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Whip use in trotting racing–effects on speed change and finishing position

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The whip is used in several equine sports. This is intensely debated from a horse welfare perspective and putting the equine sports' social license to operate at risk. Trotting racing is one of the sports where whip use is allowed. The whip is used for making the horse accelerate (encouragement) and correction. The aims of the study were to investigate if finishing position among top three horses is affected by whip use, the effect of whip strikes on changes in speed at the end of trotting races and if whip strikes potentially comply with the training principle of negative reinforcement. Race videos were analyzed retrospectively, whip strikes were registered and compared with changes in speed, which could be read out of position data from the same races. The top three horses (n=48) in 16 races were studied. The number of strikes per horse ranged from 0 to 16, with a mean of 5.6. There was no difference in number of strikes received between horses in finishing positions 1-3, and whip strikes were most often followed by deceleration. Whip strikes followed by deceleration may be an example of negative reinforcement. Whip strikes to encourage trotting horses to run faster at the end of a race should be avoided from a horse welfare perspective. The safety aspects of whip use in trotting racing need to be investigated further.

KEYWORDS
equine, welfare, negative reinforcement, positive punishment, operant conditioning, trotting racing, harness racing

1 Introduction

The equine sports mainly use negative reinforcement (R-) as training principle, but positive punishment (P+) is also commonly used. Whip use is an example of negative reinforcement in equine sports (McLean and Christensen, 2017). The whip may be used as a signal to increase the speed (Deuel and Lawrence, 1988), by first applying the whip and then removing it as soon as the horse increase the speed (R-). According to the Swedish animal welfare legislation it is prohibited to beat animals (SFS, 2018), but even so the whip is still used in several equine sports. This is intensely debated (Taylor, 2022) and is putting the equine sports' social license to operate at risk. An analysis of the debate on whip use in UK and Australian Thoroughbred racing performed by Graham and McManus (2016), showed that the major difference between advocates and opponents was their perception of whether the whip is an essential tool or a cruel instrument. These perceptions did not seem to change at any large degree after the introduction of new whip regulations.

Trotting racing, where the horse pulls a cart and driver and is only allowed to trot, not canter, is one of the sports where whip use is allowed. The whip is one of the tools the driver can use to communicate with the horse, apart from e.g. the reins, the bit and the voice. In comparison with a rider, mounted on the horse, the driver has limited physical contact with the horse.

A typical trotting race begins in fairly high speed, whilst in the middle of the race the horses run a bit slower saving energy for the end, when the speed increases again. Whip striking is often intense at the end of the race, with drivers using the whip repeatedly until the finish line or until the horse is not keeping up with the other horses and there is no possibility for a good finishing position. It is possible that the behavior of the drivers is affected by the position relative to the other horses, as briefly discussed in Evans and McGreevy (2011). But as negative reinforcement reinforces the *behavior* which the horse is performing when the pressure is released (the striking stops), there is a possibility that the horses are, in fact, trained to slow down when being struck, even though drivers may not be aware of this.

In equine sports the whip is e.g. used for making the horses accelerate (often called "encouragement"), punishment, making them rapidly move in another direction or keeping them moving straight (for safety purposes) (McGreevy and Ralston, 2012; ST, 2022), however the response of the horse to the whip may vary (McLean and McGreevy, 2010). As early as 1988, Deuel and Lawrence (1988) studied the effect of whip use on stride length and horse speed. The horses received one whip strike on the leading leg per canter stride. The whip use resulted in an increased step frequency but a shorter stride length, leading to unchanged speed. Evans and McGreevy (2011) evaluated whip use and race performance in thoroughbred races. Whip use and speed were measured in 48 horses during the last 600 m of the races and the results showed that the speed was lowest in the two last 200 m sections of the race, when increased whip use was most frequent. The one horse of the 48 studied who did not receive any strikes won its race. Hood et al. (2017) found more violations of whip regulations among riders finishing in the top three, implying that the possibility of winning may affect the riders' propensity to use the whip.

There are few previous studies on trotting racing and whip use. Wilson et al. (2018) compared winning times in Australian harness racing in different years when the regulations of whip use differed. Wilson et al. (2018) found that the winning times were unaffected or slightly faster when restrictive regulations of whip use were introduced, however the tracks were improved during the same period, which could affect the winning times.

Apart from the issue with the effectiveness of the whip use there is also a welfare aspect. Being whipped is painful. In thoroughbred racing several countries only allow padded whips, meant to cause less pain (Jones and McGreevy, 2010). Mills and Higgins (1996) already in 1996 tested different types of whips to evaluate marks caused by whipping. Padded whips left more shallow marks and where hence considered more horse friendly. A Turkish company has invented a sensor-equipped whip (WhipChip, 2017) that registers both the number and force of strikes, which can give a more accurate estimate of the impact on horses. The whips used in trotting racing are not padded, they are thin with a short lash at the end. According to the Swedish trotting racing regulations the length must be 90 -125 cm, lash included (ST, 2024).

A study by Pinchbeck et al. (2004) on whip use and race progress in hurdle and steeplechase racing found that horses being whipped and progressing through the race were at seven-fold greater risk of falling than horses not being whipped and showing no change in position or lost position through the field. Furthermore, Parkin et al. (2006) found that the risk of fatal fractures in British Thoroughbred racehorses increased when they received speed increasing signals (including use of the whip) within 10 seconds before the fracture occurred. Whip use, specifically at the end of the race, is also one of the welfare risks mentioned by racehorse industry stakeholders (Mactaggart et al., 2021).

To our knowledge, there is no scientific evidence that use of the whip in fact increases safety in either Thoroughbred races or trotting races, although that is a widely held opinion within the horse industry. McGreevy and Oddie (2011) studied the safety argument proposed by riders saying the whip was used only for directing the horse and found that actual whip use in practice did not support this. Thompson et al. (2020) analyzed stewards' reports for 126 British Thoroughbred races concerning safety and integrity and found no difference between races where whipping was allowed and not allowed. Norway, which to our knowledge is the only country with a total whip ban in trotting racing, has not seen an increase in accidents since the ban (Jones et al., 2015), but no systematic statistics seem to be available.

The aims of the present study were to investigate:

- if finishing position among top three is affected by whip use,
- the effect of whip strikes on changes in speed at the end of trotting races and,
- if whip strikes in trotting racing potentially comply with the training principle of negative reinforcement.

2 Materials and methods

Data were collected by retrospectively observing videos of trotting races, where the numbers of whip strikes were recorded and time-stamped by combining the videos with position data on the horses. The videos were obtained from the TV-production company Kanal 75 and the position data from the betting company ATG. Races were chosen according to nine criteria:

1. Races for warmblood trotters (Standardbreds).
2. Horses aged 3 years or older.

3. Races for horses with total earnings of 100 000-500 000 SEK (10 000-50 000 USD).
4. Auto-start (mobile starting gates).
5. Distance 2140 m.
6. Excluding tracks with 'open stretch'[1].
7. Including only races with positioning data technology.
8. Races with light track conditions[2].
9. Races within the betting form V75.

These criteria were chosen to reduce the variation among race conditions and the experience of horses and drivers. The warmblooded trotter is a more common breed than the coldblooded trotter. Naïve horses, due to young age or less race experience, were excluded through criteria concerning age and total earnings. A specific distance, start method, track condition and excluding of tracks with open stretch were selected to reduce the variation of race conditions. Races within the betting form V75 were selected due to availability of position data and for standardization of driver experience. All drivers in V75 races must have driven at least 100 races within the previous five years, with a minimum of 20 races performed during the previous two years.

The focal horses chosen were horses finishing first to third in each race. A horse could only be a focal horse once, i.e. if it finished first to third more than once, another race was chosen. The races observed were run during 2018-2019 and were chosen from 14 of the 33 racetracks in Sweden, due to the availability of position data extracted from transponders on the number signs attached to the harness. In total, 16 races were used for data collection.

2.1 Observation methodology

The three horses finishing in the top three in selected races were observed during the last 800 m of the race. The last 800 m were sectioned in 4 parts. 0-100 m, 100-200 m, 200-400 m, and 400-800 m to the finish line. The race videos were run in a VLC media player (an open source multimedia player provided by VideoLan, https://www.videolan.org/vlc), allowing for slow-motion playback. A zoom tool in the VLC player enabled observations of one frame at a time. A whip strike was defined as a rapid movement of the driver's hand holding the whip, and the whip making contact with the horse. The expected behavioral reaction to a whip strike, at the end of a trotting race, is for the horse to respond with acceleration. For each whip strike, the time on the video was noted. These time stamps were then synchronized with the position data. The parameters available were m/s or km/h and distance to the finish line (m). When studying the videos, the observer was unaware of whether any of the drivers had been punished for excessive whip use.

1 Extra inner tracks on the home stretch allowing horses positioned behind to pass horses in front of them on the inner side.

2 Track condition estimated based on expected race time for each race category. Track condition classified as 'light' if horses finished the race up to 1 s/km slower than expected.

2.2 Position data and speed

Position data was extracted from the transponders each horse had attached to the harness during the race. Position data was measured 25 times per second for each horse continuously throughout the race, but only data from the last 800 m was selected. Speed (m/s) was assessed 3 s before a whip strike, at the strike, and 3 s after the strike. Three seconds was chosen as the interval since it is the industry's own estimate of the time needed to give the horse the possibility to react to a whip signal (Sandberg, personal communication)[3]. A trotter moves roughly 50 m during these 3 seconds. For each strike, the distance to the finish line was also recorded. Speed changes, acceleration or deceleration, was calculated as the difference between speed at the strike and speed 3 seconds after the strike.

2.3 Statistics

The relation between number of strikes and final position was tested in two-way analysis of variance with number of strikes as the explained variable and finishing position (as a categorical variable) and race ID as explanatory factors.

The effect of a strike, as one of three categorical outcomes; acceleration (m/s^2), constant or deceleration, was examined with a chi-square test for proportions. The relation between effect of strike and race section was assessed with a chi-square test for a frequency cross-table, with one factor given by effect (acceleration, constant, or deceleration) and the other factor given by race section (as intervals 0-100 m, 100-200 m, 200-400 m and 400-800 m to the finish line).

The speed change from strike to 3 s after the strike was analyzed in a mixed linear model. Distance to finish line, speed change in the 3 s before the strike, current speed, number of previous strikes, and interaction between distance to finish line and speed change were used as explanatory fixed factors. To simplify interpretation and capture possible non-linearity, distance to finish line was implemented as a factor with four levels: race sections 0-100 m, 100-200 m, 200-400 m, and 400-800 m to the finish line. Horse and an AR(1)-component over time (with horse as subject) were random factors. Factor effects were tested in a chi-square test and pairwise comparisons were tested in a Tukey *post-hoc* test. Model residuals were checked for normality with a Shapiro-Wilk test and for homoscedasticity using diagnostics graphs.

Data were compiled in Microsoft Excel 2016. Data analysis was performed using R version 4.3.1 (R Core Team, 2023) through RStudio version 2023.06.0 (Posit Team, 2023) and including the packages *tidyverse* (Wickham et al., 2019), *nlme* (Pinheiro et al., 2023), *car* (Fox and Weisberg, 2019), and *emmeans* (Lenth, 2023). Results were considered significant at $p<0.05$ and considered a tendency when $p<0.1$.

3 Sandberg, A. (2019). Personal communication about the trotting industry policy regarding horse reaction time (Bromma: Swedish Trotting Association).

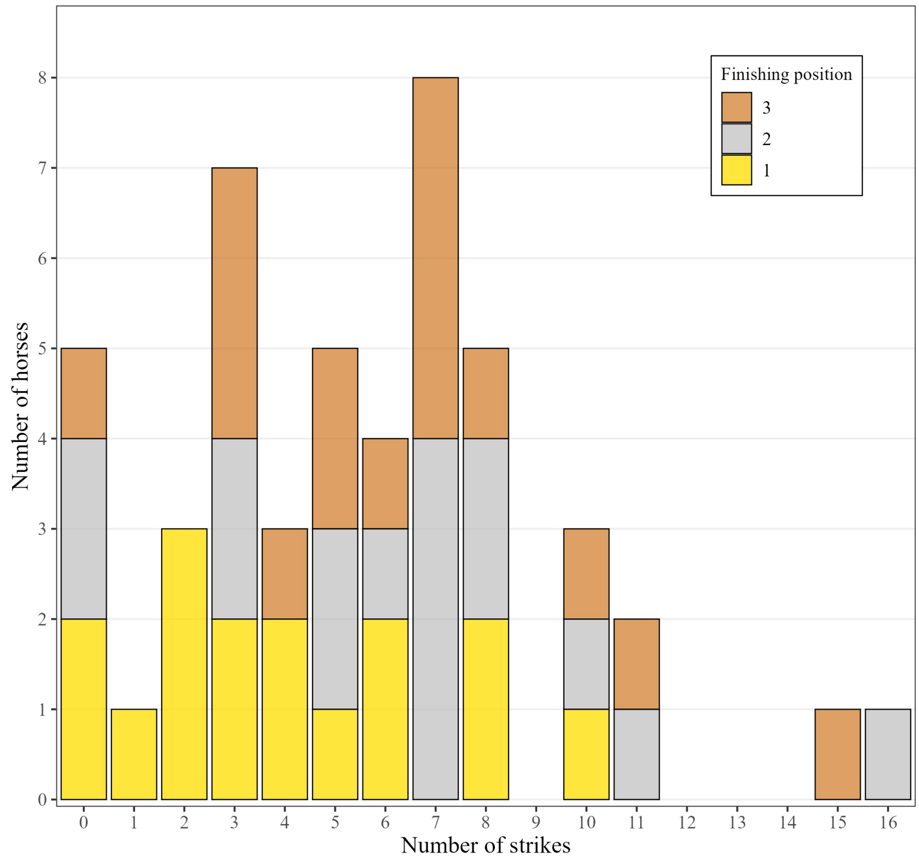

FIGURE 1
Trotting horses grouped based on number of whip strikes received during the last 800 of the races. Colors represent finishing position in the race, yellow are winners, gray are placed second and brown placed third.

3 Results

The top three horses (n=48) in 16 races were studied. In total, 268 strikes with the whip were recorded. Of these, 29 strikes were received at 800-400 m before the finish line, 56 at 400-200 m before the finish line, 93 at 200-100 m and 90 at the last 100 m of the race.

The number of strikes per horse ranged from 0 to 16, with a mean of 5.6. Five of the horses studied did not receive any strikes, and these five horses finished first (2 horses), second (2 horses), or third (1 horse) (Figure 1). The horse receiving most strikes (16) finished second. Intervals between strikes varied (Table 1).

TABLE 1 Grouping of horses receiving more than one strike (n = 42) into categories of minimum duration (s) between two strikes.

Seconds between strikes	Number of horses
0	9
1	17
2	8
3	5
4	2
>5	1

On assessing whether a whip strike led to acceleration or deceleration at 3 s after the strike, we found a tendency for a strike to lead to deceleration (chi-square test for proportions, X = 2.81, df = 1, p=0.093). This effect was stronger the closer to the finish line the horses were (chi-square test on frequency cross-table, X = 36.36, df = 4, p<0.001) (Figure 2).

On assessing the effect of a whip strike on speed change from strike to 3 s after the strike, we found a difference depending on section of the race (linear mixed model, chi-square test, X = 10.45, df = 3, p=0.015) and a negative relationship to current speed (linear mixed model, chi-square test, X = 31.40, df = 1, p<0.001). In the final 100 m of the race, the horses decelerated within 3 s of the whip strike (linear mixed model estimated marginal mean tested against zero, t-test, t = -2.704, df = 15, p=0.016), whereas the effect on speed was not significantly different from zero for other race sections. The number of previous strikes a horse received did not affect speed change (linear mixed model, chi-square test, X = 2.13, df = 1, p=0.145).

There was no difference in number of strikes received between horses in finishing positions 1-3 (Two way anova model, F = 2.25, df = 2/30, p=0.123).

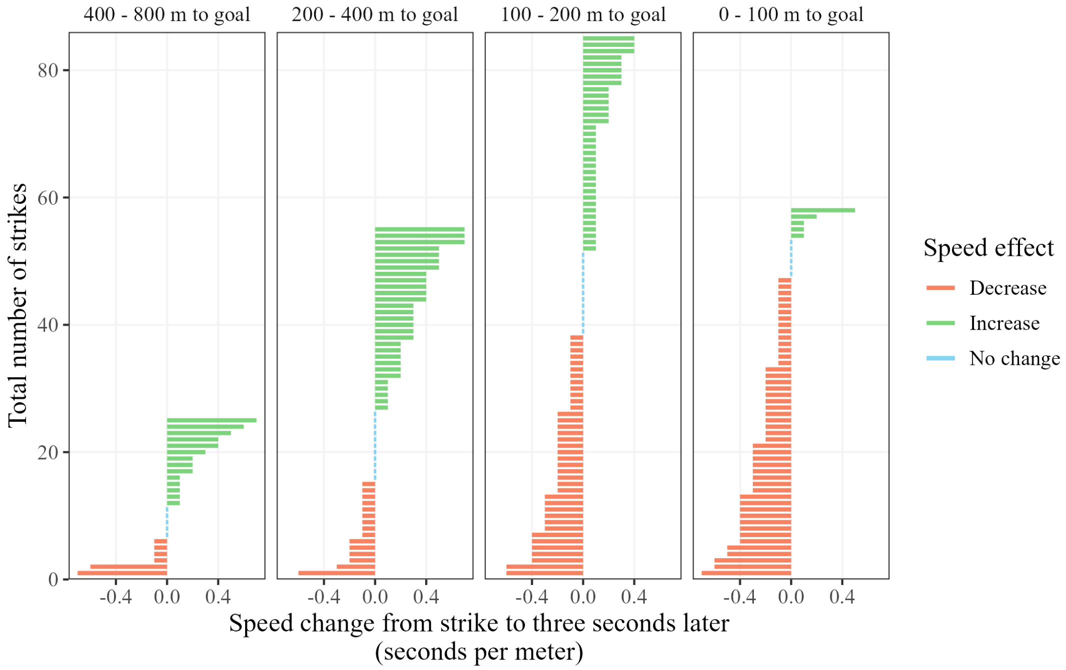

FIGURE 2
Speed change of trotting horses in different race sections from 800 m to the finish line (left to right). Green bars represent whip strikes leading to acceleration, blue bars represent strikes leading to constant, and red bars represent strikes leading to deceleration. Strikes received on the same second are only represented once in the figure. Strikes where the horse crosses the finish line within three seconds are not included, as speed change could not be estimated.

4 Discussion

Most of the whip strikes observed were followed by deceleration, and this effect was more pronounced the closer to the finish line the horses were when they received the whip strike. This supports findings in a study of Thoroughbred races by Evans and McGreevy (2011) that horse speed in certain sections of the track was negatively correlated with number of whip strikes. However, Evans and McGreevy (2011) did not study what happened immediately after the whip strikes, so it is difficult to make direct comparisons.

According to the principle of negative reinforcement (Domjan, 2020), the behavior immediately before the release of pressure is reinforced. In practice, striking a horse with a whip is equivalent to applying pressure and when the striking stops, the horse experiences a relief that reinforces its current behavior. Hence, if the horse is accelerating after the strike, acceleration is reinforced. If the horse is decelerating after the strike, deceleration is reinforced.

The data in this study, where we found that most strikes in the last 100 m of the race were followed by deceleration, and in the light of other studies (McGreevy and Ralston, 2012: Evans and McGreevy, 2011), indicate that striking horses in this situation is completely pointless and that it may even teach the horses to slow down when receiving a whip strike.

We found that the number of strikes did not show any correlation with the finishing position among the top three horses in the race. Most strikes were received between 200-100 m from the finish line. Striking a horse that is fatigued or otherwise unable to respond with acceleration is ethically very difficult to justify. When drivers continue to strike their horses, this may be based on a perception of their position relative to that of other horses and to the finish line, rather than of the actual speed, speed change, and the principle of negative reinforcement.

The drivers in this study were all experienced, which may have affected their whip use. In a study on Thoroughbred races, McGreevy and Ralston (2012) found that less experienced riders used the whip more often than experienced riders and that most strikes were delivered at the end of the race, when the horses were tired. This led those authors to suggest that experienced riders may have learned that whip use is less relevant to race outcomes. However, to study potential effects of driver experience, we would have needed to increase our sample to also include races with less experienced drivers.

Position relative to other horses and the possibility of winning may also affect the propensity to strike a horse. In a study on Thoroughbred races, Hood et al. (2017) found that the top three horses were struck the most, but that the horse finishing last also received many strikes, potentially because the rider did not want to end up last.

One frequently used argument for whip use in horse racing is for perceived safety reasons. This is an important consideration, since horse racing is a dangerous sport for both horses and humans, but the scientific data do not seem to support the safety argument. Parkin et al. (2006) and Pinchbeck et al. (2004) found quite the opposite. A study on Barrel horses by Waite et al. (2018) found no correlation between aggressive riding (using legs/spurs and/or whip) and speed of the horses. They did however, find a positive correlation between the magnitude of aggressive riding and horses rearing, a potential safety risk. It is important to stress that the whip may be of greater importance for safety in trotting races, as the driver sits behind the horse and cannot use their body and legs to control the horse, but only long reins and potentially a whip. In Norway, the whip has been banned in trotting racing for many years, but evaluations of the effects on safety and horse welfare are lacking.

It is important that the industry regulations on whip use and encouragement are based on science and proven knowledge, both for the welfare of the horses and the industry's social license to operate. There is a need for better understanding of the learning principles among industry stakeholders. This could be achieved by both updated regulations and education of trainers and drivers.

The regulations on whip use in Swedish trotting racing have been updated continuously. In cases of non-compliance the sanctions are fines and suspensions. At the time for the study the drivers were allowed to use the whip for urging a few times during the last 400 m of the race. Before the last 400 m of the race the whip could only be used for correction and light encouragement. Today all enforced use of the whip is prohibited, and the whip may only be used a few times for correction and light encouragement. The horse must be given time to respond to the signal, and the driver may not encourage the horse if it's position obviously cannot be improved. The horse is always examined by a racing official in cases of incorrect whip use.

Further research could potentially investigate effects of new regulations on horse welfare and safety for horse and driver.

4.1 Limitations

The races were chosen according to nine criteria to reduce the variation among race conditions and the experience of horses and drivers. Coldblooded horses, and naïve horses and drivers were excluded. Horse reactions to whip strikes could possibly be affected by multiple horse and driver traits and as for all research conducted under non-experimental conditions, with little or no control, results need to be interpreted carefully. However, the results do indicate that horses may be given the benefit of the doubt, as deceleration was a more likely reaction the closer to the finish line the horses were. Striking the horses close to the finish line do not make them run faster or increase the likelihood of winning. If our results are correct, they primarily seem to run slower and might, if learning according to negative reinforcement occurs, run even slower in the coming races, when receiving whip strikes.

4.2 Conclusions

Scrutiny of video footage of 16 Swedish trotting races in this study revealed that number of whip strikes received did not vary between horses finishing in top three positions, and whip strikes were most often followed by deceleration. The observations also indicated that whip strikes followed by deceleration may be an example of negative reinforcement, training the horses to slow down. However, in race conditions the learning situation of the horses is suboptimal, and learning may be ineffective.

In the light of these findings, whip strikes to encourage trotting horses to run faster at the end of a race seems to be pointless and should be avoided from a horse welfare perspective. The safety aspects of whip use in trotting racing need to be investigated further.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material. Further inquiries can be directed to the corresponding author.

Ethics statement

Ethical approval was not required for the study involving humans in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and the institutional requirements. Ethical approval was not required for the studies involving animals in accordance with the local legislation and institutional requirements because We used video material filmed for commercial purposes at least one year previous to the study. Written informed consent was not obtained from the owners for the participation of their animals in this study because The purpose of the races was commercial and all races are broad casted on national television. Upon participation horse owners know their horses are filmed. All horses and drivers were anonymous.

Author contributions

AS: Conceptualization, Data curation, Methodology, Writing – original draft, Writing – review & editing. AF: Data curation, Formal analysis, Methodology, Writing – review & editing. MM: Conceptualization, Investigation, Methodology, Writing – review & editing. JY: Conceptualization, Methodology, Project administration, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fanim.2024.1416503/full#supplementary-material

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