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ARMY MEDICAL INTELLIGENCE AND INFORMATION AGENCY WAS--ETC F/6 2/5
CONDITIONED REFLEXES IN SWINE (OB USLOVNIKH REFLEKSAKH U SVINEY--ETC(U)
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DEPARTMENT OF THE ARMY
U.S. ARMY MEDICAL INTELLIGENCE AND INFORMATION AGENCY
WASHINGTON, D.C. 20314

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ADA 041 165

USAMIIA TRANSLATION

Number:

⑭ USAMIIA-K-8198 ✓

Date Completed:

⑪ 14 Jun 1977

⑫ 12p.

Language:

Russian

Geographic Area:

English Title:

⑥ CONDITIONED REFLEXES IN SWINE

Foreign Title:

(Ob Uslovnikh Refleksakh u Sviney)

Author:

⑩ V. A. Konyukhova, A. A. Bogomol'tsa Institute of Physiology, Academy of Sciences USSR, Kiev

Source Document:

Fiziologicheskii Zhurnal SSSR, Vol 41, No 3

Pages Translated:

pp 326-333

Publisher:

Date/Place Publication:

1955

Distribution Statement:

Approved for public release;
distribution unlimited

DDI
JUL 5 1977
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UNANNOUNCED	<input type="checkbox"/>
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Pavlovian physiology is the theoretical basis upon which practical animal husbandry should be developed on a broad scale. The studies of I.P. Pavlov on higher nervous activity reveal the regularity of the interaction of the organism with its environment, and offer broad prospects for controlling the physiological functions of agricultural animals. For this reason the study of their conditioned reflexes is not only of theoretical but also practical interest.

Interest in the study of higher nervous activity of agricultural animals has increased noticeably since 1950. At the present time considerable attention is being devoted to the study of higher nervous activity in horses and large horned cattle. Until now, however, swine have been studied very little.

In the literature available to us we have encountered only two works devoted to the study of conditioned reflexes in swine (Medyakov, 1936; Ayzinbudas, 1952), and these represented only initial attempts to find a satisfactory method of studying higher nervous activity in these animals.

In swine-breeding all production processes are in fact based on developing in animals various conditioned reflex reactions, on constantly suppressing some and cultivating others. From the first days of the life of an animal, various conditioned reflexes appear and acquire practical significance. The development in piglets of conditioned reflexes for sucking of one certain nipple of the sow intended for suckling pigs may be cited as an example. The necessity for this procedure arises in connection with the fact that the milk production of the various mammary glands of the sow is unequal, and therefore to ensure more successful piglet rearing, the weaker ones must be pushed to the front mammaries with more milk and the stronger ones to the rear mammaries, and in this manner a conditioned reflex develops in them for the sucking of one certain nipple.

In order to make systematic and more successful use of conditioned reflex reactions in swine-breeding, it is necessary to know the basic laws of conditioned reflex activity in swine, in connection with which we undertook corresponding research with allowance for the age features of the animals.

METHODS

Conditioned reflexes in swine were studied under both natural living conditions and under experimental conditions in a special chamber. The chamber was a room insulated from outside noises and equipped with a series of light and sound signals and other mechanically controlled devices. In the chamber were special cages where the experimental animals were housed.

Conditioned reflexes were developed in the swine using various indifferent signals: bells, noise, musical notes, multi-colored lights and other stimuli.

Upon these signals various conditioned responses were produced in the swine: motor-digestive, when upon a definite signal the animals ran to an arbitrary spot in order to receive food; masticatory, when upon a signal the animals began to chew, even before the appearance in their mouths of the milk poured into them; and motor-defensive, when the animals upon reception of a conditioning signal made shaking motions of their heads and ears before they received an electrical shock by means of "Electrical Rings" attached to the ears.

RESULTS OF THE EXPERIMENTS

Table 1 presents data on the development of conditioned reflexes in sucking pigs aged 5-16 days at the beginning of the experiment.

From the data in Table 1 it is clear that conditioned reflex reactions in suckling pigs developed at ages 9-19 days. Masticatory and defensive conditioned reflexes to sound stimuli appeared between the 5th and 15th combinations, while reinforcement of these reflexes took place after 10 to 33 combinations. As we see, the rapidity of the development and reinforcement of conditioned links in piglets did not occur identically, but rather with large individual deviations.

Table 1. Formation of Conditioned Reflexes in Suckling Pigs of Various Ages

No.	Sex and Age of Animal	Age at Beginning of Experiment (in Days)	Appearance of Conditioned Reflexes			Consolidation of Conditioned Reflexes			Annotation
			Number of Experiments	Number of Combinations	Age of Animal (in Days)	Number of Experiments	Number of Combinations	Age of Animal (in Days)	
On Aural Stimuli									
1	Male 1112.....	5	7	15	12	16	33	23	} For masticatory reaction
2	Male 412.....	6	4	7	10	11	22	18	
3	Female 612....	5	4	9	9	9	21	16	} For general defensive reaction
4	Female 312....	5	5	11	10	10	21	16	
5	Male 512.....	5	5	10	10	8	16	13	
6	Male 10132....	14	3	7	17	3	10	17	} For masticatory reaction
7	Female 3132...	13	2	5	14	3	12	15	
8	Female 2252...	16	2	8	19	3	13	20	} For general defensive reaction
9	Male 1132.....	13	3	8	15	9	32	24	
10	Female 7132...	15	2	5	17	8	26	25	
On Visual Stimuli									
1	Male 412.....	6	9	18	16	41	21	34	} For masticatory reaction
2	Male 1112.....	5	12	23	18	30	73	42	
3	Female 612....	5	11	21	17	19	40	27	} For general defensive reaction
4	Female 312....	5	9	16	14	23	44	32	
5	Male 512.....	5	5	8	10	29	71	40	

The origin of the first conditioned reflexes to light signals in suckling pigs was observed in the 10th to 18th day of life, but for a long time these reflexes remained extremely unstable. They only acquired a more stable character by the 27th to 42nd day in the life of the piglet.

Experiments on the development of conditioned reflexes in piglets from age one month show that conditioned reflexes appear in them slightly quicker than at earlier ages, but not significantly (Table 2).

In older animals, for example those 3 to 4 months old, these conditioned reflexes developed very quickly. Their reinforcement occurred especially quickly (Table 3). For aural stimuli they appeared in the first day of the experiment, after two to six combinations, and were consolidated in young pigs after 7 to 9 combinations, and in castrated males after 17 to 18 combinations.

Table 2. Formation of Conditioned Reflexes in Suckling Pigs One Month Old

No.	Sex and Age of Animal	Age at Beginning of Experiment (in Days)	Appearance of Conditioned Reflex			Consolidation of Conditioned Reflex			Annotation
			Number of Experiment	Number of Combination	Age of Animal (in Days)	Number of Experiment	Number of Combination	Age of Animal (in Days)	
On Aural Stimuli									
1	Male 7/12.....	31	5	9	35	11	19	42	} For masticatory reaction
2	Male 2/132....	32	2	7	33	4	15	36	
3	Male 6/132	32	2	9	34	6	21	40	
4	Male 9/132....	32	2	6	38	7	26	41	} For general defensive reaction
5	Male 8/132....	32	3	8	34	6	23	40	
6	Male 1/252....	36	2	9	37	5	21	42	
7	Male 4/252....	51	2	7	52	3	10	54	

Table 3. Formation of Motor-Digestive Reflexes to Aural and Photo-Stimuli in Weaned Piglets

Sex and Age of Animal	Age at Beginning of Experiment (in Days)	Appearance of Conditioned Reflex			Consolidation of Conditioned Reflex		
		Number of Experiment	Number of Combination	Age of Animal (in Days)	Number of Experiment	Number of Combination	Age of Animal (in Days)
To a Bell							
Female 168.....	69	1	3	69	2	9	70
Female 174.....	69	1	2	69	2	7	70
Neuterred 259	71	1	6	71	3	18	74
Neuterred 255	71	1	1	71	3	17	74
To Light							
Female 3132.....	66	4	14	69	10	39	76
Female 5132.....	115	2	5	117	6	26	127
Male 4132.....	115	3	11	119	6	28	127
Male 6132.....	149	6	22	166	8	32	166

The appearance and consolidation of conditioned reflexes in swine occurred significantly more slowly for light stimuli than for aural stimuli. The general illumination of the animals' quarters with common electrical light caused a conditioned digestive reaction after 5 to 22 combinations, and it was consolidated after 26 to 39 combinations. It should be noted that conditioned reflexes to light are less stable in swine than reflexes to sound.

Thus, in piglets up to one month old, conditioned reactions occur with almost identical quickness in those 10-15 days old and those one month old. However, conditioned reflexes in younger suckling pigs are less stable and are characterized by feeble manifestation. Consolidation of conditioned reflexes in suckling pigs requires longer periods and a significantly greater number of combinations. In older animals (3-4 months) conditioned reflexes develop more rapidly and are consolidated more quickly.

According to the data of our investigation, a more or less clear differentiation of conditioned reflexes to aural stimuli in the conditioning chamber occurs in a majority of the animals when they reach ages of

approximately two months. We distinguish differentiations of the reactions by insufficient stability and manifestation, and this was obviously caused by the weak inhibitive processes in the young pigs.

Experiments on the differentiations of sounds by the animals at age 3-4 months showed that at later ages these differentiations developed significantly more quickly and exhibited a more stable and distinct character (Table 4). Young pigs aged 3-4 months invariably distinguished ordinary bells from slightly muted ones. To an ordinary bell indicating food, they immediately ran to the feeding trough, but to a muffled, differentiated bell an inhibitive reaction was displayed: they moved away from the feeding-trough or lay down and closed their eyes.

Table 4. Differentiation of Conditioned Motor-Digestive Reflexes to Aural Stimuli in Weaned Piglets

Sex and Age of Animal	Age of Animals (in Days)		Number of Experiment	Number of Combinations	Formation of Differentiation					
	At Beginning of Experiment	At End of Experiment			Appearance of First Differentiation			Consolidation of Differentiations		
					Number of Experiment	Number of Combinations	Age of Animal (in Days)	Number of Experiment	Number of Combinations	Age of Animal (in Days)
Female 168.....	107	114	6	21	1	4	107	2	6	108
Female 174.....	107	114	6	21	2	6	110	4	13	111
Male 10142.....	113	139	11	31	5	13	124	11	29	139
Neutered 259.....	115	136	19	73	10	36	126	14	52	130
Neutered 255.....	115	136	19	77	7	22	122	12	45	128

The animals easily distinguished the sound of a hair dryer from that of a ventilator, and were easily able to differentiate two different notes on the accordion (C and G) in the same octave; a few of the piglets even distinguished adjacent standing notes (F and G). However, it should be noted that in the development of conditioned reactions, as in the differentiation of them, significant individual variations were observed among the piglets.

Observations of the appearance of the first conditioned reflexes in suckling pigs indicated that under natural conditions (in the swinery), conditioned reflexes appear much quicker in a group than in individuals in a conditioning chamber.

It should be noted that newborn piglets began to respond to various sounds (the slamming of a door, the shouting of people, the noise of stock, the grunting and squealing of swine, and other aural stimuli) within 5-6 hours after birth. Depending upon the intensity of the sound, the young pigs either winced, remained asleep, or rose on their feet huddling together.

Within 10-15 hours the piglets still responded to common industrial noises which had no meaning for them. However, after 24 hours they did not respond to them at all, but displayed a reference reflex to unusual strong sounds which were seldom repeated in the swinery. During this period the piglets slept most of the time, but responded very clearly to sounds connected with food: for example, to the grunting of the sow or the approach of the pig-tender towards their mother. To these sounds the young pigs began to develop their first positive conditioned reactions. Thus, at feeding time for the piglets, they began to respond to a distinctive grunt by the sow after the third feeding at age 6-10 hours. After birth at age 11-15 hours, after the sixth or seventh feeding, there was a clear conditioned motor-digestive reflex in all the young pigs: upon the grunting of the mother they quickly awoke, rose to their feet and began to squeal.

To an artificial sound of sucking, imitated by a man and preceding each feeding of the piglets by the mother, a conditioned reflex began to appear from the eighth combination, in the first day of life of the young pigs. After the 11th combination they already responded to the sound earlier than the mother (in whom the reflex developed after the fourth combination) and began to squeal within 4 to 6 seconds of the beginning of the conditioning signal. If at the same time as the action of the signal a grunt from the mother was also heard, then all of the piglets quieted down for a moment, listened, and then raised an even louder squeal.

At the end of their first day of life this reflex manifested itself so strongly that the young pigs not only squealed, but even climbed the walls of the cage trying to get out. On the second day, on only one sounding of the conditioning signal when the door of the cage was opened, the piglets ran to the sow. This data shows that differentiation in young

pigs under natural conditions develops considerably earlier and more quickly than in the laboratory under experimental conditions.

During the first days of the piglets' life observations were also made of the development of a conditioned reflex for a certain nipple of the sow. At first the piglets tried various nipples, but later remained at one nipple and adjusted to it. Observations indicated that a suckling pig, having been allowed an exchange for the first time, apparently "chose" his own nipple, most suitable to him in size, elasticity and other characteristics. At subsequent feedings we helped each suckling pig to his own nipple. It was found that a conditioned reflex for his "own" nipple developed fairly rapidly in a piglet. Some of the piglets found their own nipples after having been helped 10-14 times, others later. Yet within 24 hours, after 19-20 feedings, all of the piglets moved within 40 seconds to their own nipples. This reflex developed this quickly provided that the sow was laid down for the feeding on the same side (we laid her on her right side). On the third day we began to lay the sow down on different sides. The first time that the sow was placed on her left side, the piglets became confused, but very quickly, on the same day, they adjusted and found their own nipples with the mother in various positions. On the fourth day they were distributed by nipples within 20 seconds of their approach to the mother, if she lay down conveniently.

On the basis of these observations we reached the conclusion that to quickly train piglets to certain nipples of the sow, it is primarily necessary to make it possible for each piglet to correctly pick the nipple for its own mouth, and then to lay the sow on the same side at first. After 1-2 days it is possible to permit the sow to lie on the other side.

With a view toward the practical utilization of conditioned reflexes to increase the productivity of swine, we conducted an experiment directed toward increasing the lactescence of sows and accelerating the growth of suckling pigs.

Increasing the lactation of the sow is of great practical significance in swine breeding. In accordance with the resolutions of the Central Committee of the C.P.S.U. and the Council of Ministers of the U.S.S.R., there should be more than 4 million sows on sovkhozes and kolkhozes, from which more than 30 million piglets should be obtained annually. Therefore all methods conducive to increasing the number of piglets have special priority. In addition, a solution to the problem of increasing the lactation of sows opens the possibility of raising piglets without cow's milk, which at the present time is used to feed piglets (on the majority of sovkhozes and kolkhozes) in quantities of 20-30 liters per head during the suckling period.

An experiment on increasing the lactation of sows with the aid of conditioned reflexes was conducted by us on a sow with a litter of ten piglets.

Beginning on the 18th day after farrowing, each feeding of the piglets by the sow was accompanied by a conditioning signal: the noise of a desk fan. The fan was shut off 15-20 seconds after the beginning of the feeding. In the first month we induced the sow to feed the piglets once an hour, i.e., 24 times per day, during which period the piglets were kept in a separate stall from the mother.

The conditioned reflex in the piglets was developed and reinforced within 24 hours. At the sound of the conditioning stimulus they rose together, ran to the door of the stall and began to squeal and struggle to get out. When the door opened, they ran to the sow's stall, which was located to the left of the piglets' stall. The conditioned reflex in the sow to the signal and the squeals of the piglets manifested itself as the grunting of the sow and her assumption of a suitable position for feeding. Sometimes she even rose and lay down in another, more suitable place. The piglets usually responded first, and the mother later, but in one case when the pigs were sleeping and did not immediately respond to the signal, the sow began to grunt and lay down, after which the piglets immediately began to squeal.

The feeding upon signal was carried out quickly and methodically. The sow always gave milk, and there was no case when upon coming to her the piglets did not receive milk, although such an occurrence happens more often in practical conditions, under poorly organized internal conditions on a farm.

The feeding of young pigs with various cereal foods was also carried out by means of a conditioning signal. In this case the noise of a hair dryer was employed. In this manner a new aural conditioning signal was utilized which required differentiation from the first. During the first combinations of the noise of the hair dryer, due to a generalization of stimuli, the piglets ran, as they did in response to the noise of the fan, to the sow's stall, and it was necessary to direct them to the feeding stall located on the opposite (right) side of their stall. Beginning with the 6th combination, however, differentiation began to appear in individual piglets. Differentiation developed fastest of all in female #5. This female was the "leader" for the rest of the piglets.

Due to the herd instinct peculiar to these animals in a sufficiently strong degree, differentiation of reflexes to conditioning signals increased noticeably under the influence of the "leader". After just 13 combinations at the sound of the hair dryer they unerringly made their way to the feeding stall. Within 3-4 days differentiation was very stable, and the conditioned reflex was so strong that the animals were able to respond to the conditioning signals even when they were satiated. In this case the piglets were able to run to the feeding compartment located opposite

that of the sow, and vice versa, from the feeding compartment to the stall of the sow.

The strength of the conditioned reflex to the noise of the fan was quite pronounced in the sow. She quickly responded to the conditioning signal by grunting and preparing to receive the piglets. During the first times when the sound of the hair dryer was used, which had no significance for her, the sow displayed only a reference reaction, which quickly disappeared.

The feeding of the young pigs in conjunction with conditioning signals continued until the age of two months, after which they were taken away from the sow. The lactation of the sow was very good throughout the entire lactic period, which was confirmed by the weight indices of the pigs upon weaning. The average weight of the piglets was fairly high (19.4 kg). All of the pigs weighed more or less the same, the smallest of them weighing 16 kg. Up to this time on the farm from which the experimental animals had been taken, the average weight of piglets had been only 12.7 kg. In only one sow feeding such a number of piglets had the average weight reached 15.5 kg, and this was approximately 4 kg. less than in the experimental piglets.

In the previous farrows our experimental sow had produced piglets weighing 13.2 to 16.8 kg. at the time of weaning, and had reared 7-10 piglets, although she bore 13-14. Due to insufficient lactation in the first days after farrowing, the "surplus" piglets had to be given to another sow.

After the experiments had been conducted, the sow farrowed again and raised only 8 piglets. They were not specially conditioned to signal stimuli. The average weight of these pigs at age one month totalled only 6.8 kg, approximately 700 g less than those to whom special conditioning signals were applied, and at weaning these piglets weighed an average of 13.8 kg.

Thus, the experiment conducted by us indicates the possibility that the secretory functions of the mammary glands of swine may be increased under the influence of special conditioned reflex signals.

CONCLUSION

1. The conditioned reflex activity in swine is characterized by the rapid development of conditioned reflexes, their comparative stability and their capacity for differentiation.

2. Conditioned motor-digestive and defensive reactions developed in a conditioning chamber appear at age 9-19 days after 5-15 combinations. Digestive conditioned reflexes in piglets under natural conditions in group situations develop noticeably quicker; they may be produced in the first day of the animal's life.

3. In the development speed of conditioned reflexes in young pigs of various ages from 5 days to 2 months, only insignificant variations are observed. Conditioned reflexes appear in 5-day-olds almost as soon as in one and two-month-old piglets. However, great variations are observed in the strength of manifestation of conditioned reflexes, as well as in their development and stability. The older the animal, the quicker and more striking the conditioned reflex and the quicker it is consolidated. Conversely, the younger the animal, the longer the latent period for the manifestation of a reciprocal reaction, and the longer the last period from the beginning of the first reaction until its fixation.

4. Conditioned reactions to light stimuli develop in swine significantly slower than do those to aural stimuli. Visual conditioned reflexes differ significantly in their lesser constancy and less definite response.

5. The capacity for distinct differentiation of artificial conditioned reactions in swine appears at approximately age 2 months.

6. The practical utilization of conditioned reflexes for the purpose of increasing lactation in lactating swine proves the economic advisability of this method.

The development of a conditioned digestive response in suckling pigs and of a milk producing response in sows establishes the possibility of inducing the sow to feed the piglets more often than normal. It promotes an increase in milk production and ensures better growth and development of piglets.

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