Effect of jumping style on the performance of large and medium elite agility dogs

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Abstract

Dog agility is a rapidly progressing sport worldwide. Consequentially, research and methods to improve technique and performance are becoming highly sought after. Video data were collected of elite agility dogs during a training session, with downstream analysis examining differences in apparent topline angle and jumping speed of large and medium dogs as well as collie breeds and non-collie breeds. The study further examined any correlations between topline angle and jumping speed. Findings suggest that there is a difference between the jump kinematics of large and medium dogs ($P = 0.001$) and between collie breeds and non-collie breeds ($P < 0.001$) with collie breeds jumping faster than non-collie breeds ($P = 0.013$). This information could be used to inform future training regimes and competitive strategies in a breed and size specific way, with the aim to improve long-term health and welfare of canine participants, whilst also ensuring that training and competitive expectations are within biological capabilities.

Keywords; Agility; canine; biomechanics; welfare

Introduction

Dog agility is a relatively new canine discipline, being first introduced to the UK at Crufts in 1978 (The Kennel Club, 2013). Agility continues to increase in popularity and participation, with success being determined largely by the dog's ability to jump at high speeds and complete rapid directional changes (Pfau et al. 2011). Typical agility courses include 17-20 obstacles, primarily made up of hurdles set at a predetermined height in relation to the dog's height at the withers (Table I) (The Kennel Club, 2013). This is in stark contrast to equine show jumping competitions, whereby horses are classified by ability as opposed to their wither height. Due to the increasing popularity of dog agility, more dogs and handlers are achieving higher competitive grades. Anecdotally, courses at higher competitive levels are becoming more complex, including tight turns and acute angles over obstacles. As hurdle height remains constant for all abilities of dog, increasing the course complexity remains the only way to test capabilities.

Within the large height category (> 431 mm at the withers), collie breeds tend to dominate the sport, suggesting that they may have an advantage over other breeds. Collie breeds are often reported as highly trainable and athletic, with a strong 'work ethic' (The Kennel Club, 2002) all of which are valuable attributes for agility dogs. Zink and Daniels (2011), suggested that a body height-to-weight ratio would be a better indicator for assessing the athletic ability of dogs than wither height, proposing that those with a ratio of less than 2.5 have an athletic advantage. Collie breeds, on average, score 1.9 (Zink and Daniels, 2011). However, other dog breeds demonstrate similar height-to-weight ratios, yet these are not commonly seen in agility competitions (Levy et al. 2009). Furthermore, show bred and working bred collie breeds differ largely in appearance, yet both 'types' are typically seen within the elite field, suggesting anatomical differences are not the only factor for consideration. In support of this, it has been suggested that the boldness of the dog affects its success (Svartberg, 2002) indicating that personality is a further consideration. Further studies have also found the left visual hemisphere reduced approach distance and bar clearance when dogs navigate a Sensory Jump Test (Tomkins et al. 2010). Interestingly, when examining agility dogs, they take longer to perform agility obstacles when the owners where located within their left visual hemisphere compared to their right (Siniscalchi et al. 2014).

The domestication and selective breeding of animals has permitted the selection for performance traits to be intensified greatly. Performance and sporting animals are of value to humans in a variety of ways, hence the science behind creating a successful performance animal is of interest. However, selectively breeding animals for performance characteristics is not always conducted with the animal's welfare in mind and through selectively breeding for 'better' agility dogs, there is potential for exaggerated traits to become disadvantageous i.e. longer limbs and working beyond fatigue. Indeed studies have determined that border collies have a higher incidence of injuries in comparison to other breeds (Cullen et al. 2013a, b; Levy et al. 2009). However, breeding dogs that are 'fit for function', should particular attributes be identified as decreasing the risk of injury, would be highly beneficial.

Historically, the horse (*Equus callabus*) has been the traditional performance sport animal with the thoroughbred horse being selectively bred over generations to produce the optimum racing animal. These performance horses are trained intensely, with the aim to improve energy production, skill and coordination (Vogel, 1996). This has also resulted in equine jump kinematics being well understood and researched, whilst less is known about canine jump kinematics. Consequently, equine biomechanics research can often be used as a model for canines. However, in comparing equine sports science to the expectations of canine sporting disciplines, there are important differences to be considered. Many dogs show a greater relative stride length, greater limb angulation and have more muscular limbs in contrast to the horse, resulting in them being able to jump twice their height at the withers and have a greater relative running speed (Zink and Daniels, 2011). The separate radius and ulna in the dogs' forelimb allows the front leg to rotate along its axis, aiding the dog in fast, sharp turns. The metatarsals further allow the dog to grip and adapt to different terrains (Zink and Daniels, 2011). Interestingly, these are considered advantageous for agility, yet shoulders and metatarsals are amongst the most common injury locations, potentially suggesting otherwise.

The aim of this study was to assess how jumping style of individual dogs affected jumping performance. This was achieved by (1) identifying differences in apparent topline angles and speed between large and medium agility dogs, (2) identifying differences in apparent topline angles and speed between collie breeds and non-collie breeds and (3) investigating whether the topline angle of the dog affected speed of jumping.

Materials and Methods

Data were collected during an Agility Team GB training event, held under Kennel Club (KC) regulations, using hurdles set at current KC heights (Table I). The study gained full ethical approval from Nottingham Trent University's School of ARES Ethical Review Group (ARES60) with all dogs participating considered healthy and fit to train, with no known illness or injury. Nineteen 'elite' dogs were analysed; 13 large and 6 medium (Table II), having previously been selected to represent Great Britain at the European Open Agility Championship in 2013 and all of whom competed at the highest grade (Grade 7) at KC competitions. All dogs were filmed jumping over an upright hurdle, set at 650 mm for large dogs and 450 mm for medium dogs, within two separate courses. These particular hurdles were selected due to them having a straight entry and exit point. Casio Exilim EX-FH100 cameras were used for data collection and were positioned 6m from the hurdle, at 1m in height ensuring the take-off and landing phase of the jump was recorded. Owners warmed their dogs up, ran them and cooled them down as they would do normally. Downstream data analyses were conducted using Dartfish software with angles and distances drawn within a single frame from the video.

The apparent topline angle during the bascule phase of the jump was measured and speed was calculated in m/s. The bascule phase was considered to be midpoint over the hurdle (Clayton, 1989), with the apparent topline angle being measured from the top of the skull, top of the scapula and base of the tail (Figure 1). Topline angle for the purposes of this study included the head position to ensure a full outline of the dog was measured. For speed, the take-off and landing distances were measured using the foot of the hurdle wing for calibration (0.48 m) alongside the time taken to complete the hurdle between these two phases. Take-off was considered to be the final point of contact between the dog and the ground and was measured from the tip of the trailing hind limb to the hurdle wing. The landing phase was considered to be the first point of contact between the dog and the ground once the hurdle had been completed and was measured from the back of the carpus from the leading forelimb to the hurdle wing.

Normality was determined using Kolgomorov-Smirnov tests, followed by an unmatched pairs t-test. Pearson product-moment coefficient tests were then used to identify correlation between data with Dancy and Reidy's (2004) categorisations used to ascribed the strength of the correlation. When assessing collie breeds and non-collie breeds, both height classifications are mixed together. The alpha level for all statistical tests was set at 0.05 with means (± standard deviation) reported.

Results

Dartfish analysis showed that 85% of large dogs and 17% of medium dogs jumped with an apparent topline angle >180° during the bascule phase. When examining collie breeds, 80% jumped with a topline angle of >180° during the bascule phase, whilst none of the other breeds represented had a topline angle of >180° during the bascule phase.

When examining topline angles, large dogs had a significantly greater topline angle compared to medium dogs (large; 194.27° ± 13.7°, medium; 158.62° ± 23.67°, $t(17) = 4.19$, $P = 0.001$; Figure 2). Collie breeds demonstrated a greater topline angle compared to non-collie breeds (collie; 192.24° ± 15.19°, non-collie; 148.43° ± 18.11°, $t(17) = 4.946$, $P < 0.001$; Figure 2) . When examining speed, collie breeds were faster than non-collie breeds (collie; 5.87 m/s ± 0.78 m/s, non-collie; 4.63 m/s ± 0.91 m/s, $t(17) = 2.759$, $P = 0.013$; Figure 3) whilst there was no significant difference in speed between large and medium dogs (large; 5.85 m/s ± 0.82 m/s, medium; 5.12 m/s ± 1.06 m/s, $P = 0.117$). When total jump distance was examined, large dogs had a significantly greater jumping distance than medium dogs (large; 2.99 m ± 0.55 m, medium; 2 m ± 0.3 m, t(17) = 4.075, $P = 0.001$) and collies jumped significantly further than non-collie breeds (collie; 2.9 m ± 0.57 m, non-collie; 1.9 m ± 0.96 m, t(17) = 3.602, $P = 0.002$).

Pearson-product moment coefficient results demonstrated a large negative relationship between topline angle and speed for large dogs (r = - 0.597, $P = 0.031$; Figure 4) and collie breeds (r = - 0.605, $P = 0.017$; Figure 5) whilst medium dogs and non-collie breeds demonstrated a weak, non-significant correlation. The data showed no violation of linearity, homoscedasticity or normality. There was also a large negative correlation found between topline angle and total jump distance in large dogs (r = - 0.696, $P = 0.008$; Figure 6)

Discussion

In examining how jump style affects the performance of agility dogs, this study suggests that both the dogs' size and breed affects the topline angle, whilst only breed appears to affect the speed. There were similarities in the topline angles of both large collies and medium collies with 80% having a topline angle >180°. In comparison, none of non-collie breeds jumped with a topline angle >180°. These results suggest that the ability to jump with a topline angle of >180° might be related to the dog's breed, rather than its height. This may in part be determined by conformational parameters which limit the bascule position adopted by the dogs when jumping.

Results demonstrate a significant difference in the topline angles during the bascule phase of the jump between large and medium dogs and between collies and non-collies. Thus, it is suggested that both the size of the dog and its breed affects topline angles. Similarly, collie breeds jumped faster when compared to non-collie breeds whilst height did not significantly affect speed. Additionally, large dogs had a significantly longer jump distance than medium dogs and collie breeds again had a larger jump distance than non-collie breeds. These results support the notion of breed differences in canine jump kinematics. In large dogs, due to an increased jump distance but not speed, it can be suggested that they may spend a greater length of time in the air, potentially needing to produce larger impulses upon landing to support their body weight against gravity.

When examining correlations between topline angles and speed for large dogs, a strong negative relationship was identified. From these results, it can be proposed that the larger the topline angle of a dog during the bascule phase of the jump, the slower it will jump. Arguably, this observation could in part be due to the height of the jump being proportionately greater than themselves to the withers that results in this jumping style. However, medium collies also appear to jump in this manner, therefore it might be a breed preference or characteristic as opposed to a necessary trait to clear a large height hurdle. It is also worth noting that the entirety of the large sample was formed of collie breeds thus, it cannot be confirmed as to whether these results are representative of all large classed dogs, or just large collie breeds. Interestingly, when examining the correlation between total jump distance and topline angle, there is a strong negative relationship for large dogs, yet this is not seen for collie breeds in general. This indicates that the height of the hurdle may indeed impact upon a dog's topline angle with it being an adaptation to allow clearance of the hurdle. This is supported by the correlation becoming weak and non-significant when examining all collie breeds, some of whom jumped a lower jump.

Studies in humans have determined that an increase in jump height results in a decrease in speed (Pandy et al. 1990; Ricard and Veatch, 1994), with this being mirrored in equines (Clayton and Barlow, 1991). On this basis, one potential reason for the negative correlation between topline angle and speed being observed is the diversity of dog heights within the large height classification. The smaller 'large' dogs (i.e. of 435 mm at the withers), may jump slower due to the hurdle height being proportionally greater for them than taller 'large' dogs (i.e. of 600 mm at the withers), with the increased topline angle being a consequence for having to jump a large height hurdle. Therefore causality between topline angles and speed should not be drawn.

Overall collies had significantly greater topline angles and were significantly faster than non-collies, yet there was a negative correlation between topline angle and speed. These results suggest that despite the negative correlation and greater topline angle being observed, the greater speed demonstrated in collies puts them at a competitive advantage irrespective of height category. These results potentially explain, in part, why the majority of large dogs competing in the UK are collie breeds (The Kennel Club, 2013). However, Levy et al. (2009), found that collie breeds are the most commonly injured dog in agility. Therefore, although the performance of a border collie may surpass that of other breeds, being prone to injury may discount them as being the optimum agility breed. Helton, (2010) found that the physical capability of a dog breed affects its success in agility, rather than cognitive and learning ability with these results supporting this notion. However, extrapolating differences between physical ability and cognitive ability warrants additional research before conclusions can be drawn and is beyond the intent of this study.

It would have been beneficial to repeat the jump three times, however due to the nature of the filming and this study being conducted in the field, this was not possible. Likewise, due to only analysing each jump once, dogs may have altered their jump kinematics due to a number of reasons. However, the sample consisted of elite dogs who were therefore experienced at jumping, theoretically meaning that their agility jumping styles should be consistent. Factors such as distance between obstacles have been shown to alter the speed of a jump (Birch et al. 2015) and should be taken into account when evaluating the results. Further to this, studies have found that owner location impacts upon the latency to complete agility obstacles (Siniscalchi et al. 2014) thus future studies should examine relationships between owner location, topline angle and speed.

This study represents a novel examination of jumping style and performance within a field setting using non-invasive procedures. Were this study to be repeated it would benefit from a larger sample size, examining a variety of breeds. It would also be of interest to examine differences between ability, as this study only examined elite agility dogs. Should differences be seen between level of ability, it would increase the understanding of canine jump kinematics and indeed whether jump skills develop with experience and training, or if a natural jumping style is apparent from an early age. This study may improve the health, welfare and active longevity of agility dogs by ensuring that future rules and regulations are informed via scientific research.

Conclusion

This study was conducted to investigate how jumping style affects performance in agility dogs by examining apparent topline angles and speed whilst traversing a hurdle. Data revealed that larger topline angles during the bascule phase of the jump was associated with a reduced speed. It can be concluded that topline angles and jump style does vary between height categories and breed. It remains to be seen through further research whether it is in fact the effect of different breed conformations generating differences in jump kinematics, rather than the size of the dog that affects these topline angles. This study has also shown the potential for an optimum agility dog breed being present. However, this may result in welfare implications, due to the selective breeding of dogs for optimum jump kinematics.

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Appendices

Table I: Jump height categories under KC regulations (The Kennel Club, 2013)

Dog category	Height of dog at the withers (mm)	Jump height (mm)
Large	> 431	650
Medium	351-430	450
Small	< 350	350

Table II: Breeds participating in the study

Dog	Size Classification	Breed	KC Jump Height (mm)
1-13	Large	Collie breeds	650
14	Medium	Shetland Sheepdog	450
15-16	Medium	Collie breeds	450
17	Medium	Cross Breed	450
18	Medium	Kelpie	450
19	Medium	Cocker Spaniel	450