ZOOL 567: Annotated Bibliographies

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I have ten annotated bibliographies - seven primary articles and three secondary articles. They are organized by three themes – Housing Systems (5), Feeding Methods (3), and Hormones/Physiology (2). In each section, they are ordered chronologically. The articles are also organized according to these three themes in my topic summary.

Housing Systems

Jensen, M. B. (2003). The effects of feeding method, milk allowance and social factors on milk feeding behaviour and cross-sucking in group housed dairy calves. *Applied Animal Behaviour Science*, *80*(3), 191–206. https://doi.org/10.1016/S0168-1591(02)00216-2

Summary

Older articles suggest that cross-sucking does not occur in calves that have been raised with their mother or with nurse cows. With changes in farming, calves older than eight weeks are housed in groups, in which cross-sucking is often observed. The objective of this review article was to look at what literature says about how the amount of milk, feeding methods, and social factors influence cross-sucking. Non-nutritional sucking can occur between the calf and its mother to help the calf stimulate its mother to produce more milk. Calves are observed to perform cross-sucking right after drinking milk, and the behavior decreases within 10-15 minutes in an exponential manner. It is suggested that an unbalanced diet and too much milk allowance can contribute to cross-sucking prevalence. The speed of drinking is an important contributor to cross-sucking; slow flow decreases the frequency of the behavior. The amount of milk calves receive also plays a role in oral behaviors. The higher the milk intake, the less calves performed the behavior. However, this solution is not completely effective, because the behavior did not stop completely even when the feeder was always available, as shown by one study. The timing of weaning, which is the transition stage in the diet of calves from milk to solid food, is also important in preventing cross-sucking. With this information in mind, weaned calves need to be separated from un-weaned calves right away, so the younger calves have more time at feeders, and less competition with fellow pen mates. With these factors considered, the author suggests that giving calves more space is beneficial. More studies can be done to compare how different weaning methods could affect the behavior and devise a way to reduce the competition among calves around a feeder.

Contribution

As a secondary article, this paper goes into great detail about many different aspects that affect cross-sucking. Just by reading this paper, I gained a broader perspective of the complex factors that play into a single, observable behavior. This article does a good job reviewing how deprivation of natural sucking opportunities ties into the development of abnormal sucking. Furthermore, the suggestions by the author are consistent with some other articles I have come across.

Lidfors, L., & Isberg, L. (2003). Intersucking in dairy cattle—review and questionnaire. *Applied Animal Behaviour Science, 80*(3), 207–231. https://doi.org/10.1016/S0168-1591(02)00215-0

Summary

Inter-sucking is seen to occur in cows and heifers (young female cattle that have yet to give birth). The origin of inter-sucking can be traced to cross-sucking as calves. While this article has a review component, the primary objective of this article is to develop a questionnaire from information in literature about inter-sucking. Cattle that perform inter-sucking is seen to have preferences for partners, but this partnership seems different than an actual bond. Inter-sucking also peaks around feeding time, like cross-sucking. But unlike cross-sucking, there is less conclusive data concerning how nursing affects its prevalence. Feeding schedules, housing systems, and cattle mobility (such as letting cattle roam outdoors) can influence inter-sucking prevalence. The authors also synthesized a flow chart describing how many articles talked about animal, housing, and feeding factors in relation to cross-sucking and inter-sucking. The authors developed a questionnaire that was sent to 2000 farms, and 230 farms agreed to answer the questionnaire with a final reply rate of 66%. The questionnaire consisted of 35 questions which touched on housing, breed, mastitis (disease) prevalence, number of animals, feeding methods, inter-sucking prevalence, and measures taken to prevent this behavior. The results showed that only a few cattle on each farm actually performed the behavior, the majority of which were heifers. Inter-sucking was more frequent in loose housing than confined housing, and its prevalence was found to be positively reinforced by the intake of milk (which is also observed in cross-sucking). The authors suggest that individual housing and constant regrouping of cattle (so the sucker and the one being sucked lose connection) can reduce the prevalence. Future research can look at why sucked individuals do not do anything in response to being sucked, and other environmental factors that affect this behavior.

Contribution

This is my only article that focuses on the manifestation of cross-sucking into adulthood. I think this paper is worthwhile to include because it shows how an abnormal behavior can start early in life and continue all the way through adulthood if not monitored and corrected. It contributes to understanding the longevity and complexity of the behavior. Furthermore, I have classified this article as primary because of its extensive methods and synthesis of new information, but it also has great references to look back to.

Leruste, H., Brscic, M., Cozzi, G., Kemp, B., Wolthuis-Fillerup, M., Lensink, B. J., Bokkers, E. A. M., & van Reenen, C. G. (2014). Prevalence and potential influencing factors of non-nutritive oral behaviors of veal calves on commercial farms. *Journal of Dairy Science*, *97*(11), 7021–7030. https://doi.org/10.3168/jds.2014-7917

Summary

While cross-sucking is of great interest to researchers and farmers, there are other types of abnormal oral behaviors that calves can perform, which include the biting, nibbling, and licking of pen mates, and tongue rolling. Researchers think these behaviors are due to poor living conditions, and since calves have an innate motivation to suckle, the animals have to express their natural motivations in other, abnormal ways. The objective of this study was to see how different factors present on farms can possibly influence these abnormal behaviors. 98 farms from the Netherlands, 45 from France, and 14 from Italy were contacted for this study. Data collection lasted from summer of 2007 to spring of 2009. The 98 farms were divided into categories based on the size of cattle group housing, as well as the type of feeding (bucket or trough). Cattle behavior was monitored through individual observers on farms, with clothing and time of observation consistent. Each then filled out a questionnaire, which asked about different parameters, such as farmer experience, housing system, breed, feeding system, and so on. The results found that factors that influence cross-sucking include the living space, food received, breed, group size, farmer's experience, and the season when the calves entered the farm. It was found that cross-sucking had the greatest variance between the farms, with a 40% variance. The researchers suggest that calves should have living spaces at least 1.8 meters squared per calf. Future research can look at how temperature and humidity of where calves are housed influence a calf's oral behaviors. The factors mentioned in the results can also be studied in different climates to achieve more confidence in the results.

Contribution

This paper tried to do a lot, as it looked at many different potential factors, as well as many different behaviors (I have just mentioned the results about cross-sucking in my summary). The suggestion for more space for housing calves is supported by other articles, as well, which strengthens this piece of advice as a consideration for dairy farmers. I think this article will be valuable in my literature review because it looked at many potential factors that could affect cross-sucking that other studies have not considered.

Beaver, A., Meagher, R. K., von Keyserlingk, M. A. G., & Weary, D. M. (2019). Invited review: a systematic review of the effects of early separation on dairy cow and calf health. *Journal of Dairy Science, 102*(7), 5784–5810. https://doi.org/10.3168/jds.2018-15603

Summary

This article follows the format of a review article. It focused on what literature has to say on how cow and calf health compare in different rearing systems, namely artificial (machine) and cow-calf contact. Some literature suggests separating mother cow from calf almost immediately after birth to reduce the risk of disease. This has become common practice on farms. However, other literature says there are health benefits that animals can obtain from longer mother-offspring contact. Hence, the objective of the article was to resolve this discrepancy in literature. The Web of Science database was used in this review, and seven targeted searches were conducted ("scours", "cryptosporidiosis", "Johnes disease", "pneumonia", "immunity", "health and mortality", and "mastitis"). The selection process then took place in four-steps: articles in languages other than English were removed, abstracts were read, reference lists were checked, and full texts were read. After this process, 70 articles were selected. The researchers then extracted the data from these articles and normalized them through calculating the risk ratios and confidence intervals. The researchers then compared the two rearing systems and their correlations with cattle health through analyzing each against the seven search terms. Statistics for each category were presented in table format. Johne's disease was not found to be significantly influenced by mother-offspring rearing. Beneficial or minimal effects of suckling were shown by articles addressing scours and mastitis. As such, the researchers concluded that literature does not suggest against cow-calf rearing. For future studies, the practicality of keeping the calf with the mother needs to be investigated. Furthermore, it is also important to figure out how to effectively provide colostrum (a nutrient-rich fluid) to calves immediately after birth for their long-term health.

Contribution

This review article does not suggest against cow-calf rearing. In terms of application, this article can be beneficial when implementing or evaluating rearing practices in the best interest of cattle health. As a secondary article, it provides good context on the various diseases associated with cattle birthing and cites many primary articles regarding how suckling can play a role in regulating cattle welfare. I have found a few primary articles that are also worth investigating in the reference section of this article.

Reipurth, M., Klausen, S. K., Denwood, M., Forkman, B., & Houe, H. (2020). The effect of age when group housed and other management factors on playing and non-nutritive sucking behaviour in dairy calves: a cross sectional observational study. *Acta Veterinaria Scandinavica*, *62*(1), 63. https://doi.org/10.1186/s13028-020-00562-y

Summary

As of now, many farms keep calves in individual pens, and this results in minimal social interactions which can negatively impact calf wellbeing. Individual housing also prevents social learning from occurring naturally between calves. Hence, the objective of this study was to see if play behaviors (which are considered positive behavior) and cross-sucking (considered negative behavior) are associated with how calves are housed. Telephone interviews were conducted with 40 farms, and 22 farms successfully completed the study. Between the 22 farms, there was a total of 176 calves. It is known from other literature that cross-sucking prevalence is at its highest 10-15 minutes after milk consumption, and play behaviors are usually the highest from 9:00-11:00 and 15:00-17:00, so these times were under observation when constructing ethograms. Play behavior was defined as running, turning, jumping, bucking, mounting, butting, rubbing, pushing, and head shaking. Cross-sucking was defined as the sucking or licking of objects, and the sucking of other calves. A GOPRO camera was used for video recording. It was found that play and cross-sucking share a "good" measure of agreement with each other (0.69 and 0.65, respectively), which means that observing either play or cross-sucking is a sufficient substitute for the other. The researchers found no correlation between cross-sucking and the age of calves when they were grouped, and there was also no significant association between play and the age the calves were grouped. Less cross-sucking was observed when calves drank from teats, instead of buckets. Researchers also found that play and age were negatively correlated. Taking into consideration the data collected about play and cross-sucking, there is no evidence that housing calves earlier improves their welfare. In future studies, the behaviors during cattle regrouping can be included in the analysis, as it was not included in this study.

Contribution

This article is interesting because it offers a different perspective on cross-sucking as an indicator of negative welfare. The finding that cross-sucking was reduced when calves drank from teats rather than buckets, and the finding that it has no association with milk flow agrees with previous studies. This study is helpful to my literature review because it focuses on group housing of cattle and its effects on welfare, as opposed to only looking at individual housing.

Feeding Methods

de Passillé, A. M. (2001). Sucking motivation and related problems in calves. *Applied Animal Behaviour Science*, *72*(3), 175–187. https://doi.org/10.1016/S0168-1591(01)00108-3

Summary

Cross-sucking is a huge problem because if it is not controlled, it can lead to inter-sucking, which is the persistence of non-nutritional sucking behaviors as adult cattle. The objective of this review article was to summarize findings concerning factors involved in promoting cross-sucking, how teat feeding systems affects the behavior, and how the behavior adapts in different feeding conditions. One article found that tying up calves for 10 minutes after feeding can reduce cross-sucking. Once the motivation to suck, which is upregulated by the taste of milk, has passed, calves are less likely to perform the behavior. These results agree with other research, which suggests that until calves drink milk, they do not have a motivation to suck. The hormones insulin and cholecystokinin, which are involved in metabolism, increase in abundance when sucking time increases. They are not observed to correlate with other oral behaviors, which suggests that sucking behavior in and of itself is important for physiological mechanisms in calves. In an experiment with different sized orifices (tubes that deliver milk), calves adjusted their rate of sucking to match the milk delivery rate. It was concluded that when the delivery rate is slow, the calves took longer to consume each meal, and less cross-sucking occurred later. It appears that once again, once the sucking motivation is fulfilled, cross-sucking will occur less. The authors summarized a few suggestions for farms, which include the provision of artificial teats, hay provision after meals, and a slower milk delivery rate. Future research can look at how the relationship between the mother and calf, and how disruptions in this relationship, influence cross-sucking and inter-sucking prevalence.

Contribution

The suggestion about slowing down the rate of milk delivery resonates with another article. The mention about metabolism hormones also agrees with information from another later article. This review article touched on something very profound, which is instead of targeting solutions for specific abnormal behaviors associated with different types of housing, there needs to be solutions to improve every type of housing system. I believe this is a great suggestion to mention in my summary, and to share with AFAC.

Margerison, J. K., Preston, T. R., Berry, N., & Phillips, C. J. C. (2003). Cross-sucking and other oral behaviours in calves, and their relation to cow suckling and food provision. *Applied Animal Behaviour Science*, *80*(4), 277–286. https://doi.org/10.1016/S0168-1591(02)00231-9

Summary

Cross-suckling is an abnormal behavior in cattle in which they suckle the body parts of other cows without obtaining any milk. The development of this behavior is complex, and is impacted by environmental, physiological, and social factors. Given this information, the researchers wanted to compare the behaviors of calves in different social suckling conditions. There were 48 cows utilized in the study, and each of the cows had birthed more than one calf. Cows and calves were divided into three treatment groups. In Treatment A, calves were housed with feeding machines, so they had no opportunity to suckle. In Treatment M, calves could suckle cows that were not their own mothers. In Treatment O, calves suckled their own mother. Both cow and calf behavior were recorded using ethograms. It was found that the behaviors of cows were consistent between the three groups. There were also no differences in behaviors of calves, except for cross-sucking prevalence. The prevalence of cross-sucking was significantly greater in calves that were not allowed to suckle (Treatment A) than calves that were allowed (Treatment O and Treatment M). These results suggest that giving calves access to the nipples of a cow, even if it is not their own mother, can reduce cross-sucking. Future studies can perform this protocol in a cooler environment, as this study performed their research in a hot environment. This could have affected the targets of cross-sucking (groin instead of mouths and ears as suggested by previous studies). The researchers suggest the groin could have been the preferred target so calves can avoid sodium deficiency in the hot environment. As such, a cooler environment would provide more confidence in these results.

Contribution

This study provides valuable insight into the different strategies of cow-rearing and behaviors associated with them, and their relation to abnormal sucking behaviors. The results from this study bridges a gap in literature, as it provides evidence that calves that suckle their own mother versus other cows do not show any significant differences in cross-sucking prevalence (both lower than machine reared). The results from this study can be applied to dairy farms in hopes to reduce cross-sucking in cattle.

Horvath, K. C., & Miller-Cushon, E. K. (2017). The effect of milk-feeding method and hay provision on the development of feeding behavior and non-nutritive oral behavior of dairy calves. *Journal of Dairy Science*, *100*(5), 3949–3957. https://doi.org/10.3168/jds.2016-12223

Summary

There are minimal suckling opportunities for newborn calves on commercial farms because bucket feeding is a more common practice nowadays. Previous studies have suggested that bucket feeding has a correlation to cross-sucking prevalence. As such, the objective of this study was to understand what contributes to the motivation of calves to suck, namely regarding the effects of access to teats and hay provision, and how they relate to abnormal sucking behaviors. 30 Holstein heifer calves were utilized in the study. Since birth, they were assigned one of three treatment groups: control (no hay, drink milk from a bucket), having access to hay (but still drink milk from a bucket), and having access to teats for milk consumption as well as hay. The data collection lasted from when calves were two weeks old to six weeks old. The calves' behaviors were recorded through a time-lapse camera attached to a ladder next to their pens. There were five researchers who then observed the videos to ensure more reliability of the behaviors seen. The nutrients present in the calves' food were also noted, and graphs were generated from the data to determine significance. The results showed that the control group had more abnormal sucking behaviors than the other two groups. Furthermore, the group that had teat and hay access ate more hay than the group that just had hay access (bucket fed). As such, it is suggested that teats and hay are both important in helping reduce cross-sucking in calves. The researchers also suggested that giving the calves more time for feeding can also help reduce abnormal sucking. For future studies, the connection between the type of hay offered to calves and its effects on oral behaviors is of interest.

Contribution

Many other articles do not look at hay, which is a factor that should not be overlooked, as it can affect calves' oral behaviors (as shown by this article). While the consumption of hay does not cause a sucking motion, it is a behavior that involves the mouth, which can in turn affect sucking prevalence. This article shows a connection between these two actions, which is quite novel. This article builds on many other articles mentioned in my literature review and does not appear to contradict anything prior.

Hormones/Physiology

de Passillé, A. M., & Rushen, J. (1997). Motivational and physiological analysis of the causes and consequences of non-nutritive sucking by calves. *Applied Animal Behaviour Science*, *53*(1–2), 15–31. https://doi.org/10.1016/S0168-1591(96)01148-3

Summary

Since the onset of commercial farming, animals cannot perform many natural behaviors, which can lead to development of abnormal behavior. The Lorenzian model can be used to explain farm animal behaviors by examining internal and external causes of the behavior. The objective of this study was to apply the Lorenzian model to cross-sucking to analyze the motivations behind the behavior. The researchers first started with a basic motivational model that states that sucking is influenced by stimulations from the mother cow, energy demand, and the volume of milk consumed. The authors then revisited some data from one of their previous publications (de Passille et al., 1992)*. 16 male calves were given milk replacer through bucket feeding, and were then allowed to suck on a dry artificial teat, which gave no milk to the calves. The artificial teats allow for sucking without fulfilling any functions. The artificial teats were then presented to the calves in different intervals in three different experiments (10 minutes, 30 minutes, and 60 minutes after their meal). Data was recorded through a single observer on an electronic data recording device (OS-3), then made into an ethogram. Researchers found a negative correlation between delay of teat offer and cross-sucking: calves performed a lot more sucking of the artificial teats immediately after their meal. They also found that when calves did not receive milk, they did not perform as much cross-sucking. With this information, the authors revised their Lorenzian model to suggest the taste of milk positively regulates sucking motivation. In conclusion, milk stimulates sucking behaviors, and immediately offering artificial teats to calves post-meal reduces cross-sucking prevalence. While the authors briefly mentioned the effects of sucking on hormone production and release, future research can investigate how cross-sucking impacts metabolic processes in cattle.

Contribution

This paper suggests that calves should suck teats right after a meal to prevent cross-sucking later. The researchers use an interesting model that looks a bit deeper into the psychology of animals. Overall, it explains the actual motivations behind the behavior quite well, which is a key part in understanding this behavior. It is different from other articles, which just observe the outcomes and effects of this behavior.

*de Passillé, A. M. B., Metz, J. H. M., Mekking, P., & Wiepkema, P. R. (1992). Does drinking milk stimulate sucking in young calves? *Applied Animal Behaviour Science*, *34*(1–2), 23–36. https://doi.org/10.1016/S0168-1591(05)80054-1

Veissier, I., de Passillé, A. M., Després, G., Rushen, J., Charpentier, I., Ramirez de la Fe, A. R., & Pradel, P. (2002). Does nutritive and non-nutritive sucking reduce other oral behaviors and stimulate rest in calves? *Journal of Animal Science*, *80*(10), 2574. https://doi.org/10.2527/2002.80102574x

Summary

In some other mammals, sucking is performed by infants to reduce stress. However, there is less information regarding this phenomenon in cattle, especially in regard to how non-nutritional sucking interacts with other systems in the body, such as the vagal system, which mediates stress and calmness. Hence, the objective of this study was to see how nutritional and non-nutritional sucking affects cardiac activity, growth, and resting behaviors in calves. In the first experiment, 24 Holstein calves were divided into two feeding treatment groups (open bucket or artificial teat). Cardiac activity was recorded through an electrocardiogram, and sucking behaviors were controlled by taking away any possible sucking objects. In the second experiment, 29 Holstein calves were divided into two feeding groups (bucket or artificial teat), but both groups had access to artificial teats in their pen. This experiment looked at how nutritional and non-nutritional sucking affects resting and oral behaviors, which were recorded through observation. In the last experiment, 29 Holstein calves were divided into two feeding groups (bucket or automatic device with teat attached) to determine if automatic feeding devices can limit cross-sucking prevalence. The results showed that there was no effect of cross-sucking on heart rate, calves that were bucket fed spent more time cross-sucking, bucket fed calves spent more time licking themselves, and all calves fed with automatic machines displayed more cross-sucking. Teat-fed calves were seen to rest more after meals, but there were no differences in growth of calves. As such, these results suggest that feeding using teats helps the calves enter a calmer state after a meal and should be implemented in commercial practices to reduce cross-sucking. Future research can study the effects of cross-sucking on the sympathetic nervous system and vagal system, and how the cross-sucking affects the hormone release in these systems.

Contribution

Interesting connections were made between rest and cross-sucking, and no other papers have made this correlation. This article demonstrated how other physiological systems affect cross-sucking, and how cross-sucking affects these systems in return. This contributes to a deeper understanding of the proximal causes and effects of the behavior.