

Validation of RumiWatch sensors: a confusion matrix approach

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RumiWatch (RWS; ITIN+HOCH GmbH, Switzerland) is a pressure sensor based system measuring eating, ruminating and drinking time of cattle. In the present study we use confusion matrix approach for validation and calculate sensitivity and precision of the RWS measurements. The method also reveals what kind of erroneous classifications RWS makes. Five non-lactating dairy cows kept in tie-stalls were equipped with RWS halters for 48 hours. The cows were offered 7 DM kg silage per day and water was provided ad libitum from water bowls. Two trained observers recorded eating (ET), ruminating (RT) and drinking (DT) bouts by continuous recording from video-recordings and these measures were compared to RWS ET, RT and DT classifications second by second. There was three to nine hours (i.e., 10800 - 32400 seconds) of data per animal. For each of the three behaviour patterns, we calculated sensitivity (true positives / [true positives + false negatives]) and precision (true positives / [true positives + false positives]). The results are presented as lowest value - highest value of all the five halters separately, as well as for the pooled data from all the five halters.

RWS measured ET little more reliably than RT: sensitivity for ET was 81.8 - 99.3 % (calculated from pooled data 90.3 %) vs. RT 62.5 - 97.0 % (82.7 %). On the other hand, RWS misclassified other four behaviours more to eating than to rumination: precision of ET 33.5 - 75.9 % (48.6 %) and RT 61.1 - 96.6 % (87.3 %). The major reason for the overestimation of ET were behaviour categories that included "behaviour resembling eating" (jaw movements without feed in the mouth) and "other behaviours" (behaviours other than eating, rumination, drinking or "behaviour resembling eating") being classified as ET (Table 1). The RWS system did not measure DT reliably: sensitivity was 0.0 - 7.6 % (3.4 %) and precision 0.0 - 4.4 % (2.4 %).

RWS classified eating and rumination, but not drinking, reasonably well although there was a lot of variation between the individual halters. The detailed information of RWS misclassifications can be used in the further development of the system.

Table 1. A confusion matrix for eating, ruminating, drinking, "other behaviours" and "behaviour resembling eating" RumiWatch (RWS) measurements. Continuous behaviour recording is regarded as gold standard.

		Gold standard				
		Eating	Ruminating	Drinking	Other	Resembling eating
RWS	Eating	20716	3002	862	6972	11043
	Ruminating	2044	21248	3	860	190
	Drinking	43	0	43	1316	368
	Other	143	1453	354	49226	2514

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