The Veterinary Journal 257 (2020) 105454

Contents lists available at ScienceDirect

The Veterinary Journal

journal homepage: www.elsevier.com/locate/tvjl

Short communication

Subjective and objective evaluations of horses for fit-to-compete or unfit-to-compete judgement

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ARTICLE INFO

Article history:
Accepted 27 March 2020

Keywords:
Asymmetry
Equine
Gait analysis
Motion capture
Observer agreement

ABSTRACT

At Fédération Equestre Internationale (FEI) competitions, horses undergo veterinary inspection for judgement of 'fit-to-compete'. However, FEI Veterinary Delegates (VDs) often differ in opinion. The aim of the present study was to evaluate intra- and inter-observer agreements of fit-to-compete judgement and compare these with objective gait analysis measurements. Twelve horses were evaluated by three experienced VDs and one veterinary specialist and video-recorded for re-evaluation later. Simultaneously, quantitative gait analysis measurements were acquired. Inter-observer agreement during live evaluations was fair ($\kappa = 0.395$, 58% agreement). Intra-observer agreement between live observations and videos at one and 12 months was 71% and 73% respectively. Sensitivity and specificity of motion symmetry measured with quantitative gait analysis system were 83.3% and 66.7% respectively, against the consensus of all observers as a reference. These findings might suggest that more VDs should be used to adequately judge fit-to-compete. Quantitative-gait-analysis may be useful to support decision making during fit-to-compete judgement.

The Fédération Equestre Internationale (FEI) is the global governing body for equestrian sports, responsible for ensuring the fitness, health and animal welfare of the competing horses at major equestrian events. Each horse at an FEI competition must undergo a veterinary inspection for 'fit-to-compete' or 'unfit-to-compete' judgement, performed by an FEI certified veterinarian delegate (VD) or a Veterinary Committee together with the Ground Jury. The judgement is based on visual inspection of the horse, followed by a subjective assessment of the gait at walk and trot on a straight line[1] ; and sometimes gives rise to controversies.

Previous studies have shown that lameness is one of the main risk factors for failing a fit-to-compete judgement (Nagy et al., 2010, 2014; Bennet and Parkin, 2018). However, there are very few studies reporting on motion symmetry of competition horses (Nissen, 2016; Lopes et al., 2018). Quantitative methods of gait analysis have been developed that allow for practical, on the spot and real-time measurement of gait parameters (Serra Bragança et al., 2018). This can be helpful, as previous studies have shown less than optimal observer agreement when grading lameness (Keegan, 2007). The aims of this study were: 1) To compare the intra and inter-observer agreement in fit-to-compete judgement; 2) To compare the ratings performed live with the ratings of simultaneously recorded videos one and 12 months later; 3) To compare the live ratings with simultaneously recorded quantitative motion symmetry parameters commonly used for objective lameness assessment. We hypothesised that: 1) fit-to-compete judgement would have an acceptable inter-observer agreement, similar to studies in lameness assessment; 2). Scores based on live assessment, video evaluation and from different view angles will differ; 3) Fit-to-compete judgement is correlated to motion symmetry as measured using objective gait analysis.

Twelve horses that were in regular use for low-level dressage and pleasure riding were included. The horses were evaluated according to the FEI horse inspection procedure for jumping competition ([1]; Supplementary Fig. 1). The Animal Ethics Committee of Utrecht University approved the study (Approval number AVD 108,002,016,386; Approval date: March 2016). The

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[1] See: Fédération Equestre Internationale, 2018. Veterinary Regulations. Fédération Equestre Internationale. https://inside.fei.org/system/files/RULES%202020%20VRs.pdf, pp. 28–29 (Accessed 18 March 2020).

http://dx.doi.org/10.1016/j.tvjl.2020.105454

complete data set used in this study, including raw OMC data, processed OMC data, and videos (side and back views) can be accessed online[2].

Briefly, all observers were placed at the beginning of the inspection track, so that they first saw the horse moving away, and then towards them, as prescribed by the standard FEI protocol (Supplementary Fig. 1). For each run, the observers were asked to rate the horse as fit-to-compete or unfit-to-compete. Each observer was blinded to the scores of the others. At the same time, two video cameras recorded each run. One camera was placed at the same location as the observers, the other perpendicular to the inspection track (Supplementary Fig. 1), mimicking the spectators' perspective by viewing the horse from the side. The observers were asked one and 12 months later to judge the horses again from the videos. The videos had been anonymised and were presented in random order for these evaluations.

For the measurements, horses were led by an experienced handler on the inspection track (25 m, non-slip, hard surface) where the horses performed a minimum of 15 strides. First, the horses were allowed to perform one or two runs without gait analysis markers attached to the skin and they were scored by the VDs. After these first run(s), each horse was equipped with clusters of spherical (19 mm Ø[a]) reflective markers. Three markers were placed in the frontal plane of the head, three markers on the withers and three on the pelvis (left/right tuber coxae and tuber sacrale) attached to the skin using double-sided adhesive tape. Horses were then walked and trotted over the inspection track for kinematic measurements (QHorse, Qualisys AB, Motion Capture Systems, Göteborg, Sweden) and simultaneous judging by the judges for a second time. The four veterinarians graded the horses as fit-to-compete or 'not fit-to-compete' according to the official FEI regulation.

The motion capture data was processed using designated software (QHorse v1.0a, Qualisys AB, Motion Capture Systems, Göteborg, Sweden) and the symmetry parameters MinDiff/MaxDiff (difference in minimum and maximum height, respectively, during limb stance between right and left halves of a stride) from head, withers and pelvis at the trot were calculated. These parameters were chosen based on their known correlation with lameness. From these, vector sums (VS) of head, withers and pelvis were calculated as:

$VS=\sqrt{}(MinDiff^2+MaxDiff^2)$.

Since the fit-to-compete judgement is an overall appraisal of how the horse moves and not only based on a single biological parameter of symmetry (e.g. head or pelvis), outcome of quantitative gait analysis was also expressed as a comprehensive overall symmetry parameter calculated as: Overall symmetry=(VS head)/2 + VS pelvis. This resulted in a single symmetry value for each measurement that could be directly compared to the observers scoring.

Statistical analysis and data visualisation were performed using R-studio[3] (version 1.1.453). The Fleiss-k and the percentage of agreement were calculated to evaluate the inter- and intra-observer agreements using the package IIR (version 0.84). Interpretation of the k values was performed according to Landis and Koch (1977): <0 (poor); 0.01–0.20 (slight); 0.21–0.40 (fair); 0.41–0.60 (moderate); 0.61–0.80 (substantial); 0.81–1.00 (almost perfect). Receiver operation characteristic (ROC) plots were generated using the R package pROC (version 1.10.0) and from these, sensitivity and specificity were also calculated, using the consensus of all four veterinarians on the fit-to-compete judgement as a reference. Horses were classified as fit-to-complete if all veterinarians agreed on the judgement and horses were classified as not fit-to-compete if at least one veterinarian classified the horse as not fit.

When comparing the live runs with and without gait analysis markers, the inter-observer agreement was fair (Fig. 1) and higher for the runs without markers (κ = 0.53) when compared to the runs with markers (κ = 0.39). The intra-observer agreement between the runs with and without gait analysis markers was almost perfect (ranging between κ = 0.8 and κ = 1).

When comparing the scores among horses and observers for the video evaluation, between the back and side perspective a total of 14/48 scores changed at the evaluation one month later and 5/48 scores 12 months later (Fig.2). When comparing the scores among horses and observers, between the video evaluation one month later and the live evaluation in total 13/48 scores changed (Fig.2). Video evaluation 12 months later differed from live evaluation in a total of 13/48 scores.

There was a trend for overall symmetry values to be higher for the consensus of all observers when horses were judged as not fit-to-compete compared to fit-to-compete (P = 0.06; Fig. 3, Supplementary Fig. 2). Receiver operator characteristic (ROC) curves for the overall asymmetry (sum of head and pelvis vector-sum [VS]) showed the highest sensitivity and specificity, 83.3% and 66.7% respectively while symmetry of the withers showed the lowest sensitivity and specificity, 44.4% and 0% respectively (Supplementary Fig. 3).

The results support our hypothesis that fit-to-compete judgement has an acceptable inter-observer agreement, similar to lameness assessment (Keegan, 2007) and that the intra-observer agreement is substantially higher than the inter-observer agreement. We have also confirmed that when judging horses for a fit-to-compete judgement from different perspectives (back vs side), the same observer can come to different verdicts. Furthermore, we have demonstrated that quantitative gait analysis has an acceptable sensitivity and specificity to detect motion asymmetries that are taken into account when judging fitness to compete.

The inter-observer agreement for the live observations in our study was classified as fair but remained far from perfect. When comparing the scores between the different video observations and comparing the video observations to the live observations, it was clear that there were substantial differences in scoring performed by the observers. Inter-observer agreement for the live scorings was substantially better than for the video scorings. Previous studies have proposed that video recordings can negatively affect the assessor's ability to assess gait (Strobach et al., 2006) due to less and potentially worse auditory and two-dimensional visual information. Another issue is the position of the observer. Further, video scoring is clearly different from live scoring and comparing the different modalities should be done with caution. It is also important to notice that VDs assess unridden horses, whereas during competition horses are ridden and gait evaluation between ridden and unridden exercise may lead to different conclusions.

In this study there was no clear cut-off value based on objective measurements, but based on the low agreement between observers, we hypothesise that the subjective judgement of VDs could benefit from an additional objective assessment of motion symmetry. There is evidence to relate lameness to some parameters of motion symmetry and also to support the incorporation of quantitative gait analyses in a clinical setting (Keegan, 2007; Serra Bragança et al., 2018), hence, the incorporation of this technology in other activities of a veterinarian, such as the work of a VD in an FEI inspection, should be considered. This is further supported by a recent study reporting the incorporation

[2] See: Data Archiving and Networked Services NARCIS. https://www.narcis.nl/dataset/RecordID/doi%3A10.24416%2Fuu01-clv1f1 (Accessed 18 March 2020).
[3] See: R studio. https://rstudio.com (Accessed 18 March, 2020).

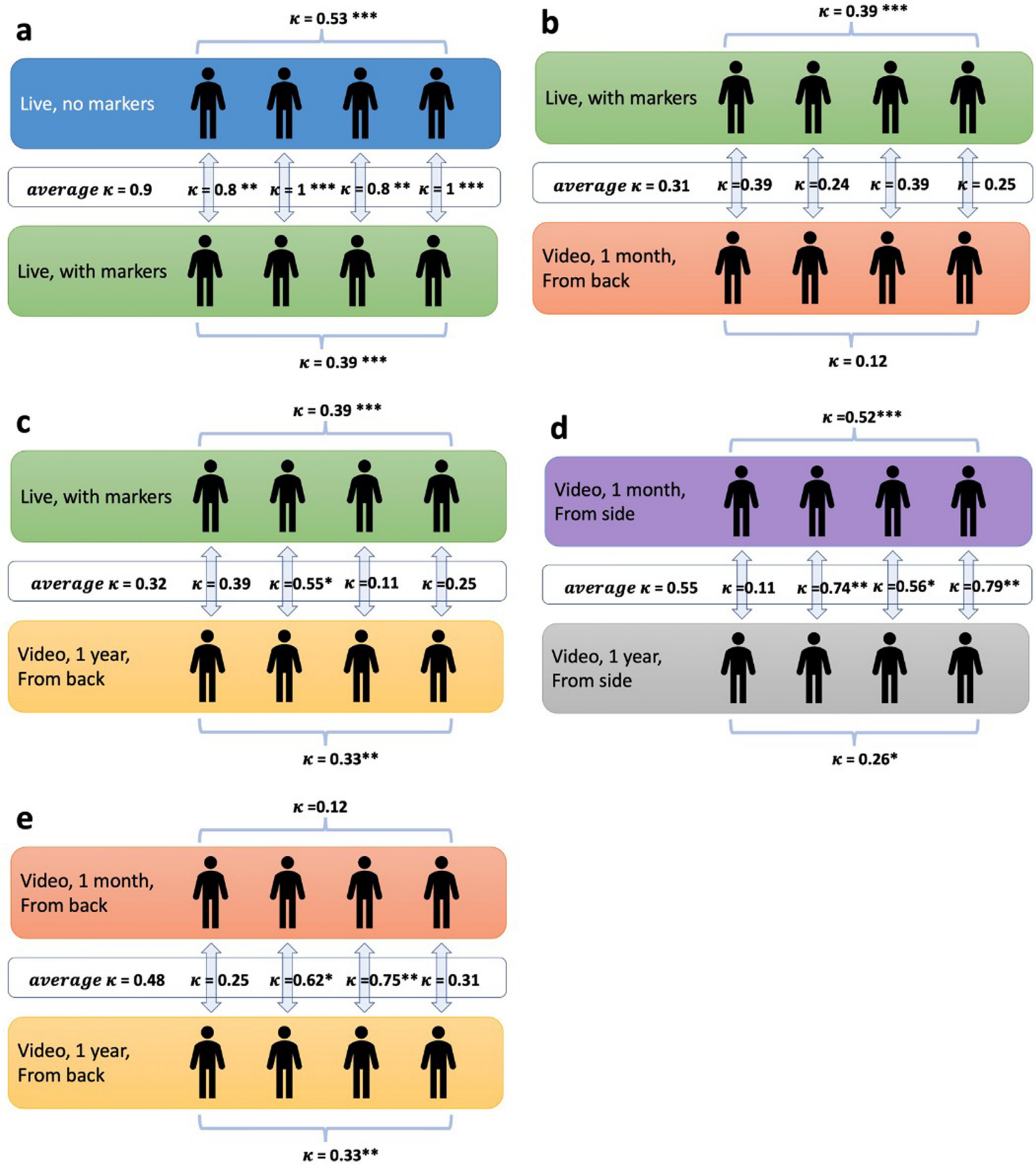

Fig. 1. Fleiss kappa for inter and intra-observer agreement for the live and video fit-to-compete assessment. Intra-observer agreement is indicated in the vertical arrows and inter-observer agreement is indicated in the horizontal brace. a) Inter- and intra-observer agreement for fit-to-compete assessment between the live scorings with and without gait analysis markers; b) Inter- and intra-observer agreement for fit-to-compete assessment between the live scorings with gait analysis markers and video observation from the back one month later; c) Inter- and intra-observer agreement for fit-to-compete assessment between the live scorings with gait analysis markers and video observation from the back 12 months later; d) Inter- and intra-observer agreement for fit-to-compete assessment between the video observation from the side one and 12 months later; e) Inter- and intra-observer agreement for fit-to-compete assessment between the video observation from the back 12 and one month later; *P<0.05, ** P<0.01, ***P<0.001.

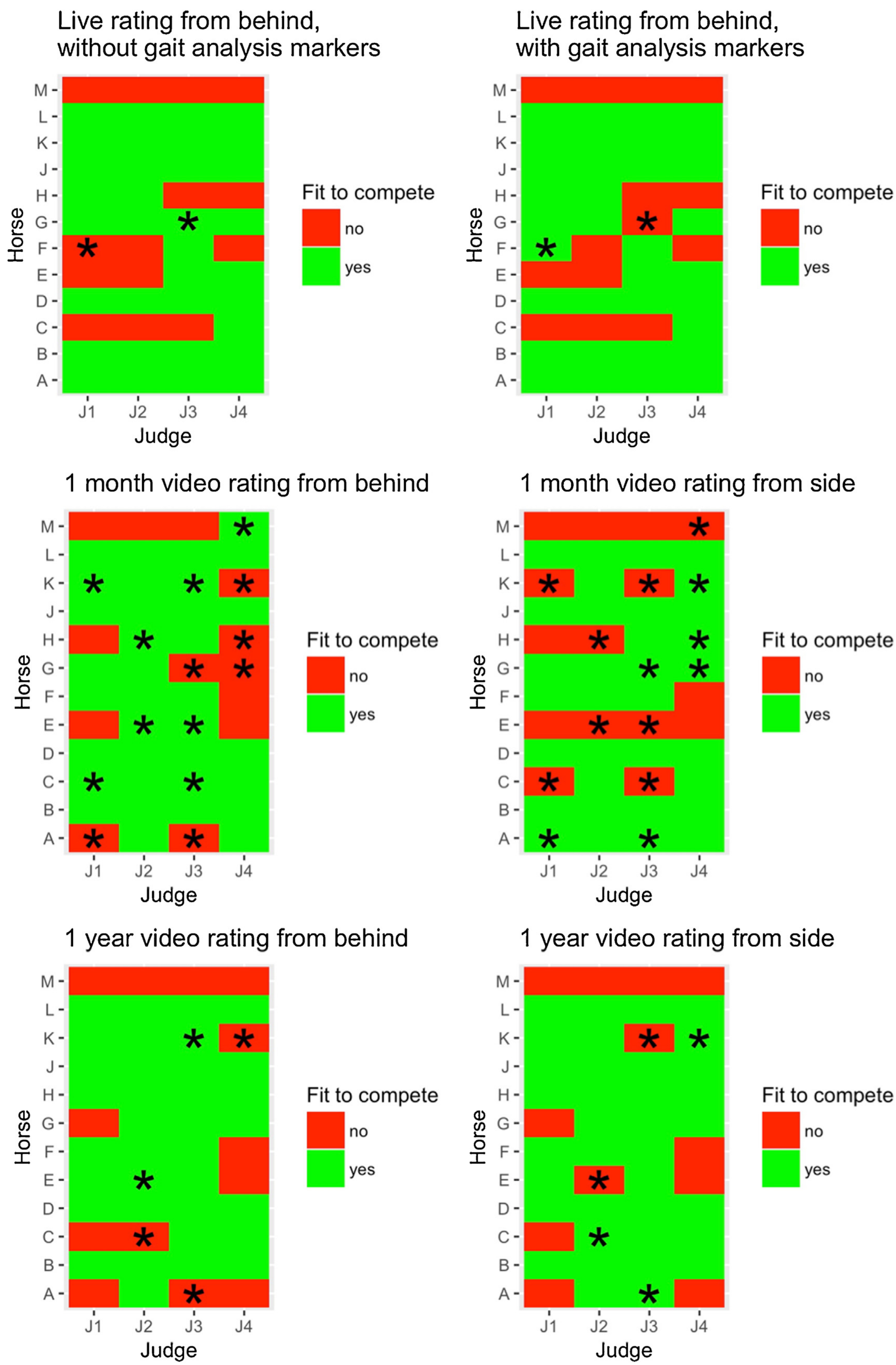

Fig. 2. Heat map of the live fit-to-compete assessment. X-axis observers one to four. Y-axis, horses A to M. * Indicates the fit-to-compete assessment that differ between the different timepoints for the top heat maps and indicates the scorings that differ between the different view angles (back and side) for the middle and bottom heat maps.

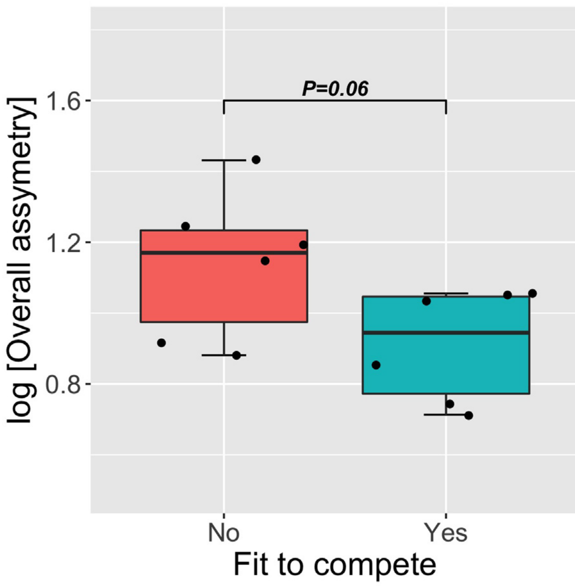

Fig. 3. Box plot of the overall motion asymmetry log (Head vector-sum + Pelvis vector-sum) between the two classifications. Horses were classified as fit-to-compete if all four observers agreed on the classification same classification (fit-to-compete). The difference between the two groups is not significant (P = 0.06). The middle line in the box represents the median, upper and lower margins of the box are the 75th and 25th centiles, respectively. The upper and lower whiskers represent the 95th and 10th centiles, respectively.

of quantitative gait analysis at veterinary inspections for endurance competitions (Lopes et al., 2018). Quantitative tools are far from all-deciding in such complex matter as fit-to-compete judgement, but they may be helpful in improving the current standards and in defining reference values for motion symmetry that could be used in such conditions. This is not different from the quantification of some other biological parameters such as heart rate, already used by VDs in endurance competitions.

Quantitative-gait-analysis may be useful to support decision making during fit-to-compete judgement.

Conflict of interest

None of the authors of this paper has a financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

Acknowledgements

Special thanks to the technical assistance of the students and animal care takers of the Department of Equine Sciences, Faculty of Veterinary Medicine, Utrecht University. This study was partly supported by the FEI that bought the videos without markers for teaching purposes.

Appendix A. Supplementary material

Supplementary figures and text associated with this article can be found, in the online version . . .

Appendix B. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.tvjl.2020.105454.

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