

Behavioural synchronization and its determinants in horses (*Equus caballus*) and sheep (*Ovis aries*)

Verena Hauschildt

Summary

Socially organized animals have to synchronize the timing and directions of their movement decisions, in order to maintain group cohesion. To what extent social and environmental mechanisms trigger behavioural synchronization is still poorly understood. When housing management restricts space availability or predetermines feeding schedules, synchronization may rather develop as a random phenomenon due to external cues, even when a lower degree of behavioural synchronization might be advantageous for the individual under these conditions.

This thesis investigated social and environmental determinants of behavioural synchronization in horses and sheep. Behavioural synchronization was calculated using different parameters: (i) $P_{100\%}$, i.e. the proportion of observations during which all group members performed the same activity, (ii) Kappa coefficient of synchronization (K), which corrects for synchronization occurring by chance, and (iii) synchronization between dyads (P_{DY}). The study was divided into four experiments. All experiments were conducted on pastures or stables of the Department of Animal Sciences, Göttingen, Germany.

The first experiment was conducted in September 2010 and from June 2011 until October 2011, and considered the temporal stability of behavioural synchronization and social structure in a herd of 10 Shetland pony mares kept on pasture. Direct field observations were conducted during the grazing seasons, lasting 1.5 to 2.5 h between 08:00 and 20:00 h. Behaviour, nearest neighbour identity and distance were recorded individually every 15 min by point sampling. All mares showed preferences for the proximity of primarily one certain group member which stabilized in the second year. Non-random synchronization was significantly higher during the second year ($K_{(2010)}=0.22$; $K_{(2011)}=0.54$; $t=2.69$; $p=0.007$). Social bonds and integration were relevant social stimuli on behavioural synchronization.

For the second experiment the same pony herd was observed from November 2011 until March 2012 in an open stable (76 m²) with or without access to an adjacent paddock (400 m²). Space and feed availability (hay and straw, or only hay) were combined to four different treatments: paddock/ hay and straw (PHS), hay and straw/ no paddock (HS), paddock/ only hay (PH), and only hay/ no paddock (H). Each treatment lasted three weeks. The ponies were observed twice a week via 24 h time-lapse video recordings. Every 15 min, behaviour and location of the mares was recorded by point sampling. Behavioural data were divided into day (08:00–16:00 h) and night (16:15–07:45 h). In order to evaluate physiological reactions, resting heart rate (HR) was obtained weekly, and rectal temperature (T_R) was measured twice a week. Faeces were rectally sampled twice a week and faecal cortisol levels (CORT) were quantified using an ELISA validated before.

Synchronization of feeding (day: $F=20.95$; $p<0.01$; night: 22.35 ; $p<0.01$) and standing (day: $F=7.91$; $p<0.01$; night: 40.18 ; $p<0.01$) differed between treatments, but not with regard to feed or space availability. Daytime synchronization reached high values during the least restricted treatment PHS(1) ($K_{(day)}=0.29$) and during the most restricted treatment H ($K_{(day)}=0.26$). $K_{(night)}$ was highest during the most restricted treatment H ($p<0.05$), indicating that decreased space increased non-random synchronization when no feed was available. Overall, neither CORT nor K -coefficients systematically reflected the housing induced resource restrictions. Possibly, more extreme restrictions would result in more conclusive effects.

The third experiment was designed to evaluate pasture size related changes in behavioural synchronization and spacing in a herd of 14 German Blackface ewes. Three plot sizes were used: S (126 m²; 9 m²/head), M (1,100 m²; 79m²/ head), and L (11,200 m²; 800 m²/ head). During direct field observations, behaviour and nearest neighbour distance were individually

recorded every 15 min by point sampling. Compressed grass sward height was measured as a possible external determinant of spacing and synchronization. Interindividual distances between all group members were derived from aerial photographs taken on plot sizes S and M.

Nearest neighbour distances <1 m accounted for more than 60% of observations. Interindividual distances averaged 4.89 ± 2.62 m and 5.99 ± 3.06 m for plots S and M, respectively, with significantly larger distances on M than on S plots ($t=7.3$; $p<0.01$). Compressed grass sward height (range between 4 and 36 cm) had no effect on behavioural synchronization. Synchronization tended to increase with plot size ($K_{(S)}=0.42$; $K_{(M)}=0.52$; $K_{(L)}=0.66$), but was not accompanied by a concomitant increase in dispersion. The sheep kept small distances on all plot sizes, thus the high degree of behavioural synchronization might have been mainly attributed to the motivation for close proximity to any conspecific.

The fourth experiment evaluated how behavioural synchronization is affected by animal personality. Synchronization was defined as a quantifiable phenomenon associated with group cohesion in sheep. Gregariousness was specified as a measure of personality variation, defined based on frequency of having a close neighbour (< 3 m). Neighbour distances obtained during the third experiment were used as a separation criterion. Highly gregarious (HG) and less gregarious (LG) animals were allocated into two separate groups ($n=7$) and were reintegrated within one herd after 18 days. During direct field observations, behaviour was recorded individually every 15 min by point sampling. Each session lasted 2.5 h (08:30-11:00 h or 14:30-17:00 h, respectively). Behavioural synchronization was highest when the group consisted only of HG individuals ($K_{(HG)}=0.69$, $K_{(LG)}=0.31$; $t=5.29$; $p<0.001$), indicating that gregariousness predicted behavioural synchronization in sheep. Though sheep are generally recognized as a highly gregarious species, HG and LG individuals could be differentiated clearly and consistently.

Behavioural synchronization was a prominent part of the behavioural repertoire of both sheep and horses kept on pasture. In environments with evenly distributed feed resources, behavioural synchronization might be inseparably linked to proximity. Stable social bonds between certain peers, associated with a high degree of synchronization were evident only in horses. The close distances between the sheep were probably based on a generally higher degree of gregariousness in this species. The results of this thesis suggest that behavioural synchronization can predict group cohesion.

Among the different parameters evaluated, the K -coefficient of synchronization proved to be a valuable measure of behavioural synchronization at the group level, because it was easily attainable and corrected for prevalence of behaviour. For future research, its use is recommended in order to enable comparisons between studies as well as to estimate “critical values” of synchronization.

Adding physiological stress parameters did not facilitate interpretations of levels of behavioural synchronization, but incorporating spatial distribution and social structure did: Nearest neighbour distance proved to be an easily attainable measure to assess socio-positive relationships in horses and individual behavioural variations in sheep. Such information should be considered in re-groupings of horses. Moreover, they have practical implications for flock handling and efficient forage utilization.

Levels of behavioural synchronization did not unequivocally reflect changes in housing conditions, especially in intensive housing systems. The present state of research does not allow deriving recommendations on adequate values of behavioural synchronization under different housing conditions, and the integration of behavioural synchronization as a welfare indicator involves the risk of misleading conclusions. Deeper understanding of what constitutes behavioural synchronization is essential in order to adequately classify behavioural changes related to synchronization, and furthermore to allow predictions of management problems in group housing of domestic animals.