Analyzing horse facial expressions of pain with Equine FACS

1 Background

The facial expression of pain in horses is now well recognized and is described as e.g. “Pain Face” [1] or “The Horse Grimace Scale” [2]. However, different studies describe the facial expressions using very different ethograms, making comparison of results difficult. As research in horse pain and other facial expressions grows, there is a need to use an objective and common language for describing and identifying facial expression changes.

The standard descriptor for human facial expressions including pain is the Facial Action Coding System (FACS) [3]. FACS comprises of action units where each one describes a specific facial movement based on the underlying musculature of the face.

Its extension to horses, EquiFACS [4] uses the underlying musculature of the horse face to exhaustively describe all observable equine facial behaviour using elements called Action Units (AU), Action Descriptors (ADs) and Ear Action Descriptors (EADs).

The aim of this study is to describe the facial expression of pain in horses using an objective coding system adapted for coding of facial activity in horses, EquiFACS.

2 Horse Pain Video Dataset

Video recording of 30 secs length were provided from an earlier study [1], where 6 horses of different age and breeds were positively reinforced to

EquiFACS Code	Percentage of total Pain video AUs	More Frequent in Pain Videos	Description
AU17	6.18%	✓	Chin Raiser
AU145	6.70%	✗	Blink
EAD101	7.47%	✗	Ears Forward
AD38	9.27%	✓	Nostril Dilator
AU47	10.56%	✓	Half Blink
AU101	11.34%	✓	Inner Brow Raiser
EAD104	11.85%	✓	Ear Rotator

Table 1: AUs that are indicative of pain based on frequency and discriminative power.

stand without stress in front of a camera for 20 minutes. After 10 days of acclimatization, baseline video recordings were performed, and pain was induced by the application of a pneumatic blood pressure cuff placed on the forelimb. The experimental protocol was approved by the [withheld for blinding] Animal Experiments Inspectorate.

3 EquiFACS Annotation

Films were blinded and coded by a certified EquiFACS coder, with rater agreement higher than 70%. The annotation program ELAN[5] was used to annotate start and stop of all AUs, ADs and EADs.

4 Discovering Pain Action Units

AUs that are ideal for identifying pain should be both frequent and distinct. Using the criteria for identifying action units associated with pain from Kunz et al [6], we first identify the action units that form more than 5% of the total action unit occurrences in the pain videos. Of these action units we retain the ones that occur more frequently in pain videos than in no-pain videos. Table 4 shows the action units that passed the first and second criteria, and their description. For ease we refer to this subset of action units and descriptors as ‘pain AUs’ for the rest of this paper.

5 AU Frequency and Duration

We evaluate the efficacy of each individual pain AU at discriminating pain and no-pain. Horses may express each AU more frequently or for longer duration when they are in pain. We therefore inspect differences in distribution of AU frequency, duration of activation, and maximum duration of activation.

In Figure 1(left), we inspect the total count of occurrences of each of the pain AUs for pain and no-pain videos. Pain videos have generally higher count of occurrences, especially for AU17 and AU38. When frequency was compared between pairs of videos for each horse (second column in Figure 1), the difference in frequency becomes more apparent.

However, a similar analysis of maximum duration, and per occurrence AU duration, does not show promising differences between pain and no-pain videos. These are shown in Figure 1 center and right. AU 47, in contrast, displays longer duration for pain videos – similar to longer eye closure in humans [6].

6 Results

Inner brow raiser (AU101), half blink (AU47), chin raiser (AU17), ear rotator (EAD104) and nostril dilator (AD38) were significantly associated to pain, while, of the 5% most frequent action units/descriptors, blink (AU145) and ears forward (EAD101) were not. Frequency statistics are a promising route to further inspect pain behavior.

7 Discussion

The EquiFACS analysis corresponded to many, but not all of the features mentioned in the Pain Face[1], namely 'low' and/or 'asymmetrical' ears (EAD 104), an angled appearance of the eyes (AU101), medio-laterally dilated nostrils (AD38), and tension of the lips, chin and certain mimetic muscles (AU17). The EquiFACS analysis also revealed features not mentioned in the pain face, such as half blink (AU47); and the withdrawn stare, which does not seem to have an EquiFACS correspondence. The HGS [2] describes features as "stiffly backwards ears", corresponding to EquiFACS ear flattener (EAD 103) which did not pass the 5% pre-selection criteria in this study. In addition, orbital tightening was not seen in the present films, and may be explained as a post-anaesthetic phenomenon. HGS features “tension above the eye”, “prominent strained chewing muscles”,” pronounced chin” and “strained nostrils” might be explained by AU101, AU17 and AD38. Also half blinks were not recorded in the still images used for scoring of the Horse Grimace Scale.

In conclusion, facial activity indicative of pain could be assessed by use of EquiFACS. Rigid conclusions on the presence of one uniform prototypical facial expression of pain should not be drawn on the basis of this limited study.

8 Acknowledgements

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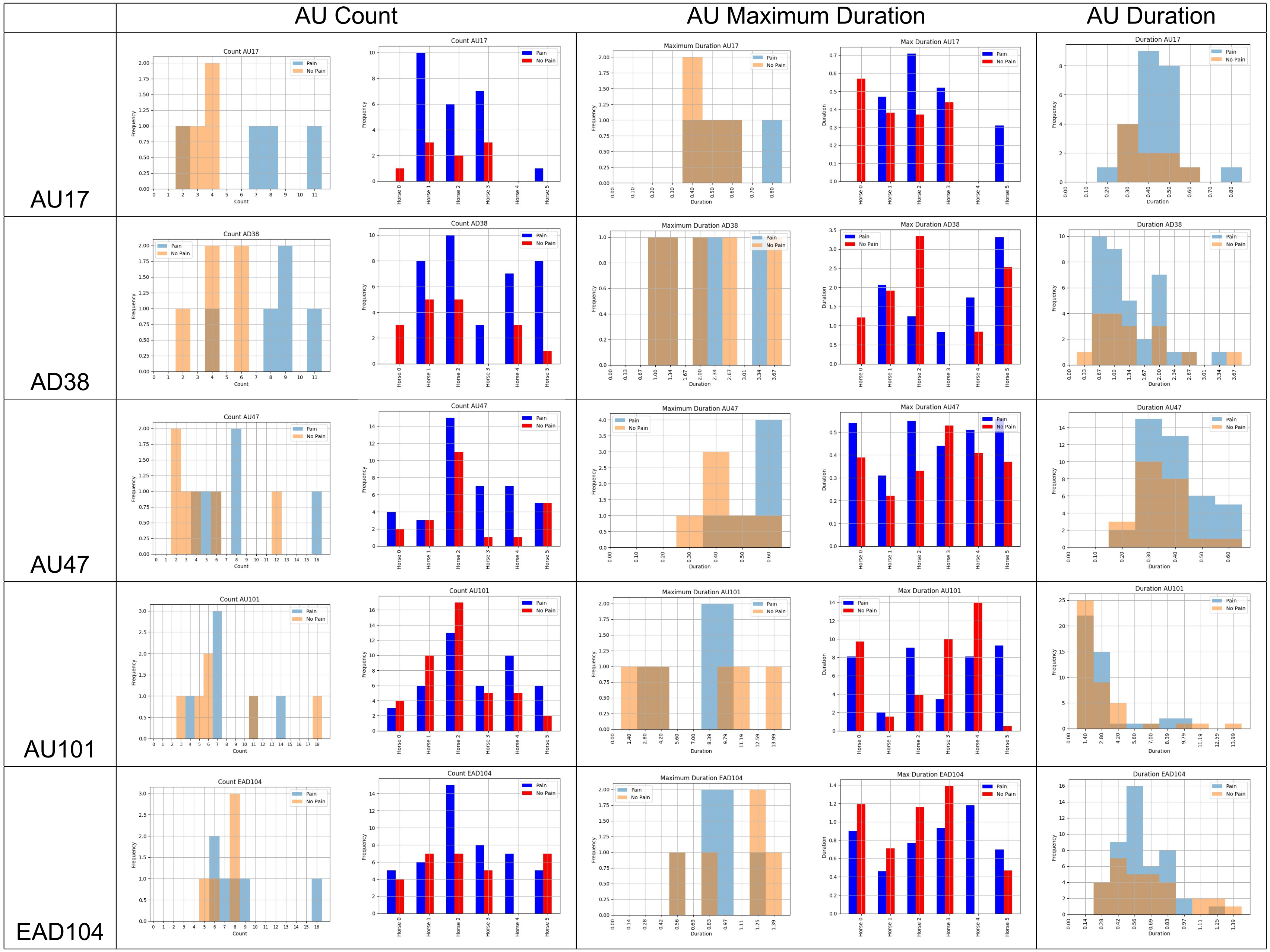

Figure 1: Distribution of number of AU occurrences (Count), maximum duration, and duration across all videos. Note that the higher bar height in the last column is due to higher frequency of occurrences.