Could snorts inform us on how horses perceive riding?

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ABSTRACT

Extensive researches showed that work can cause stress in horses. Riders' posture, when inappropriate, has been described to particularly favour horses' behaviours associated to a negative emotional state and significantly impact horses' welfare state whereas an optimistic bias was highlighted in horses ridden with loose reins and low hands. Thus, one can wonder whether horses may positively perceive work. If so, how to detect moments that they would appreciate more? We recently found that, outside the working context, snorts could reflect mild positive emotions in horses. We hypothesized therefore that snorts could help identifying the working phases and actions appreciated by horses. 127 horses and their respective riders were observed during riding lessons where the positions adopted by the horse and the rider were scored both during and outside the context of snort production. Results show that snorts were particularly associated to phases when the rider technique (long, loose reins) allowed more comfort for the horse (low neck posture), especially while walking. Results were more mitigated for higher paces since the association of snorts with signs of comfort was less clear-cut. Snorts could therefore be useful tools for identifying better practices. However, care has to be taken at higher paces.

Key words: Snort, Positive emotion, Riding, Welfare, Horse

INTRODUCTION

How animals perceive work remains under debate. In pigs, performing tasks enhances well-being (Ernst et al., 2006), but in dogs, work-related stress may emerge, either because of the type of activity (*e.g.* animal-assisted activities: Haubenhofer and Kirchengast, 2006), the type of reinforcement used (*e.g*. Haverbeke et al., 2008; Hiby et al., 2004) or the associated physical constraints (Rooney et al., 2016). In horses, the impact of work, and especially riding, has long been underestimated (Ödberg and Bouissou, 1999), but it is well established now that riding can be a source of acute stress for horses (McGreevy and McLean 2005), so that the simple view of working related objects may lead to negative reactions (Fureix et al., 2009). Several studies using preference tests demonstrated that horses did not show strong motivation for exercise performed under constraining conditions (Górecka-Bruzda et al., 2013; Lee et al., 2011), and could even perceive riding as uncomfortable (König von Borstel and Keil, 2012). In a study on jumping horses, Górecka-Bruzda et al. (2011) found that the motivation to jump, even small fences, decreased rapidly with higher effort, concluding that this exercise was emotionally costly for the horse. Accordingly Ille et al. (2013) recorded peak cortisol levels after jumping, as a probable result of the exercise. Moreover, riders' techniques, positions and skills do impact the mental and physical welfare of horses (Lesimple et al., 2010; Lovett et al., 2005; Ödberg and Bouissou, 1999) and lead when inappropriate to the display of stress ("conflict") behaviours by the horses (Górecka-Bruzda et al., 2015; Hall and Heleski, 2017; von Borstel et al., 2009; Williams and Warren-Smith, 2010), as well as postural (*e.g.*. ears backwards [von Borstel et al. 2009; Ludewig et al. 2013]) and physiological changes (for a review: König v. Borstel et al., 2017). Thus elevated head/neck postures and ears backwards reflect discomfort at work (*e.g.* Greve and Dyson, 2013, 2014; Quick and Warren-Smith, 2009; Waldern et al., 2009). Excessive rein tension appears to have a particular impact on horses' emotional and physical state since a too harsh and unnecessary use of bits by novice riders may

lead to serious sanitary problems in the mouth, a particularly sensitive part of the horse's anatomy (Cook, 2003; Mata et al., 2015). Indeed, several authors underlined the aversive aspect of rein tension (*e.g.* Christensen et al., 2011), and more generally different kinds of tension-eliciting equipment (Clayton et al., 2011; McLean and McGreevy, 2010; Murphy, 2009) which may lead to conflict behaviours such as head tossing or reefing the reins (*e.g.* König von Borstel and Glißman, 2014; McGreevy and McLean, 2005; Pickles et al., 2014; von Borstel et al., 2009). Moreover, shortening of the reins has been associated with vigorous tail switching and flattened backwards ears in the horse (Ludewig et al., 2013). Horses also try to avoid pain in the mouth by raising the head and neck, which leads to a characteristic posture where the neck becomes flat or hollow (Cook, 2003; Jeffcott, 1979). The repetition of these avoidance behaviours, (*i.e.* head rising, head tossing) may lead to back problems and chronic and behavioural or postural modifications (*e.g.* Hausberger et al., 2009; Lesimple et al., 2010). In studies on leisure and riding school horses, Fureix et al. (2011) and Lesimple et al. (Lesimple et al., 2013) showed that these two categories of horses differed greatly in terms of back/neck shape, with more roundness in the leisure horses, that, beyond living in a more appropriate environment, were also ridden with loose reins and low hands. Interestingly, when confronted to cognitive bias tasks, the leisure horses appeared more optimistic than the instruction horses (Henry et al., 2017). Similarly, considering that horses trained with positive reinforcement are more positive towards the task and the trainer than those trained using negative reinforcement (Sankey et al., 2010a, 2010b), one can wonder whether horses may learn to appreciate work, and in this case, whether there are particular moments that they would appreciate more. Lesimple et al. (2016, 2010) showed that the time spent by beginners with high hands was correlated with that spent by the horse with a high neck and consequently led to more back disorders. This means that such times are probably negative experiences for the horse.

The teacher's strategy played a major role in determining the attention beginning riders payed on their position and actions, leading to strong discrepancies in the riding techniques observed and the horse's spine state between riding schools (Lesimple et al., 2016, 2010). This also means that some strategies for teaching and riding may be better perceived by the horse. However, indicators of positive emotions in a riding context are still scarce to date. Yet, promoting positive emotions during learning has been shown to reduce problematic defence behaviours during training (*e.g.* biting or kicking) and consequently the risks of accidents, in comparison to some training methods that may induce discomfort or stress (*e.g.* von Borstel et al. 2009). Thus, it becomes really necessary to identify these positive situations in order to be able to assess how the horses perceive the situation and consequently promote favourable practices.

We recently found that, outside the working context, snorts (more or less pulsed sounds resulting from the expulsion of the air through the nostrils), when not related to any respiratory issue, could reflect mild positive emotions in horses since they are clearly more produced in a context that favours the expression of a positive internal state (*e.g.* pasturing in groups) and were more present in horses in a good welfare state (Stomp et al., 2018b). Interestingly, one study found that snort production was negatively correlated to rein tensions in dressage horses (König von Borstel and Glißman, 2014) and Dyson et al. (2018) reported that it was frequent to hear snorts after improvement in lameness as a potential sign of relaxation. We hypothesized therefore that snorts could, as observed in other contexts, help identifying the working phases and actions that horses could appreciate most. In order to test this hypothesis, we recorded snorts during beginners riding lessons in different riding schools and investigated their context of production both in terms of the phase of work (halt, walk, other) but also of riders' position and horse's posture at the precise time of the production. In the light of the abovementioned studies, a special emphasis was given to the reins' length and tension as well as hands' height

for the rider, neck's height and shape and ears' positions for the horse. We expected that more snorts would be produced during relaxed walk, associated with a low neck position for the horse as well as low hands and long and loose reins for the riders and that potentially this could be less clear-cut at higher paces, where beginners have more difficulties keeping balance and hence more chances to have inappropriate hand actions.

MATERIAL AND METHODS

Ethical note

Experiments were conducted in accordance to the European directive 2010/63/UE relative to the protection of animals used for scientific purposes and complied with the current French laws related to animal experimentation (decree n°2013-118 of 1 February 2013 and its five implementation orders (JO of 7 February 2013), integrated in the Code rural and the Code of the maritime fishing under n° R. 214-87 à R.214-137). Animal husbandry and care were under management of the riding schools staffs, as this experiment involved horses from the field (no laboratory animals). All the observed riders gave us their oral consent to be involved in the study, and a written consent of the riding teachers was obtained in each case. Riding teachers are, according to French laws, empowered to take this kind of decisions. Only behavioural observations were performed, and neither the riders nor the teachers were submitted to any other experimentation.

Subjects and management conditions

127 horses (65 geldings and 62 mares) aged 3 to 30 years old (X±SE=13.8±5.1) of diverse breeds (including 61.2% unregistered horses) were observed during riding lessons. The horses came from 16 different riding schools through various French regions with classical management and environmental conditions: all lived in individual stalls, with restricted social

contacts, were fed industrial pellets 2-3 times /day with ad libitum access to water and variable access to forage. Horses were ridden in average 10.2±2.4 hours per week.

Data collection and analysis

The study was performed between January 2010 and June 2011. Riding lessons were video-recorded in the afternoon by one single experimenter (C.L.) using JVC, Everio GZ-MG275 camcorder, which was on a tripod at a fixed place on the ground within the covered area used for lessons. Horses were ridden by beginners with typical English riding style and were equipped of snaffle bits. Riding lessons lasted between 39 and 70 min (X±SE=56.5±7.7).

The video recordings were analysed by a unique experimenter (A.M.) using Behavioral Observation Research Interactive Software (BORIS v6.3.6, a free and open source software DOI: 10.1111/2041-210X.12584).

Snort sampling

Three different non-vocal sounds have been described in horses (Kiley, 1972; Waring, 2003). All of them are produced via the passage of the air through the nostrils. The **snore** is a very short raspy inhalation sound produced in a low alert context, such as investigating a novel object or obstacle. It could also be produced prior to emitting a blow; the **blow** corresponds to a short very intense non-pulsed exhalation through the nostrils and is generally associated with vigilance/alarm postures (*e.g.* presence of a fear-inducing object in the surroundings); the **snort** corresponds to a more or less pulsed sound produced by nostril vibrations while expulsing the air, with a slightly longer duration in comparison to the blow.

Snort structure could not be analysed here as background noises during the lessons prevented to have good enough structural analyses. They were clear enough however to be recognized both by ears and examination of sonograms. In total 15.50 hours recordings were used.

Part 1: overview of snort production, comparison between schools

In order to have an overview of the their production in the different schools, snorts were recorded every time they occurred, whether the emitter was visible or not on the video using "all occurrence" methodology (Altmann, 1974). We assessed the number of snorts produced according to the lesson phase (*i.e.* stop, walk, trot, canter) while determining the percentage of time spent in each phase during the lesson for a subset of five riding schools.

Part 2: riding context of snort production

In this section, only the snorts produced while the emitter was visible were examined. At each occurrence, both the horse's postures and the riders' positions were registered (see also [Lesimple et al. 2010, 2016]) (Fig.1).

Rider's characteristics:

-hands' height: based on the fictional number of fists between the horse's wither and the real hands' position: very high (H>1, higher than one fist), high (H1,]0.5-1] fist), middle (H0.5,]0-0.5] fist) and low (H0, hands positioned at the wither height).

-reins' length: short (< ½ horse's neck length), medium (]½– 1] horse's neck length), long (>1 horse's neck length).

-reins' tension: tight (straight line between the rider's hands and the horse's mouth), loose (curve line between the rider's hands and the horse's mouth).

Horse's postures:

-the neck's height: high (>45°/back line), horizontal ([0°–45°]/back line), low (<0°/back line).

-the ears' position: forward (tip of the ear towards the front at an angle of more than 30° from the perpendicular), backward (tip of the ear towards the back at more than 30° from the

perpendicular), and sideward (auricles turning at 90°from the axial position - perpendicular to the head).

Backward ears position is commonly associated with negative emotional states, such as discomfort or pain (*e.g.* Ashley et al. 2005; Hausberger et al. 2016) and have been shown to be related to negative contexts (*e.g.* shorten the reins) while being ridden (Hall et al., 2014; Ludewig et al., 2013; von Borstel et al., 2009).

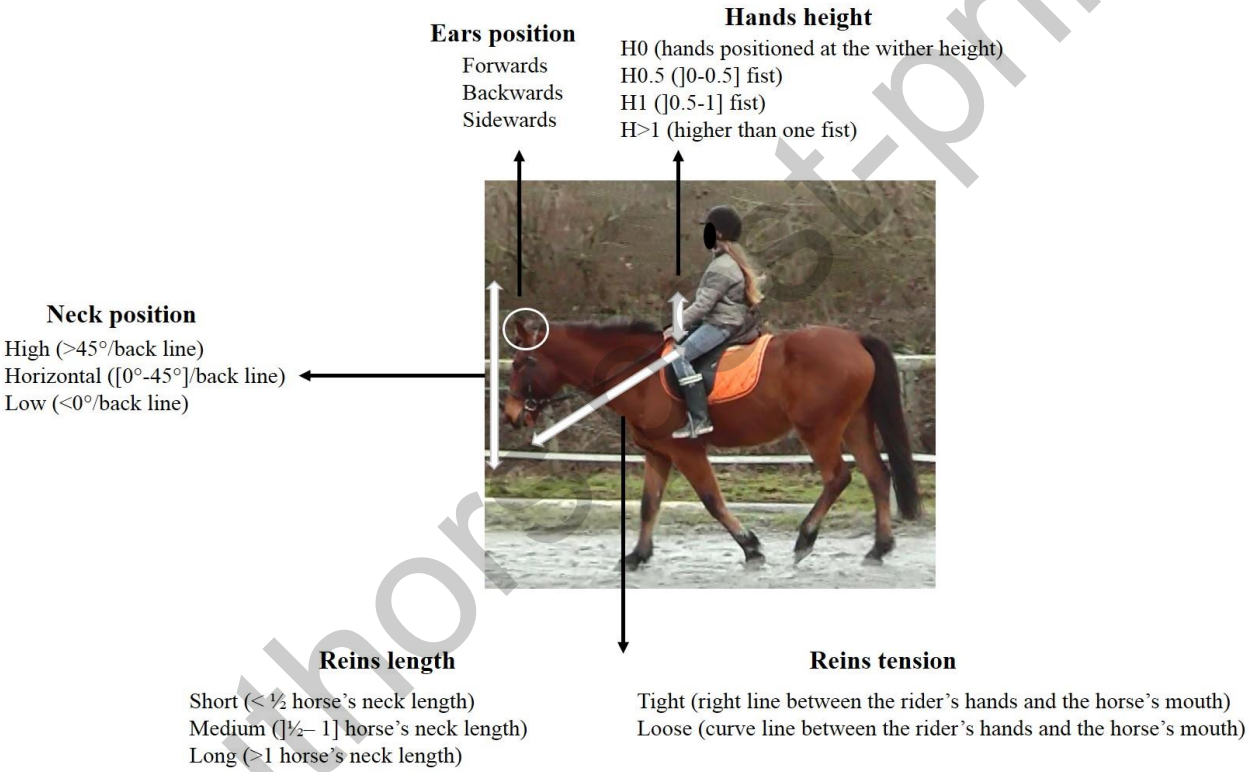

Figure 1: Horses' and riders' different postures at work, adapted from Lesimple et al., 2010.

In order to identify the differences between the time of snort production and the rest of the lesson, observations of the riders' positions and horses' postures as mentioned above were conducted outside the context of snort production as well, in order to assess the global situation displayed during riding lessons. Both the riders' (*i.e.* hands' position, reins' length and reins'

tension) and horses' (neck and ears position) postures were measured on a sampling of 15 pairs (3 pairs from 5 different riding schools) using a scan sampling method (Altmann, 1974). Ten scans were performed per pair per gait (walk, trot/canter).

Data and statistical analysis

Since all recordings were not of the same duration depending on riding schools, the number of snorts has been analysed in number of snorts per individual per hour in order to compare snort production between all sites.

Also, based on the number of snorts recorded and the total duration spent in each lesson phase (*i.e.* stop, walk, trot, canter), we calculated the number of snorts produced per minute for each lesson phase.

Moreover, we calculated the average number of "visible" snorts, *i.e.* when the emitter was visible on the video, produced for each posture. Visible snorts as well as the scans performed outside the snort production context were analysed per gait: walk and trot/canter measures were thus processed independently. To facilitate the reading and the comprehension of the illustrations, data from scans were converted in percentage of scans spent in each position per gait. Similarly, the average number of visible snorts recorded for each modality were converted in average percentage of snort produced. However, statistics were performed on the real data.

Lesimple et al. (2010) showed that horizontal and low neck positions were both associated with riders' low hands and loose reins and consequently less back disorders for the horses. Thus, horizontal and low neck observations were pooled for the subsequent analysis. Similarly, long and medium reins were analysed as one category.

As data were not normally distributed, we used non-parametric tests (Siegel and Castellan, 1988). Chi squared tests were used to compare snort production per individual per hour between the different sites as well as the number of snorts recorded according to the lesson phase (*i.e.*

relaxed, work). The time spent by the riders in the different positions out of the snorting context, as well as the average snorts number recorded per horses' postures and riders' positions were analysed using Friedman and *post hoc* tests when useful. Finally the time spent according to the rein tension during and outside snort production was analysed using Wilcoxon tests.

RESULTS

1. Overall context of snort production

In total 717 snorts were recorded over the 15.5 hours of riding lessons analysed and clear differences appeared between the 16 sites studied (Chi squared test, N=16, X^2=34.2, p=0.002), with more snorts heard in some riding schools than in others (*i.e.* from 2.6 to 14.8 snorts per hour per horse, X=6.3±3.8).

Regarding the recordings made on a subset of five sites, in average 61.6±36.5% of snorts were produced during relaxed phases (immobility, walk, *i.e.* 74.1±12.4% of the lesson time) while 38.3±36.5% of the snorts were recorded during working phases at higher paces (trot/canter, *i.e.* 25.9±12.4% of the lesson time). We showed that the number of snorts produced per minute was higher during relaxed than working phases for one site (Chi squared test, N=2, X^2=12.3, p<0.001). However, no other differences were found regarding the other sites (Chi squared tests, N=2, $0.74<X^2<2.15$, p>0.05).

2. Riding context of snort production (see Tab.1)

In total, 71 snorts, for which the emitter and its rider were visible, could be analysed. They were produced by 38 different horses (*i.e.* from 1 to 11 snort per horse, X=1.8±1.8).

a) Walk

During this phase, the riders had overall mostly long/medium reins and rarely short reins (Wilcoxon test, N=37, p<0.0001). However, horses snorted exclusively when the riders had long/medium reins and no snort was recorded when the riders had short reins (N=10, Z=2.6, p=0.0007) (Fig.2A). Riders had mostly tight reins (Wilcoxon test, N=37, Z=3.4, p=0.0005) but horses snorted in 60±16.3% of the cases when the reins were loose, although individual variations prevented statistical significance (Fig.3A). Finally, riders had overall mostly low hands (Friedman test, N=37, X^2=67.2, p<0.0001, post-hoc comparisons p<0.0001 in all cases) and horses snorted almost exclusively when this was the case (N=10, X^2=7.6, p=0.05).

While walking, horses were observed mostly with a high neck (Wilcoxon test, N=37, Z=4.3, p=0.0001) but they snorted almost exclusively when their neck was low/horizontal (Wilcoxon test, N=10, Z=2.6, p=0.007) (Fig.4A). Finally, horses were observed mostly with sidewards ears during the lesson (Friedman test, N=37, X^2=45.2, p<0.0001, post-hoc comparisons: forwards: p<0.0001; backwards: p<0.0001), but no difference was highlighted while horses snorted (N=10, X^2=2.2, p=0.2).

Thus, when both contexts were compared, it appears that horses produced more snorts when the reins were long or medium, less tight, and the riders with low hands and when their neck was in a lower position, even if these positions were not otherwise predominant during the lesson.

b) Trot/canter

While trotting and cantering the riders had significantly more often low hands (Friedman test, N=15, X^2=10.5, p=0.01, post-hoc comparisons: H0.5: p=0.01; H>1, p=0.04), long/medium (Wilcoxon test, N=15, Z=6.5, p<0.0001) (Fig.2B) and loose (Wilcoxon test, Z=2.2, p=0.02) reins (Fig.3B). During these phases, horses snorted mostly when the riders had long/medium reins (N=24, Z=3.1, p=0.001) (Fig.2B). Moreover, snorts were produced in 62.5±9.6% of the

cases when the riders had loose reins, although individual variations prevented statistical significance (Fig.3B). Snort production did not vary according to the riders' hands position.

During these higher pace phases, horses were overall mostly (86.6±8.8% of scans) observed with a high neck (Wilcoxon test, N=15, Z=7.1, p<0.0001), but snorts could be produced in association with any neck position (N=24, Z=1.1, p=0.2) showing that it differed from the usual context of high neck (Fig.4B). Finally, horses spent at these paces overall significantly less time with the ears forwards (Friedman test, N=15, X^2=8.4, p=0.01, post-hoc comparisons: backwards: p=0.003, sidewards: p=0.007) but they snorted significantly more with ears in backwards position (X^2=20.4, p<0.0001, post-hoc comparisons: forwards: p=0.001; sidewards: p=0.001).

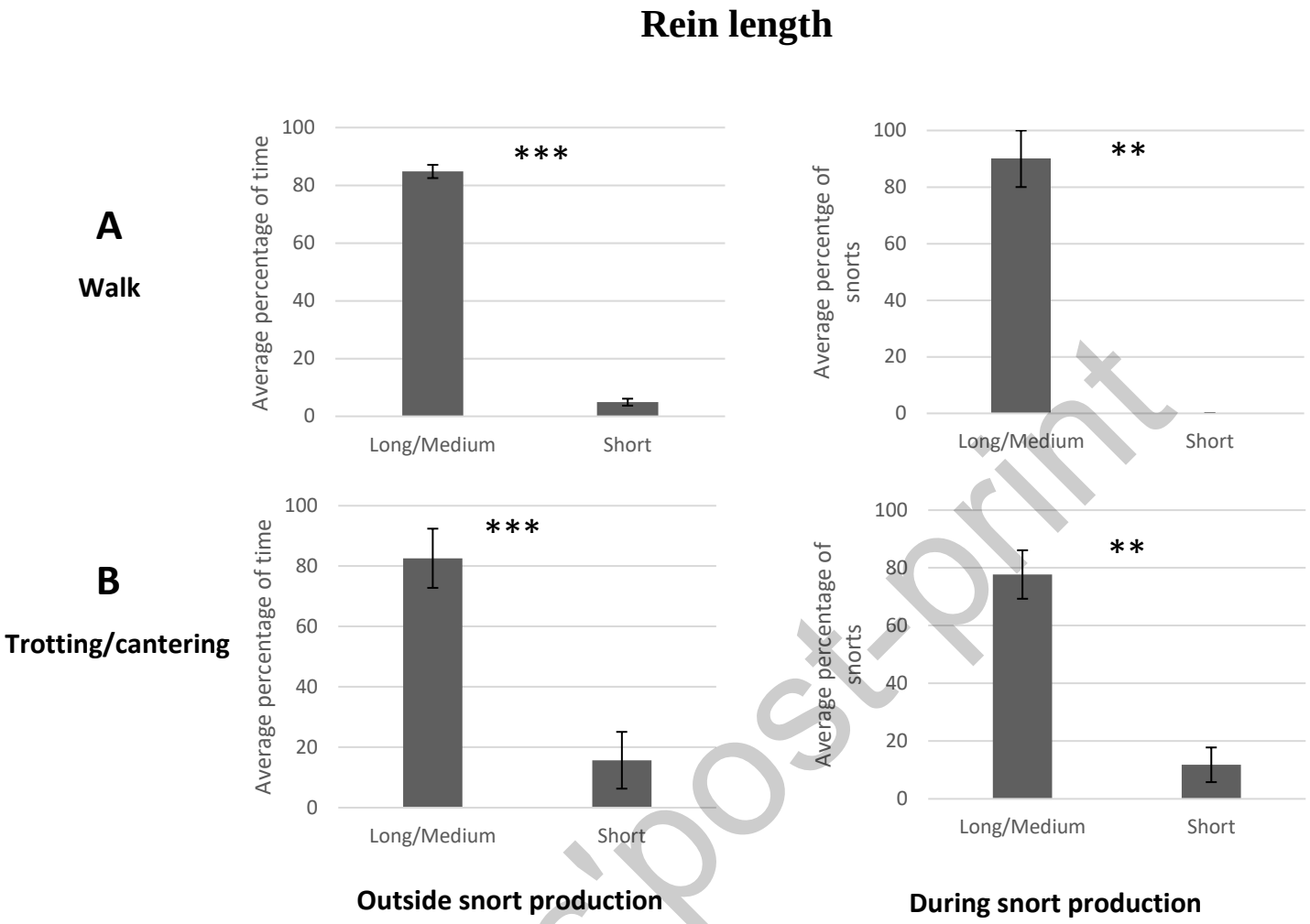

Figure 2: Average percentage of observations recorded according to the rein length outside (on the left) and during the snorting context (on the right); during walking (A) and trotting/cantering (B) phases; *p<0.05, **p<0.01, ***p<0.001.

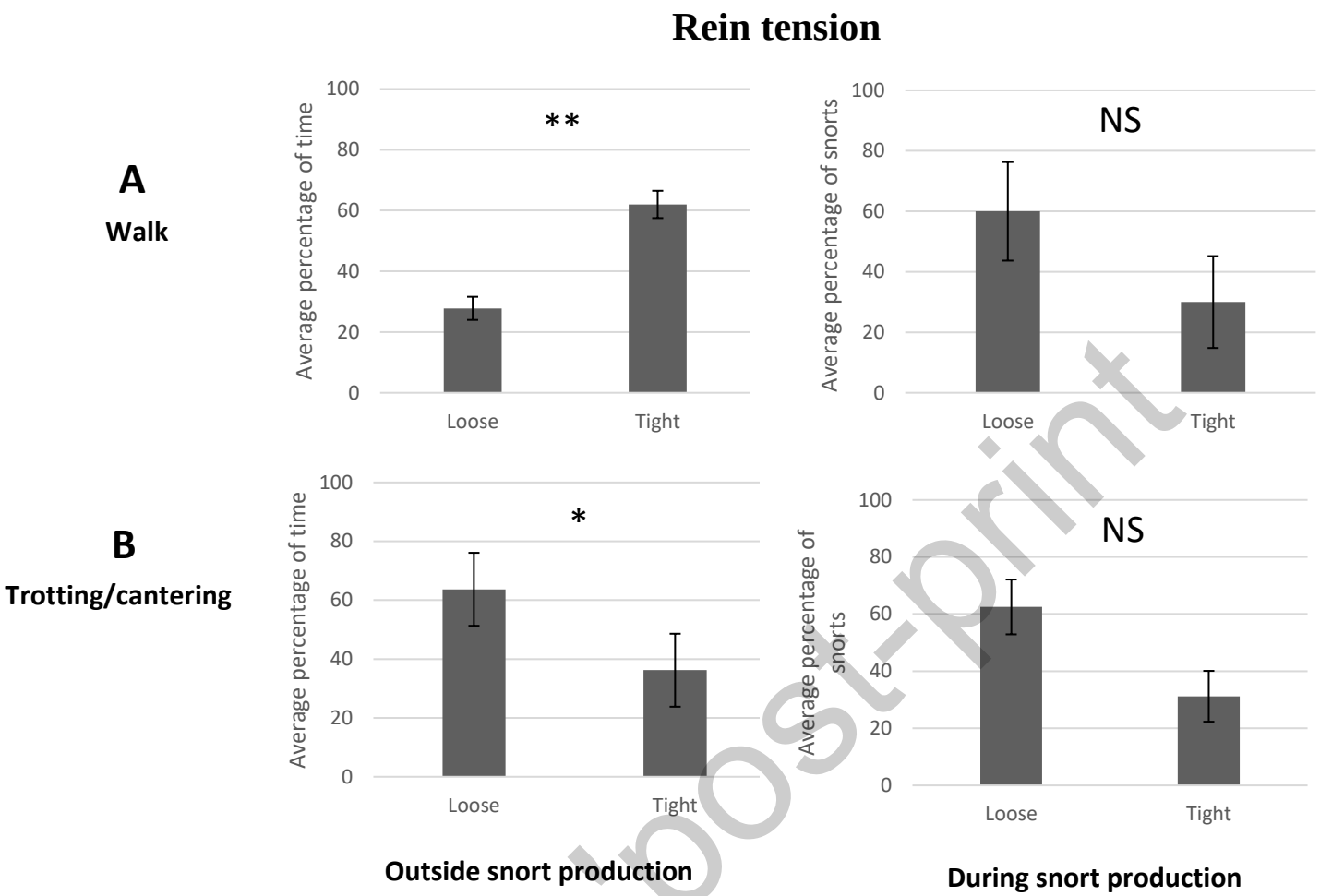

Figure 3: Average percentage of observations recorded according to the rein tension outside (on the left) and during the snorting context (on the right); during walking (A) and trotting/cantering (B) phases; *p<0.05, **p<0.01, ***p<0.001.

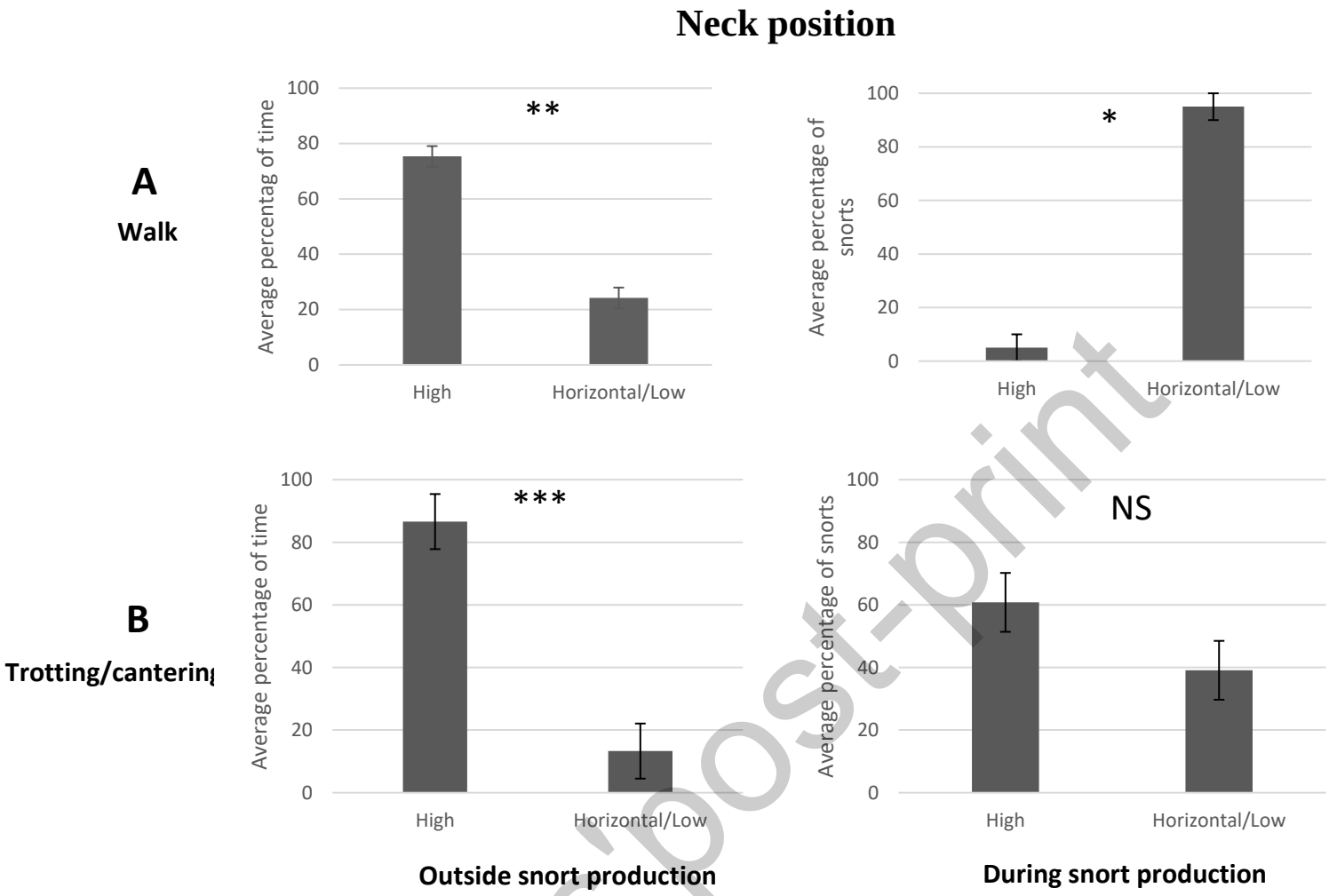

Figure 4: Average percentage of observations recorded according to the neck position outside (on the left) and during the snorting context (on the right); during walking (A) and trotting/cantering (B) phases; *p<0.05, **p<0.01, ***p<0.001.

Table 1: Average percentage of time and snorts recorded according to the different riders' positions and horses' postures.

		Reins length				Reins tension				Hands height							
		Long/Medium		Short		Loose		Tight		H0		H0.5		H1		H>1	
		Average	±sd	Average	±sd	Average	±sd	Average	±sd	Average	±sd	Average	±sd	Average	±sd	Average	±sd
Walk	% time	84.8	2.3	4.9	27.4	27.8	3.8	62	4.5	65	3.9	4	1.1	20.3	3.1	10.7	2
	% snort	90	10	0	15.4	60	16.3	30	15.2	60	16.3	20	13.3	0	0	20	13.3
Trot/Canter	% time	82.6	9.8	15.7	18.7	63.7	12.4	36.2	12.4	45.5	7.4	14.5	3.9	23.2	4.3	16.7	4.2
	% snort	77.7	8.4	11.8	13.7	62.5	9.6	31.2	8.9	11	5.9	37.9	9.6	20.1	7.8	26	10.3

		Neck position				Ears position					
		High		Horizontal/Low		Forwards		Backwards		Sidewards	
		Average	±sd	Average	±sd	Average	±sd	Average	±sd	Average	±sd
Walk	% time	75.3	3.7	24.2	3.7	17.1	2.5	20.2	2.4	62.2	2.5
	% snort	5	5	95	5	5	5	40	16.3	35	15
Trot/Canter	% time	88.6	8.8	13.3	8.8	10.5	3.5	53.3	8.4	36.2	7.2
	% snort	60.8	9.4	39.1	9.4	6.3	1.5	84.7	2.1	9	1.6

DISCUSSION

This study investigated for the first time horses' snorts production during riding in relation with riders' and horses' characteristics at the time of production. The results revealed that snorts 1) were rarely produced during beginners riding lessons, 2) their frequency varied between facilities, 3) most of all, they were particularly produced in a more relaxed context (long, loose reins, low neck posture), especially during walking parts during the session. The results were more mitigated for higher paces.

The frequency of snorts varied largely between the different riding schools during riding lessons, suggesting that snort production may be impacted by the working context. In a study where riders' positions and teachers' recommendations were analysed, Lesimple et al. (2016, 2010) highlighted that riding techniques differed between sites and could lead to differences in the prevalence of horses' back problems. Thus we could suggest that, in the present study, horses perceived more or less positively riding according to the riding techniques adopted. For example, a more positive affect was observed in leisure horses, possibly thanks to better management practices amongst which being ridden with techniques allowing more comfort for the horse (*i.e.* low hands, long and loose reins) (Henry et al., 2017) and having rounder (*i.e.* healthier) chronic body postures (Fureix et al 2011, Lesimple et al 2013). Thus, considering both that snorts were quite rare during lessons and the horses' postures observed in our study, one can argue that this particular working context does not favour the expression of positive emotions in horses. Indeed, observations of the horses' postures outside the snorts production showed that whether walking, trotting or cantering, horses spent the majority of the lesson with a high neck and expressed scarcely forwards ears, and even a majority of backwards ears while trotting or cantering. The high neck posture reflects discomfort, especially when associated with backwards ears (Greve and Dyson, 2013, 2014; Hall et al., 2013; König v. Borstel et al., 2017;

Quick and Warren-Smith, 2009; Waldern et al., 2009). Thus, we can easily suppose that horses experienced mostly negative emotions during these beginners lessons.

However, there was a clear contrast at the exact time of snort production, especially during the walking phases: horses produced more snorts when the riders had long/medium reins and low hands, with less rein tension. This is in agreement with the results of König von Borstel and Gliβman's study (2014) who showed that snorts were more frequent when lower mean rein tensions were observed in the riders. Finally, in contrary to the great predominance of high neck observed during the lesson, we showed that horses snorted more when their neck was horizontal or low while walking. The results were more mitigated for the higher paces, due in particular to high individual variations, but a horizontal/low neck posture was three times more often observed when horses snorted than the rest of the time. In a working context, horizontal and low neck postures have been already associated with less constraining riders' techniques (*i.e.* low hands, loose reins) (Lesimple et al., 2016, 2010). In summary these results show that snorts, in a working context and especially during walking phases, were clearly more frequent at the times when the riders had a more appropriate (*i.e.* more comfortable for the horse) technique. One study recently showed that snorts production was particularly associated with a positive internal state (Stomp et al., 2018b). Then one can argue that snorts could be a sign of a relaxation state at some moments of this working context, such as the walk after more constraining times at higher paces or merely when riders are just more attentive and relaxed themselves. The reported observations made by Dyson et al. (2018) about horses snorting after improvement in lameness support this hypothesis.

However, given the more mitigated results during the trot and canter phases in terms of neck and ears' postures, it is possible that snorts as indicators of positive emotions during work are mostly reliable during walking stages. At higher paces, it is possible that snorts can be related either to times of positive emotions or breathing constraints that could result in particular

from bit pain that can induce “pain, itching or tingling sensations transmitted by the maxillary nerve to the region of the muzzle” (Cook, 2003). We identified recently two types of snorts that reflected different degrees of positive emotions (Stomp et al., 2018a), it would be necessary now to investigate if there can be a third type, more typical of possible breathing constraints.

This study investigated for the first time the relationship between snorts production and postures of both horses and riders during a riding lesson. As expected, snorts were more associated, especially during walking parts, to phases when the rider technique allowed more comfort for the horse. The value of snorts as an indicator of positive emotions in horses seems therefore to extend to the riding situation (confirming Dyson et al. (2018) and König von Borstel and Glißman (2014) earlier anecdotal reports): they could therefore be useful tools for identifying better practices. Since their production differed largely between riding schools, identifying facilities where riding teaching is leading riders to better techniques could be facilitated using this indicator. However, care has to be taken at higher paces when the association of snorts with signs of comfort are less clear-cut and further signs would be then needed.

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Figures captions:

Figure 1: Horses' and riders' different postures at work, adapted from Lesimple et al., 2010.

Figure 2: Average percentage of observations recorded according to the rein length outside (on the left) and during the snorting context (on the right); during walking (A) and trotting/cantering (B) phases; *p<0.05, **p<0.01, ***p<0.001.

Figure 3: Average percentage of observations recorded according to the rein tension outside (on the left) and during the snorting context (on the right); during walking (A) and trotting/cantering (B) phases; *p<0.05, **p<0.01, ***p<0.001.

Figure 4: Average percentage of observations recorded according to the neck position outside (on the left) and during the snorting context (on the right); during walking (A) and trotting/cantering (B) phases; *p<0.05, **p<0.01, ***p<0.001.