

Endorphins implicated in stereotypies of tethered sows

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Summary. The study presents evidence that the stereotypies of tethered sows are associated with the release of endorphins. This is the first indication that stereotypies may be an effective coping strategy.

Key words. Endorphins; stereotypies; tethered sows; animal welfare.

During the last decade and a half, a great deal of scientific and popular concern has been expressed over the welfare of intensively-housed farm animals. In modern husbandry systems, pregnant sows are kept for months in a tethered position. After an initial period of resistance, many sows develop stereotypies like chain rooting, chain chewing, sham actions, and so on¹⁻³. Unpublished data on 20 tethered sows in our research facilities indicates that the sows performed stereotypies for an average of 5.8 h per 24 h period (SD = 2.5 h). Stereotypies are also common amongst other farm species^{4,5} as well as in zoo animals^{6,7}. Stereotypies have often been interpreted as signs of disturbed welfare^{1,8}. These modes of behavior are characterized by 1) a constant form, i.e. in terms of frequency, duration and sequence of elements, 2) repetitive occurrence and 3) apparent purposelessness^{3,9}, while at the same time, each individual develops its own unique pattern of performance. The questions arise as to how such stereotypies in fact develop over time and what their biological function could be. Since the sows are subjected to chronic stress conditions when tethered, the answers may be pertinent to all investigations on disturbed behavior in animals and man.

Within days of being inseminated, breeding sows are commonly restrained in individual stalls by means of neck- or girth-tethers, a predicament which they endure for nearly 4 months. During the first days of their initial tethering (usually at the start of the second pregnancy), the sows struggle fiercely to free themselves. Important elements of this struggling are biting, levering (nosing/rooting) and pulling at parts of their stall e.g. bars, tether chain, etc. Some of these actions gradually develop into real stereotypies and can be considered as derivatives of the original conflict behavior¹⁰. We followed in detail the development of these stereotypies in individuals and found that each individual stereotypy had its own life history in terms of, among other things, starting date and small modifications¹¹. A predominant characteristic of the behavior-patterns was their real addictive nature, in that they were performed for hours every day and that the sows had difficulty in terminating a bout of such behavior.

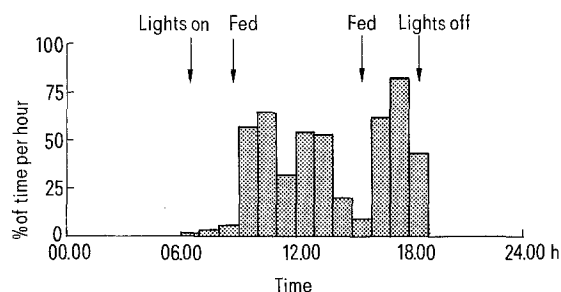


Figure 1. Change in the proportion of each hour that one sow performed stereotypies during 24 h. The values shown by the columns are the averages of 3 days preceding naloxone treatment. The sow performed stereotypies for 4.8 h per day. Time not indicated by column is mainly idling.

Considering the stressful conditions of the animals, we postulated that these stereotypies may be somehow linked to endorphins, which are released during stress¹², have inherent dependence-creating properties^{13,14} and reduce emotional distress¹⁵. As a first test, we analyzed the behavioral effect of a single treatment with the rather specific opioid antagonist naloxone.

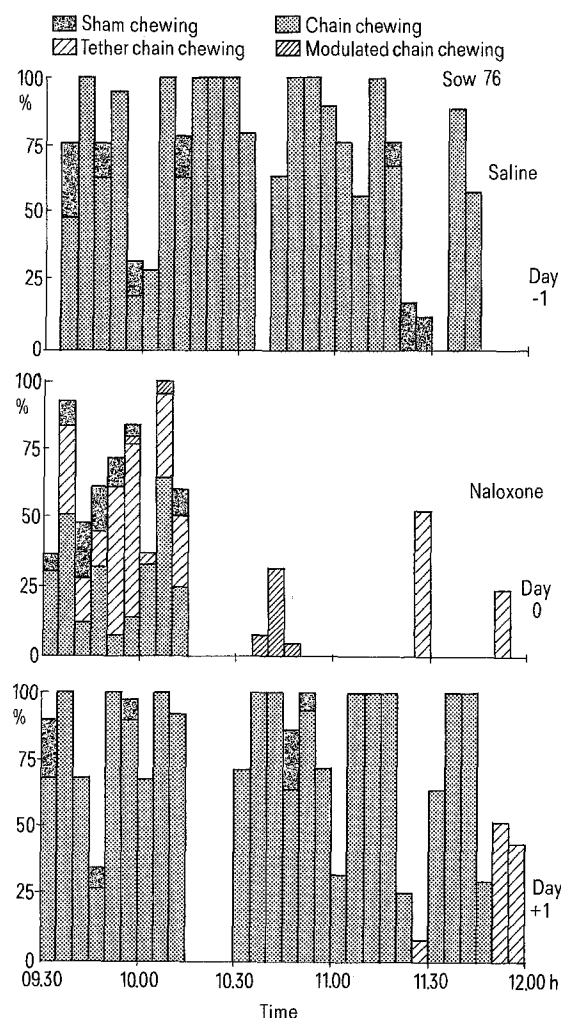


Figure 2. Stereotypies performed by the same sow as in figure 1 during an observation period of 150 min after saline or naloxone injection at 09.30 h. Each column represents the percentage of time (5 min) spent in stereotypy performance. Chain and sham chewing are the normal stereotypies of this sow; tether chain chewing is a new stereotypy. Modulated chain chewing indicates that a minor change has occurred to the normal stereotypy, but without the action stopping. Time not indicated by column is mainly idling. Data of 3 consecutive days are presented.

Materials and methods. The behavior of 9 neck-tethered sows, for which the history of their individual stereotypies was well known, was recorded. While these sows varied with respect to their initial tethering date (20–56 weeks prior to treatment), the total time that they had been tethered was less (from 17–43 weeks) since tethered periods normally alternated with “free” periods (e.g. after farrowing). Following the morning feeding (08.45 h) these sows performed stereotypies for up to 6 h before the second feeding took place (15.30 h). Stereotypy performance was then resumed until the 12 h light cycle ended (18.30 h) (fig. 1). Water was available ad libitum at all times. The behavior of the animals was recorded directly or by video during the 2.5–3.5 h after a s.c. injection with saline (5 ml) or with naloxone dissolved in saline (0.64–1.00 mg/kg). Each sow was injected at least twice (once with saline and once with naloxone) at 09.30 h on consecutive days when the animals had finished feeding and normally performed stereotypies.

In 6 other sows that were loose-housed and did not perform stereotypies, the effect of saline (5 ml) or of naloxone (0.89–1.00 mg/kg) treatment on exploratory behavior was investigated. In this case free-moving sows could explore straw, novel objects or soil. Each substrate was presented twice and with 5 min separating each of the 10-min exposure periods. Behavior was recorded by direct observation during approximately 2 h after injection. **Results.** Injection with saline hardly affected the performance of stereotypies, neither the time spent in their performance nor the quality of performance. Also when saline was injected twice on consecutive days, no effect of treatment was observed. However, after naloxone each sow interrupted her normal stereotypies for a longer or shorter period (fig. 2). The median time spent in the performance of these stereotypies between 09.30 and 11.30 h decreased significantly from 88% (range 18–97) on the preceding saline day to 38% (range 5–80) on the naloxone day (Wilcoxon test, two-tailed, $p < 0.01$), whereas idling behavior increased and some attack and attempted-escape behavior occurred. Also after naloxone, altered forms of the normal stereotypies and previously unrecorded repetitive acts were performed by the sows. The naloxone effect was small in some sows which performed old (53 weeks) stereotypies. Interestingly, there was a positive correlation (Spearman rank correlation, $r = 0.80$, $p < 0.05$) between the individual age of the stereotypies and the latency of the naloxone effect (latency is the interval between naloxone injection and the first 5-min period without any normal stereotypy). No significant difference (ANOVA on log

transformed data) could be detected in the exploratory behaviour of the sows between saline and naloxone treatment. In all cases the sows actively explored the test arena; the highest interest was shown in the soil.

Discussion. Assuming that naloxone specifically blocks the effect of brain endorphins, then on the basis of the present result that naloxone decreased stereotypies but not exploratory behavior, we may speculate that stereotypies in tethered sows are linked with endorphins. Endorphin release may be enhanced in severely stressed animals¹⁶. Since tethering is a chronic stress for sows¹¹, we may propose that the performance of conflict behavior (attack – escape) in response to tethering may become associated with the endorphin release. Because of the reinforcing^{13,14} and possibly addictive action of endorphins, these behavior-patterns may be repeated over and over again. Such a repetition may facilitate ritualization of the behavior, and stereotypies arise. In this way, and because of the calming effects of endorphins, the sows are able to cope in the short-term with the chronic stress conditions. When the effects of endorphins were blocked by naloxone, stereotypies indeed became purposeless and their performance decreased, while the original elements of struggling against the tether reappeared.

The present data are the first indication that performing stereotypies may be an effective coping strategy which in turn may be due to an association with endorphins. The probable role of brain endorphins in reducing negative emotions¹⁵ and the result that most of the sows responded to naloxone, would suggest that the responding sows were still subject to negative emotions due to their housing circumstances. The reduced response to naloxone in animals with older stereotypies may be due to the stereotypies becoming emancipated from the original reinforcing, endorphin mechanisms with time. Alternatively, sows may still need endorphins to achieve an acceptable level of well-being, but with time become tolerant to endorphins. Such animals would therefore be expected to increase the amount of stereotypy performance over time. Further research is urgently required on these points. Firmer conclusions could be drawn from the results had we sacrificed our sows to measure brain endorphin levels. Alternatively, and in order to avoid the wastage of such valuable research animals, the measurement of pain thresholds in tethered sows during treatment with naloxone or saline, or before and during stereotypy performance in untreated sows, may provide additional indirect evidence for the involvement of endorphins.

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