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Attraction to Blood as a Factor in Tail-Biting by Pigs

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ABSTRACT

Canvas models, about the size of a pig's tail, were impregnated with pigs' blood or left plain, and were presented to pigs for 12 days in a 2-choice preference test. The pigs showed large, consistent, individual differences in response: some pigs chewed the models continuously while others chewed only slightly; some chewed much more on the blood-covered model, while others showed no preference. On average, the pigs chewed considerably more on the blood-covered model than on the plain one. In a second experiment, pigs presented with a choice test involving a blood-covered and a plain model showed a significant increase in chewing over a baseline level seen with plain models only. It is suggested that this strong but highly variable response to blood could explain how a relatively minor tail injury can stimulate a large but unpredictable increase in tail-biting among pigs.

INTRODUCTION

Tail-biting by pigs is one of the most widespread but most poorly understood "vices" of farm animals. Critics of animal production often cite tail-biting as a sign of impaired well-being among intensively-housed pigs (e.g. Buchenauer, 1981). Tail-biting causes economic embarrassment also, as the behaviour is often associated with poor growth rate (England and Spurr, 1967) and may involve infection and subsequent condemnation of the carcass (Van Putten, 1969; Penny and Hill, 197 4; Sambraus, 1985). To prevent such problems, many farmers practice routine clipping of pigs' tails soon after birth, but this is widely seen as a way of masking, not rectifying, the underlying problem.

Largely as a result of anecdotal and survey studies, tail-biting has been attributed to a bewildering variety of factors including crowding, "boredom", lack of bedding, poor ventilation, uncomfortable temperatures and disease (e.g. Sambraus, 1985). As Fritschen and Hogg (1983) put it, "any feature of the pig's environment that makes it uncomfortable may be expressed as tail-biting". Dietary factors are also cited as causes. These include low dietary fibre, inadequate or poor-quality protein, excessive dietary energy, and deficiencies or imbalances of iron, copper, sodium chloride, calcium, phosphorus or iodine (Gadd, 1967; Ewbank, 1973). However, such lists of possible predisposing factors fall far short of providing a coherent explanation of why this variety of ills should lead to so specific an activity as damaging a pen-mate's tail. Furthermore, most of the suggested factors are long-term features of husbandry systems, and fail to explain why tail-biting often occurs in sudden outbreaks.

Van Putten (1969) comes closest to providing a plausible mechanism for tail-biting outbreaks. In essence, Van Putten argues that the persistent, destructive tail-biting seen in an outbreak of the behaviour is actually derived from the "quiet", low-intensity chewing and rooting on pen-mates that is observed almost universally among pigs in groups. Pigs appear to have a natural tendency to chew on objects in their environment, and (especially in barren surroundings) some of this behaviour is directed at other pigs. Van Putten (1969) argues that ears and tails are the easiest to chew, but ear-chewing is more likely to provoke an attack by the recipient. Hence, considerable chewing is directed to pen-mates' tails. After a time, this behaviour causes a wound. According to Van Putten (1969), the bitten animal reacts by waving its tail vigorously, and this attracts further biting by other pen-mates as well as by the original biter.

Although the behavioural reaction of the bitten pig may help to precipitate increased biting, the availability of blood on the injured tail could also serve as an attraction. In particular, if certain pigs had a strong attraction to blood, this could explain why the initial wounding of a tail could trigger a sudden escalation of biting. Furthermore, dietary deficiencies might produce an appetite for specific nutrients in blood, thus explaining how various dietary inadequacies could make a severe outbreak more likely.

An attraction of pigs to blood has been suggested in semi-technical writing by Ray (1961), Dunne (1961), Gadd (1967) and Colyer (1970), but has not been addressed seriously in research. In the following two experiments, this possibility was explored by presenting pigs with tail-like canvas models which were either plain or impregnated with blood.

METHODS

Thirty-six Yorkshire pigs (18 females, 18 castrated males), each from a different litter, were aged 39-52 days at the start of the experiments. The pigs had been housed in groups of 4-6 in raised pens since being weaned at 4 weeks of age. Four days before observations began, the animals were moved to raised, individual pens 1.1 × 1.2 m with partitions consisting of steel rods separated by 6-cm spaces allowing partial physical contact between neighbours. Food (a pelleted corn-barley-soybean diet fortified with vitamins and minerals) and water were continuously available. The room was maintained at approximately 22-25°C, with 12 h of light per day.

The "tail models" were heavy canvas strips sewn in the form of rectangular sacks 15 × 3 cm. The gate of each animal's pen was fitted with a clear plastic panel with two 2.5-cm holes that allowed easy attachment and removal of two tail models 30 cm apart and 28 cm above the floor. When attached to the panel, the models could be chewed by the pig in the pen, while an observer watched through the clear plastic. In most cases (as described below), the pigs were presented with one plain and one blood-covered model. The latter was soaked with 5 ml whole pig blood on the afternoon before each use and was allowed to dry overnight. Plain models received no treatment between uses.

On the 3 or 4 days before observations began, the observer allowed the pigs to become accustomed to his presence near the pen. For the normal daily observation periods, two tail models were attached simultaneously to the plastic panel for 12 min. During this time, a click sounded every 6 s, and the observer (always the same person) noted whether the pig was (a) touching or (b) chewing each tail at the time of the click. Chewing was scored if the model was inside the pig's mouth; touching was scored for other contact between the model and the pig's snout or mouth. The tail models were removed at the end of the 12-min test.

Experiment 1

In the first experiment, a 2-choice preference test was used to determine whether pigs would chew a blood-covered model more than a plain one. The experiment involved 24 tail models permanently assigned to 12 pairs, each consisting of one blood-covered and one plain tail model. Each pair was presented to each of 12 pigs (6 males, 6 females) on one of 12 days (consecutive except for weekends), with the order of presentation determined by a Latin square. In this way, differences among pigs would not be confounded with any differences among pairs of tail models. The positions of the blood -covered and plain tail models were alternated daily to eliminate any position effect. The results were analyzed by Latin-square analysis of variance, the factors being pigs (i.e. individuals), days and pairs of tail models.

Experiment 2

Even if a pig prefers to chew blood-covered models in a choice test, it does not necessarily follow that the presence of blood will stimulate an increase in the amount of chewing the animal will perform. In the second experiment, the total amount of chewing in a choice test (with one blood-covered and one plain tail model) was compared with a previously-established "baseline" level of chewing seen when only plain models were offered. This was intended to parallel, in the simplest possible form, the situation in a tail-biting outbreak when a tail is injured and a blood-covered tail first becomes available to a pen of pigs.

Twenty-four pigs were tested for 12 consecutive days. One pair of clean tail models was permanently assigned to each pig. For half of the pigs ("control" animals), no blood was applied to the tail models. The other pigs ("experimental" animals) received the tail models without blood on Days 1-5; then, one model of each pair was chosen at random to be treated with blood for Days 6-12. The positions of the models were alternated daily.

The experiment was run with 4 consecutive replicates, each consisting of 3 males and 3 females. After Days 1-5, the 6 pigs in a replicate were divided into 3 experimental and 3 control animals in such a way that the amount of chewing performed by each group on the first 5 days was approximately the same. Differences between experimental and control pigs in the amount of chewing on Days 6-12 were analyzed by analysis of variance using a randomized block design (4 replicates, 2 treatments, and the interaction). The amount of chewing performed by each pig on Days 1-5 was included as a covariate because of the large individual differences.

RESULTS

Experiment 1

On average, the pigs in the first experiment spent 11.8% of the test time chewing the plain model and 23.6% chewing the blood-covered model. However, this overall difference masks large differences among individual animals. Six of the 12 pigs (Table I) showed a significant preference for chewing the blood-covered model, while others chewed at least as much on the plain model. Latin-square analysis of variance of the preference scores (amount of chewing on the blood-covered model as a percentage of total chewing) showed highly significant differences among pigs (F = 5.74, d.f. = 11, 110, $P \ll 0.001$; data treated by arcsine square-root transformation).

The preference scores also showed differences among days and among pairs of tail models. These were less pronounced than the differences among pigs, but were still significant (F = 2.15 and 3.19, P < 0.05 and 0.001, respectively). These differences probably resulted from the fact that some of the plain tail models became slightly contaminated with blood transferred inadvertently by the pigs' mouths from the blood-covered models. This contamination was more pronounced in some pairs than others, and became apparent only in the last few days of testing. The contamination probably caused the increased amount of chewing seen on some of the plain models on the later days.

The pigs differed greatly in their total amount of chewing (on both models combined). Daily averages for individual pigs ranged from 7 to 73% of time spent chewing (Table I). Latin-square analysis of variance showed highly significant differences among pigs (F = 20.08; d.f.= 11, 110; $P \ll 0.001$), but not among days or pairs of models (P > 0.10).

TABLE I
Results (mean ± S.E.) of two behavioural measures for the 12 pigs in the 2-choice preference test (Experiment 1)

Pig number	Percentage of chewing directed at blood-covered model[1]	Percentage of test time spent chewing models
3	87 ± 4**	73 ± 5
4	80 ± 3**	58 ± 3
12	71 ± 5*	43 ± 3
5	70 ± 8*	31 ± 4
10	68 ± 5*	28 ± 3
11	67 ± 6	7 ± 2
6	65 ± 5*	24 ± 4
7	62 ± 5	28 ± 4
1	55 ± 8	27 ± 6
8	54 ± 5	34 ± 5
9	50 ± 5	52 ± 5
2	40 ± 8	21 ± 5

* There was significantly more chewing on the blood-covered tail (*$P < 0.01$; **$P < 0.001$) as shown by Student's *t*-test for paired comparisons, 2-tailed.

There was a modest positive correlation between the pigs' preference scores and the amount of chewing they performed ($r = 0.50$, $P < 0.10$ by rank order correlation). Preference for chewing the blood-covered model was about equal among males (mean ± S.E., 60.7 ± 4. 73) and females (67.3 ± 5.82).

The pigs also spent a small but variable amount of time touching the tail models. Individual pigs averaged 4.7% (range 2.0-8.1) of time touching the plain model and 6.8% (range 2.6-12.0) touching the blood-covered model. Touching was most common on the first 2 days of testing, when some pigs appeared hesitant to chew the models.

Experiment 2

During the first 5 days of testing in Experiment 2, the pigs spent, on average, about 30% of the test time chewing the tail models (Table II). There were large individual differences, with extreme values of 3.5 and 63.5%.

Among the 12 experimental pigs, chewing increased substantially (to 53.3% of test time) on Days 6-12 when blood was available on one of the tails. This was due entirely to increased chewing on the blood-covered model, as there was no change in the reaction to the plain model. The 12 control pigs showed virtually no change in behaviour, on average, between Days 1-5 and Days 6-12 (Table II). Analysis of variance showed a highly significant difference between experimental and control pigs in the amount of chewing performed on Days 6-12 ($F = 12.22$; d.f. = 1, 15; $P < 0.005$). Use of the covariate (amount of chewing performed by each pig on Days 1-5) also caused a significant reduction in the residual mean square ($P < 0.01$). There was no significant difference among replicates and no significant interaction.

As in Experiment 1, the experimental pigs showed large individual differences in behaviour. Preference for the blood-covered model (calculated as the amount of chewing on the blood-covered model as a percentage of chewing both models) ranged from 59 to 97% among different pigs, with a mean of 77%. Similarly, there were large differences in the degree of increase in chewing when blood became available. Among the 12 experimental pigs, daily chewing on Days 6-12 ranged from 0.82 of the amount seen on

Days 1-5 to a more than 9-fold increase (Table II). Rank order correlation showed that percentage preference for the blood-covered model and proportional increase in chewing were positively correlated ($r = 0.55$, $P < 0.05$). However, it should be noted that proportional increase in chewing was a limited measure for some pigs because their "baseline" level of chewing (on Days 1-5) was relatively high.

TABLE II

Percentage time (mean and range) spent chewing on the two tail models (combined) for 12 experimental and 12 controls pigs during Days 1-5 and Days 6-12, and proportional increase in chewing between the two periods

Variable	Experimental pigs	Control pigs
Chewing, Days 1-5	29.2 (3.5-63.5)	30.6 (6.8-61.5)
Chewing, Days 6-12	53.3 (16.8-81.5)	32.9 (3.9-67.0)
Proportional increase	2.55 (0.82-9.59)	1.16 (0.29-2.60)

DISCUSSION

The two experiments show that pigs, at least under the conditions used in this study, show a definite but highly variable attraction to blood. On average, the pigs directed considerably more chewing to a blood-covered model than to a plain one. However, this tendency showed large idiosyncratic differences between animals, with responses varying from indifference to ardent chewing on the blood-covered models. Furthermore, Experiment 2 showed that the presence of blood on an object will cause a net increase in chewing, above a previously-established baseline level.

These findings could have considerable bearing on the problem of tail-biting among pigs. To clarify this relationship, it is important to recognize two distinct stages in an outbreak of tail-biting.

In the first or "pre-injury" stage (i.e. before any wounding of tails has occurred), pigs are commonly seen rooting and gnawing on various parts of the bodies of their pen-mates. As Van Putten (1980) notes, this is often a "quiet" activity, and it may be performed while both the biter and the recipient are lying down. This behaviour probably represents nothing more than the pig's natural tendency to root and chew on objects in its environment, but the behaviour is directed toward other pigs at least partly because of a lack of more suitable objects (Van Putten, 1969). Attraction to blood probably plays no role in the behaviour at this stage.

How this "quiet" chewing of tails leads to an injury is not entirely clear. According to Van Putten (1969), tail-chewing causes a small bleeding wound "more or less by accident". Sambraus (1985) writes of a gradual increase in tail-chewing leading to a wound.

Once a tail has been wounded, the situation can change considerably. Colyer (1970) describes a "general attack" on the wounded pigs, while Sambraus (1985) writes of the wounded animal becoming "the object of a hunt". At this point the second or "injury stage" can be said to have begun.

Why does an injured tail lead to such a drastic change in behaviour? Van Putten (1969) proposes that the wound irritates the bitten animal, and that the increased movement of the bitten tail encourages further biting. Blackshaw (1981) suggests that biting is a learned behaviour spread by visual communication. According to Newton (1961), the biter learns that its behaviour evokes a squeal from the victim and this serves as enough reward to establish the habit.

I suggest that an attraction to blood, as shown in the present experiments, provides a further and more plausible explanation for why the development of a wound can lead to such a drastic escalation of tail-biting. If this is true, then the large idiosyncratic differences in the degree of attraction to blood could explain the common observation that certain pigs are persistent biters while others in the same environment do not show the behaviour at all. Furthermore, once a pig has come to associate blood with the action of chewing damaged tails, the target could easily become broadened to include previously undamaged tails by stimulus generalization (Kimble, 1961), thus giving the pig the opportunity to learn that all tails yield blood if bitten sufficiently.

Factors contributing to tail-biting may differ depending on whether the behaviour is in the pre-injury or injury stage. In the pre-injury stage, various environmental stressors (e.g. poor ventilation, uncomfortable temperature, crowding) may increase the likelihood of tail-biting simply by making the animals more restless and increasing the amount of active time available for "recreational" or "exploratory" chewing of pen-mates. At this stage, provision of straw or other chewable objects is often sufficient to divert casual chewing into harmless forms (Van Putten, 1969; Sambraus, 1985).

In the injury stage, however, attraction to blood could add further complications. At this stage, a monotonous diet could increase the animals' attraction to the novel taste of blood, and dietary deficiencies might create a specific appetite for nutrients present in blood. In sheep, rats and rabbits, injections of ACTH can produce large increases in sodium appetite (reviewed by Denton, 1982). If the same is true with the pig, then various stressors might cause increased attraction to the sodium component of blood. To stop a serious outbreak of tail-biting at the injury stage, it may be necessary to develop more potent diversions with enough taste and/or other attractive properties to compete with a blood-covered tail for the pig's attention.

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