Four Leg News

Winter 2021 – Volume 10 – Issue 1

CANINE AGILITY RESEARCH UPDATE (Part 1)

INTRODUCTION

The last time I reviewed canine sporting articles was 2014 (Sept-Oct, Vol 3: Issue5). There wasn't much in the literature back then. It's wonderful that there are now people actually researching specific aspects of canine agility. As any good sports physiotherapist will tell you, you need to learn the sport, watch the sport, understand the sport in order to do the best job possible for your patient. Treating the canine athlete is not any different. So, in this issue, you'll learn about kinematics of jumping and a wee bit about muscle activation in the canine forelimb. I hope you enjoy the read!

Cheers!

Laurie Edge-Hughes, BScPT, MAnimSt (Animal Physio.), CAFCI, CCRT

Birch E, Boyd J, Doyle G, et al. The effects of altered distances between obstacles on the jump kinematics and apparent joint angulations of large agility dogs. The Veterinary Journal 204 (2015) 174–178.

Introduction: In agility, dogs move around a course with their handlers, with most of the obstacles being upright hurdles, set at a height relative to the dog's height. The distance between obstacles varies between 3.6 m to 5 m and its effect on kinematics and performance, as well as injury risk, is unknown.

Question 1: How does the distance between hurdles, as well as the skill level, affect take-off and landing distances in agility dogs?

Question 2: How are the shoulder, lumbar spine and neck angles affected by different hurdle placements and the skill level of the dog?

Methodology: Fifty-four large breed dogs competing at an international level were screened to be injury free. Dogs were classified by skill level: 7 dogs were classified into grades 1 and 2 as beginners; 10 in grade 3 as novices; 17 in grades 4 and 5 as intermediate; 20 in grades 6 and 7 as advanced. Each dog was required to jump 3 x 65cm (appx 25.5 inches) jumps in three different set-ups: One where jumps were spaced 3.6m apart; Another where jumps were 4.0m apart, and; Lastly where jumps were 5.0m apart. A camera was placed at jump #2 in each scenario.

Distance Findings:

- Dogs took off significantly closer to the hurdle in the 4m distance.
- Landing distance was further away from the hurdle in the 5m distance compared to the 3.6m and 4m distances.

Speed Findings:

- Take-off speed was fastest at the 5m distance, followed by the 3.6m distance, leaving the 4m distance being the slowest of take-off speeds.
- Speed of landing was fastest for the 5m distance, followed by the 3.6m, and then the 4m distances.

Skill Level Findings:

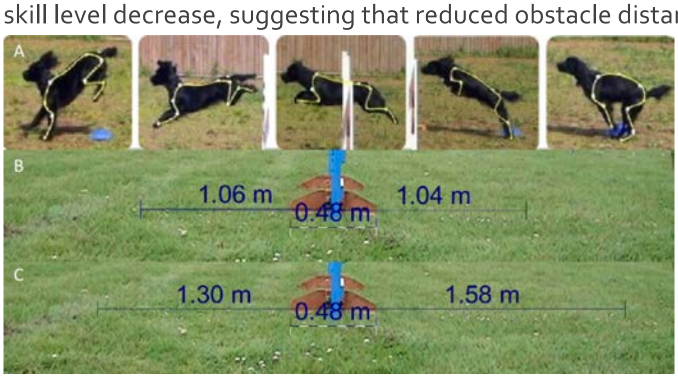
- The skill level had a significant effect: Advanced dogs took off and landed further away from the hurdle, at a greater speed when compared to less skilled dogs; Beginner dogs jumped slower than the other dogs in both the 3.6 m and 5 m distances, which shows that speed may be a contributing factor, increasing with skill.

Angulation Findings:

- During take-off and landing, a more acute neck angle was observed in the 3.6 and 4.0m distances
- Lumbar extension was take off in the 4m distance, and midpoint lumbar flexion was greatest at the 5m distance
- Shoulder flexion was only different for the midpoint phase, with the 4m distance showing the greatest flexion
- Angles varied significantly at the 3.6m and 5.0m distances between the different skills levels of the dogs.

Additional Points: When controlling for skill, the greatest number of differences was seen at the 3.6 m distance, which supports the concept that dogs may find hurdles spaced at this distance more challenging. In this study, 11 dogs had to be removed from analysis due to being unable to complete the 3.6 or 4 m jumps, and nine of these dogs were beginner or novices.

Conclusion & Recommendation: As the distance between hurdles increases, the differences in jump kinematics between skill level decrease, suggesting that reduced obstacle distances should be limited to advanced agility dogs.



(A) Illustration of measurement of apparent joint angles.
(B) Mean take-off and landing distance for the 3.6 m hurdle distance.
(C) Mean take-off and landing distance at the 5m hurdle distance.
Take-off and landing distances were calibrated for Dartfish analysis using the foot of the hurdle (0.48m).

Alcock J, Birch E, Boyd J. Effect of jumping style on the performance of large and medium elite agility dogs. Comparative Exercise Physiology, Volume 11, Number 3, 1 September 2015, pp. 145-150(6).

The Question: How does the jumping style of individual dogs affected jumping performance?

The Study: This was achieved by (1) identifying differences in topline angles and speed between large and medium agility dogs; (2) identifying differences in 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.

Methodology: Nineteen 'elite' agility dogs were recruited (13 large and 6 medium). Fifteen of the dogs were border collies and the other four consisted of a Shetland sheepdog, a Cross breed, a Kelpie, and a Cocker spaniel. They were filmed jumping over upright hurdles set at 65cm or 45cm (respective of size of the dog), within two separate courses.

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 speed, collie breeds were faster than non-collie breeds whilst there was no significant difference in speed between medium and large breed dogs.
- When total jump distance was examined, large dogs had a significantly greater jumping distance than medium dogs and collies jumped significantly further than non-collie breeds.

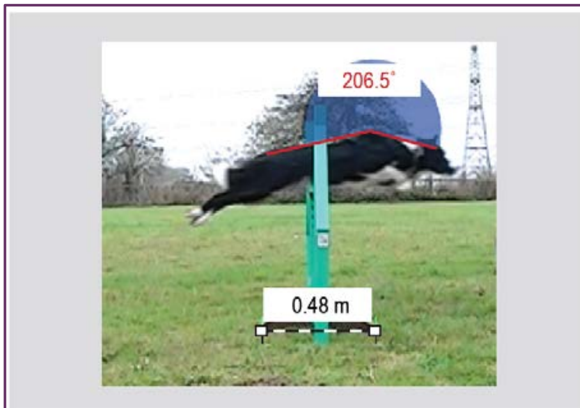
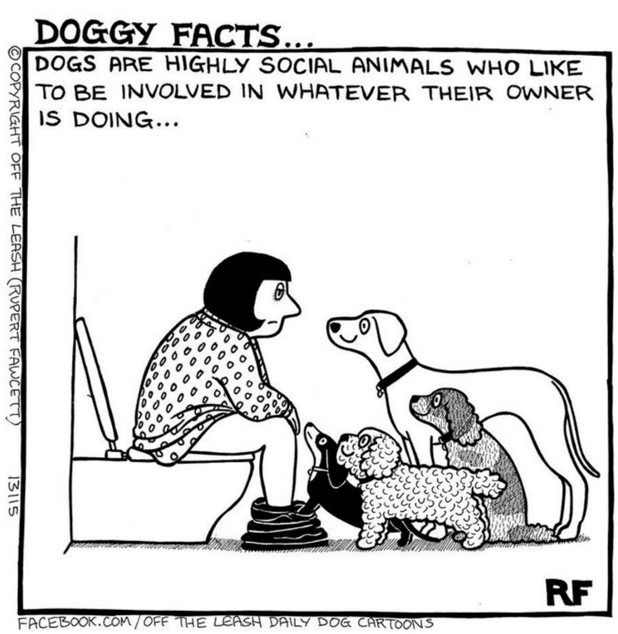


Figure 1. Illustration of Dartfish analysis of the topline angle during the bascule phase of the jump.

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.



Birch E, Carter A, Boyd J. An examination of jump kinematics in dogs over increasing hurdle heights. Comparative Exercise Physiology: 12 (2), March 2016, Pages: 91 – 98.

The Question: How do certain jump kinematics alter in experienced agility dogs as hurdle height increased gradually?
The Study: Length of trajectory, jumping speed (in this instance the time taken to clear the hurdle) and apparent neck, lumbar spine and shoulder angles were examined over the gradually increasing hurdle heights.
Methodology: 19 border collies and 1 border collie cross were utilized for the study. Due to agility dogs being categorized by wither height, for each dog, the percentage of the hurdle height in relation to their height at the withers was determined and used for subsequent analysis. The study consisted of three hurdles set at 5m apart with the camera located at the second jump.

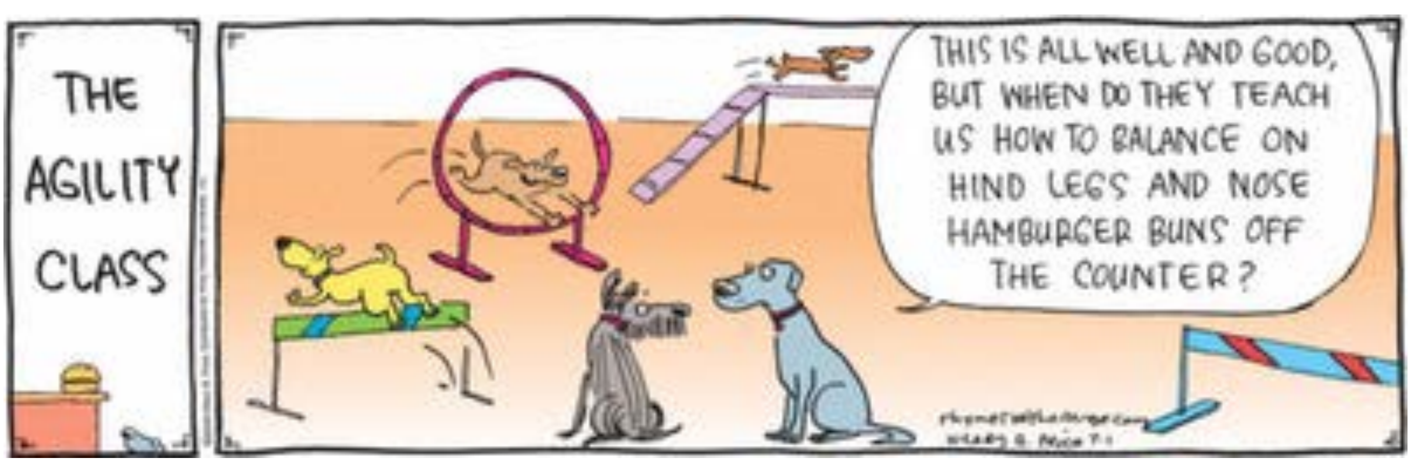
Jump speed and distance results:

- As percentage height increased, there was a significant decrease in jump speed. Dogs were significantly slower when the hurdle reached >76% of their height to the withers.
- There was a significant difference in length of trajectory as percentage height increased. 51-125% had a significantly longer length of trajectory compared to percentages 0-50% and 126-150%.
- The data showed a significantly strong negative correlation between percentage height and jump speed and a strong positive correlation between percentage height and length of trajectory.

Joint angle results:

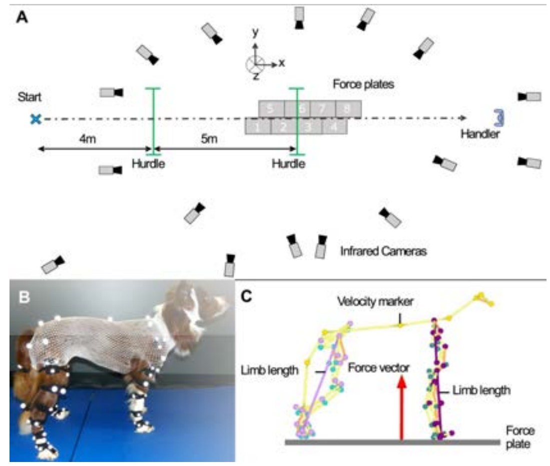
- During the suspension phase of the jump, there was a significant flexion of the shoulder joint as percentage height increased.
- Shoulders were significantly more flexed when the percentage height was 76-150% compared to 0-75%.
- During the landing phase of the jump, neck angles showed a significant increase in extension when percentage height increased.
- Lumbar spine angles became significantly more extended dorsally as percentage height increased.

Discussion: When a hurdle reaches ≥76% of their height to the withers, dogs begin to significantly alter their kinematics. When the hurdle reaches ≥126% of their height to the withers, kinematics alter again resulting in a significantly more acute neck angle and shorter length of trajectory. The height at which a hurdle should be set at as test of athletic ability compared to the height at which a hurdle becomes a welfare concern is not yet fully understood requiring further investigation.



Söhnel K, Rode C, de Lussanet MHE, et al. Limb Dynamics in Agility Jumps of Beginner and Advanced Dogs. Journal of Experimental Biology 2020 Apr 1;223(Pt 7):jeb202119.

The Goal of THIS Study: To assess the effect of skill in dogs jumping and limb dynamics, as well as find evidence for a strut-like effect in dogs, by investigating kinematics and kinetics of all four limbs in beginner and advanced agility dogs during take-off and landing phases of a jump.



Methodology: They used 20 Border Collies (divided into beginner and advanced groups), 16 cameras, 83 passive markers attached to shaved skin, as well as Kinesiotape at the distal ends of the limbs. Additionally, 8 force plates were utilized and two hurdles set at 90% of the dog's height were placed 4 m from the starting point, at 5 m apart.

Results: 271 valid jumps were analyzed from the 20 subjects.

- Advanced dogs show higher limb stiffness, decreased limb compression and higher limb length in take-off and landing in their forelimbs. Their hindlimbs act almost simultaneously during take-off.
- For all dogs, our results show that forelimb dynamics differ between limbs during take-off. The angle of attack in the leading limb is shallower and its stiffness is higher than that of the trailing limb. This leading limb configuration leads to a strut-like action that helps to translate horizontal motion into vertical motion. During landing, strut-like limb action is used conversely to translate vertical motion into horizontal motion. Here, the trailing forelimb takes the role of the strut. The angle of attack in the trailing forelimb is steeper than in the leading limb and its stiffness is higher. The vaulting role alternates between trailing and leading limbs which is a key mechanism to redirect impulse.
- For beginner dogs, there was a longer time between toe-down of the trailing and leading forelimb during take-off phase of the jump, showing a reduced stride frequency, which suggests that beginner dogs lack the skill set to jump at higher speed.
- Advanced dogs overextended their hindlimbs at toe-off, while beginner dogs merely reached initial limb length, suggesting that advanced dogs' hindlimbs contribute more work.
- In advanced dogs, the averaged acceleration impulse of the hindlimbs is twice the deceleration impulse of the hindlimbs; while in beginners, acceleration and deceleration impulses are equal.
- In take-off, advanced dogs placed their hindlimbs almost simultaneously and parallel to each other, as in half-bound, which allows them to attain a long and balanced aerial phase. Beginner dogs did not achieve the same level of synchronicity of the hindlimbs during the take-off phase with longer time differences and distances between toe-down of hindlimbs.
- We found that beginner dogs showed more synchronized forelimbs in landing than advanced dogs, which indicates that they had to deal with impact with limited ability to quickly roll over using the strut-like effect of forelimbs.
- During the landing phase, the change from braking to propulsion occurs later in beginner dogs than in advanced dogs in all four limbs, and beginner dogs were less effective in re-establishing speed after landing. Advanced dogs re-established their gallop pattern in the phase of hindlimb landing, with only slight differences compared to normal gallop.
- During landing, beginner dogs showed a less pronounced strut-like effect with lower limb stiffness and higher limb compression, which limited their ability to convert vertical motion into horizontal motion.
- We found no differences between advanced and beginner dogs with respect to forelimb length and angle of attack at toe-down, during landing so it seems that muscle forces in advanced dogs are higher.

Conclusion: The level of skill in dog jumping is shown by limb dynamics. Limb stiffness and limb length at toe off could be used as parameters to monitor training progress.

Cullen KL, Dickey JP, Brown SHM, et al. The magnitude of muscular activation of four canine forelimb muscles in dogs performing two agility-specific tasks. BMC Veterinary Research (2017) 13:68.

The Study: to measure muscular activation in four forelimb muscles, using fine-wire electromyography (fEMG), while dogs performed agility tasks to provide insights on level of muscular activation and risk of injury. The muscles studied were the Biceps Brachii (BB), Supraspinatus (SP), Infraspinatus (IF), and Triceps Brachii – Long Head (TBLH).
Methodology: Eight sound, experienced, border collies had fine wire electrodes inserted into the 4 muscles on their left sides, and a grounding surface electrode applied to the left inner thigh. Data was collected for ascending and descending the A-frame at two different heights, jumping two bar hurdles (55cm high and 4.5m apart), and baseline measures while walking. *Note:* For each agility task, three strides (pre-transition, transition, and post-transition) were identified from EMG signals using a window that started and ended with the left forelimb paw contact. For the jumping task, the transition stride was when the dog lifted off the ground and jumped over the bar until landing. For the ascending A-frame task, the transition stride was defined when the dog lifted off the ground until paw down on the ramp; and when the dog left the A-frame and landed on the ground for the descending A-frame task.
Results:

- Across all agility tasks, the four forelimb muscles demonstrated their peak activation levels during the swing phase of the gait cycle for many strides.
- In the jumping task, the peak activation across all four muscles was greater than that observed during the baseline walking task, ranging from 2.7 times walking to more than 10.6 times walking.
- The peak activations across all four muscles were substantially greater in both of the ascending A-frame tasks than during the baseline walking task, ranging from 2.8 times walking to more than 7.4 times walking.
- The peak activations across all four muscles continued to be higher in both of the descending A-frame tasks than during the baseline walking task, ranging from 1.7 times walking to more than 7.6 times walking.

- TBLH and BB muscles were significantly higher while jumping, and TBLH activation was significantly lower while descending the A-frame during the pre-transition stride.
- Activation for the BB muscle was significantly lower than other conditions while landing from a jump. It was also significantly low when descending the A-frame during the pre-transition stride.
- SP activation was highest while leaving the A-frame, regardless of height, followed by the transition strides when descending an A-frame and when jumping. SP activation was lowest while preparing to take-off and land from a jump, followed by ascending the A-frame.
- Although not significant, inspection of the IF muscle showed that ascending the A-frame required the highest level of muscular activation. The descending pre-transition strides continued to have the least activation in this muscle, consistent with the other muscles.
- No differences in muscle activation were seen with the differences in height of the A-frame.

Conclusion: Compared to ascending and descending an A-frame, jumping requires the highest level of forelimb muscle activation for all muscles of interest.

Ascend_hi
(Pre-transition)

Ascend_hi
(Transition)

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Descend_hi
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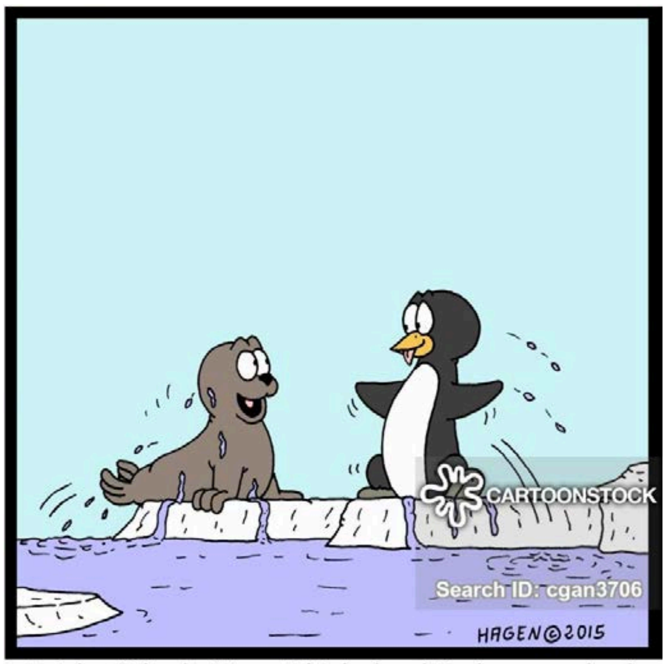

I take it back: You might look a bit clumsy on land, but boy you're amazingly agile in the water!