well have removed many of the natural selection pressures that act on feral species, and the results of experiment 1 may reflect such a change.

In the experiments presented here the most striking overall effect was the differential peeping of the mirror and no-mirror chicks. Kaufman & Hinde (1961) have also demonstrated that a mirror greatly reduced the peeping of group-reared chicks. It has been suggested that brooder-reared chicks imprint on each other and that the peeping of group-reared chicks in isolation is due mainly to the absence of brood mates (Guiton 1958, 1959; Kaufman 1960, Bronson 1968; Cronhelm 1970). More generally, the peep vocalizations of the domestic chick and similar sound signals of other precocial nidifugous young are activated by the absence of the imprinted stimulus and under natural conditions function to elicit parental retrieval (Brückner 1933; Lorenz 1935; Collias & Collias 1956, 1967; Collias 1960, 1962; Hinde 1961; Driver 1962; Bermant 1963; Hoffman 1968; McBride, Parer & Foenander 1969; Kear 1970; Eibl-Eibesfeldt 1970; Artmann 1971). The interpretation of peep signals as a response to the absence of the imprinted object does not conflict with Andrew's (1963, 1964, 1969) hypothesis that the repertoire of chick vocalizations function as a unitary response system from which varying degrees of stimulus contrast elicit different sound signal outputs. The absence of the broody hen, brood mates or any other imprinted object will always result in a persistent change from accustomed stimulation which should elicit peep vocalizations. The 'wi wi' call of goslings (Eibl-Eibesfeldt 1970) and the peep calls of ducklings and gallinaceous young may represent homologous signals in other precocial nidifugous species.

Taylor & Taylor (1964) have demonstrated that chicks reared in isolation imprint upon the static properties of their rearing environments. Broom (1969) suggested that chicks reared in isolation learn the properties of their rearing environments and that this environmental model acts as a basis of comparison for subsequent changes in stimulation. The peeping of isolation-reared chicks might be interpreted as a response to the absence of or change in the accustomed stimulus configuration. Moreover, as Andrew's or Salzen's (1962, 1970) hypothesis would suggest, any sufficient and persistent change in accustomed homeostatic levels, e.g. body temperature fluctuations, hunger or thirst, should elicit peep responses and probably similar sound signals in other precocial nidifugous young.

A final note on terminology seems in order. When referring to the sound patterns of the

domestic chicken (or other avian species), neutral designations such as peeps, twitters, clucks, and so on are preferable to those which connote underlying states of emotionality such as distress calls, fear trills and pleasure notes. However, if a more functional designation is sought for peeps and similar signals in other precocial nidifugous young, which act to re-instate close parental proximity, then the Lorenzian (1935) designation, abandonment or separation call, might be applicable.

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A research report which describes the drug dosages and other characteristics of the tranquilizer can be obtained from the Gland-O-Lac Co., 1818 Leavenworth St, Omaha, Nebraska 68101.

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