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Differences in Disposition to Hunting Behaviour Between Magyar Vizslas (Hungarian Pointers) and Border Collies, Based on a Questionnaire and Preliminary Behavioural Tests

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Abstract

This study investigated breed-related genetic predisposition on hunting behaviour by comparing Magyar Vizslas (in English known as Hungarian pointers) and Border Collies using behavioural tests and an online questionnaire. Differences in specific sequences of the hunting behaviour chain were examined with respect to frequency, duration, and latency. Three standardized test situations were conducted with fifteen dogs (eight Magyar Vizslas, seven Border Collies), including reactions to a thrown toy, a play rod, and a running human. Behavioural data were analyzed using the Mann–Whitney U-test for frequencies and randomization tests for duration and latency. Significant breed differences were found for the duration of chasing behaviour: Border Collies exhibited longer chasing durations than Magyar Vizslas in response to a play rod ($p = 0.004$) and a running human ($p = 0.025$). To increase sample size, an online questionnaire was issued, completed by 359 dog handlers and then analyzed using the Kruskal–Wallis test. Particularly striking were the findings regarding the behaviour of pointing: Magyar Vizslas showed significantly higher frequencies of pointing behaviour both in response to thrown toys and during wildlife encounters ($p < 0.001$). Overall, results from both behavioural tests and questionnaire data indicate breed-typical predispositions affecting specific components of hunting behaviour in these two breeds.

Keywords: genetic predisposition; hunting behaviour; herding behaviour; pointing dogs; herding dogs

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Academic Editor: Nicola J. Rooney

Received: 11 June 2026
Revised: 1 October 2026
Accepted: 5 October 2026
Published: 12 October 2026

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1. Introduction

In order to understand the influence of genetics on dog behaviour, the biological background of breed-typical dispositions has to be explored. While an individual dog's genetic predisposition is immutable, some phenotypes only develop in correspondence with environmental conditions. Therefore, genetic and environmental factors are closely linked, and numerous studies suggest that categorizing behaviours as "innate" or "learned" or attributing them solely to genes or environmental factors is futile [1–3]. Even in controlled laboratory settings, separating genetic and environmental influences is challenging, as they interact. On top of that, examining the influence of the genetic predisposition itself can be particularly complicated, because often multiple genes interact and do not follow simple inheritance patterns [4].

As many dog breeds have undergone artificial selection for specific tasks like hunting or herding, their behavioural development reflects the influence of genetics very clearly.

Based on the breeds' different functions and origins, they can be divided into various groups. Dutrow et al. (2022) categorize breeds in "10 major domestic dog lineages": scent hound, pointer-spaniel, terrier, retriever, herder, sled, African and Middle Eastern, Asian spitz, dingo, and sighthound [5]. A study by Parker et al. (2017) [6] examines over 1300 dogs from 161 breeds, considering factors like migration and geographic separation to understand breed history. Despite the complexity, the study reveals origins, migration effects, and the transfer of traits and disease alleles among breeds, which lead to 23 breed clades [6].

Many studies regarding heritability of behaviour traits are quite sobering. For example, Hradecka et al. (2015) [7] found low within-breed heritabilities (9.3–15.4%) in all tested categories, which were behaviour towards environment, herding, hunting, play, and psychical characteristics. According to the authors of this study, this is probably due to the many environmental influences on behaviour traits over the whole life of an individual (e.g., quality of maternal milk, food as a puppy, socialization, early experiences and therefore neuronal changes when young) [7]. Moreover, there are many difficulties in testing heritabilities because of the influence of the handler and small litters in dogs. In contrast, heredities of physical characteristics, such as weight and height, are easier to measure and also significantly higher (40–70%) [8] (pp. 56–57). Nevertheless, Gnanadesikan et al. (2020) [9] discovered that specific cognitive traits are highly inheritable between breeds. These are inhibitory control with up to 70% heritability and communication with handler with up to 50%. They stated that these heritabilities must have been increased by domestication, since self-control and focus were important features for selecting the dogs, which were bred for practical reasons [9]. In a publication of the same year, they also found out that these breed-specific cognitive traits are correlated with genetic clusters and identified three significant single nucleotide polymorphisms (SNPs) in 140 genes associated with the traits inhibitory control, memory, and physical reasoning. The identified genes are tied to nervous system development and brain-specific expression and consequently are linked to specific behavioural traits. Hence, the study supports the idea that selective breeding (e.g., for herding vs. hunting) has shaped the cognitive profiles of dog breeds [10]. In another study, MacLean et al. (2019) [11] ascertained that the genotype is responsible for half of the differences in behaviour across breeds/breed groups (e.g., 75% trainability, 68% stranger-directed aggression). These behaviour-associated genes play a part in processes involving the nervous system and the brain. They also found that between-breed heritabilities are up to 25 times higher than within-breed heritabilities, probably because different breeds have been selected for particular behavioural characteristics for a long time [11].

However, socialization during puppyhood and adolescence should also be considered an important factor influencing the later development of behaviour, as there are specific periods during which the brain exhibits increased neuroplasticity and is particularly susceptible to environmental influences [12]. Of particular relevance to this study is the socialization period, which is generally assumed to last between approximately 2.5 and 9–13 weeks of age [13]. During this stage, dogs show a heightened willingness to form social bonds. Consequently, early exposure to other animals during this period may reduce the likelihood of these animals being perceived as prey [14]. It should be noted, however, that some studies suggest that in Border Collies, the critical period for socialization may begin earlier and extend up to 20 weeks of age [15,16].

In our tests, we decided to examine the influence of the genetic predisposition on hunting behaviour, as tests are easily feasible, and the different behavioural components of the hunting ethogram can be distinguished very clearly. Hunting behaviour in canids comprises a chain of actions, with wolves typically displaying the entire sequence, while dogs show variations depending on breed groups. The hunting sequence ("Coppinger

chain") includes searching, locating, freezing, staring, stalking, chasing, grabbing, killing, and potentially carrying or eating prey [17]. To investigate the differences in the hunting behaviour chain, two breeds were chosen, Magyar Vizsla and Border Collie. We selected them because on one side they are very common, so it was feasible to find enough dogs and dog handlers for our examinations, and on the other side they were and partly still are selected for different tasks. The Magyar Vizsla is a pointing dog, originally bred in Hungary for hunting birds, which therefore shows especially freezing (more specifically pointing) when detecting prey and subsequently retrieves it [18]. On the contrary, Border Collies are British herding dogs, bred to herd sheep. Thus, their behaviour includes freezing, stalking, and chasing, but the actions of grabbing and killing prey were selected against [17].

These distinctions also appear in their neuronal development. Hecht et al. (2019) [19] looked for underlying neural differences, since the heritability of behavioural differences across breeds is relatively high. Notably, they identified six specific regional brain networks that differ between individual dogs or their breed groups and therefore explain neuroanatomical variation. These differences in brain organization are the result of selection for specific behavioural traits and typically appear on the terminal branches of the phylogenetic tree. The fact that all six networks are associated with at least one specific behaviour (e.g., sight hunting, scent hunting, guarding) demonstrates that the canine brain has been shaped by selective breeding. Unfortunately, in this study there was no Magyar Vizsla, but at least some closely related breeds (German short haired pointer, Weimaraner) [6]. These breeds have a factor loading of +1 for the component that is significantly related to bird flushing and retrieving, and high values for the networks that have high correlation coefficients for sight and scent hunting. Additionally, the two Magyar Vizsla-related breeds have a negative factor loading for component 4, linked to herding. Based on this research, it is likely that the Vizsla's brain organization is meant for bird flushing and retrieving, as well as sight and scent hunting, in contrast to that of the Border Collie [19].

Consequently, we hypothesized that the hunting behaviour of Magyar Vizslas and Border Collies vary in different sequences of the behaviour chain "hunting" (appearance and intensity) because of a breed-related genetic predisposition. The Border Collie was thought to display stalking and chasing behaviour more frequently and more intensively, whereas the Magyar Vizsla should show more frequent and more intense pointing behaviour.

2. Materials and Methods

2.1. Behavioural Observations in Specific Test Situations

Behavioural observations were conducted using three different tests: Firstly, a helper drew the dog's attention to a toy and then threw the object approximately 15 metres away, in the opposite direction from the dog. Initially, the handler held the dog on a leash and then unleashed it approximately 2–3 s later, while the toy was lying still on the ground. The dog handlers were asked to bring a toy suitable for throwing (test setup in Figure A1). The second test assessed the dogs' reaction to a play rod (Figure A2). As in the first test, the helper drew the dog's attention to the play rod while the dog was leashed. The helper then moved the play rod in figure-of-eight and circular patterns at an approximate distance of 15 metres from the dog. Then, 2–3 s after the helper stopped moving the play rod, the dog was also unleashed (test setup in Figure A3). Finally, the third test involved the helper running in a specific pattern away from and past the dog. In this test, the dog remained on the leash throughout the procedure (test setup in Figure A4). Hereafter, the tests are referred to as "test 1—toy throwing", "test 2—play rod" and "test 3—running human". Please note that, in practice, we decided to change the order of the tests and conducted test 1—toy throwing last due to concerns that the dogs might remain focused on their toys and thereby influence their behaviour in the subsequent tests.

The same helper was used for each dog and each test and received detailed instructions for the test setups to ensure comparability. All the tests were conducted outdoors on grass or short meadows. Since the tests were performed within a relatively short period of time in autumn, the weather conditions were similar. Additionally, we ensured that it did not rain during the tests. In all tests, the dog handler was instructed to remain neutral towards the dog, meaning that they were not allowed to speak to, touch, or pull the dog on the leash, in order to minimize its influence on the dog's behaviour. The leash was required to be 1–2 metres long. We instructed the handlers to use their dog's usual everyday collar or harness. In this study, this consisted of a medium-width collar or a Moxon leash with a pull stop. During all test situations, the dogs were filmed in order to be able to assess the behaviours afterwards. Filming was stopped either when the test action, such as moving the play rod or running by the human, had ended and the dog had been unleashed (except in test 3—running human) and subsequently lost interest in the toy, play rod, or human. If this was not the case, then we stopped 20 s after the dog had been unleashed or the human had stopped running. The dog owners were aware that their dogs were being filmed. Between the three test situations, each dog had a break of about 2–3 min. During this time, the dog remained on a leash with its handlers and waited a few metres away while the next test was prepared.

Through acquaintances, handlers of 15 dogs (8 Magyar Vizslas, 7 Border Collies) who agreed to participate in the behavioural tests were recruited. Their dogs were filmed in the three test situations, and their behaviour was subsequently analyzed using six categories: locating, freezing, pointing, stalking, chasing, and grabbing and mouthing (definitions of these behaviours in Table 1). These behaviours were selected because they represent key components of the Coppinger chain. The behaviours searching, killing, and eating prey were excluded, as they were not considered applicable for our test setups. We evaluated the six categories by the frequency of a particular behavioural pattern, duration in seconds (except for grabbing, as this did not seem sensible) and latency in seconds. Other behaviours, potentially originating from frustration, were not considered. All video recordings were coded by one investigator (F. Brandsch) using the predefined behavioural categories and definitions of them established prior to the analysis. The data were transferred to a table and assessed using IBM SPSS Statistics software version 29.0 for Mann–Whitney U-Test and the browser versions of StatKey v. 3.0.4 [20] as well as "*p*-Value from F-Ratio Calculator" [21] for randomization test. Mann–Whitney U-test was employed to calculate *p*-values for differences between Magyar Vizslas and Border Collies in behaviour frequency, whereas the randomization test was applied for the data on duration and latency. With both statistical tests, we looked for significance values below 0.05. Finally, boxplot diagrams, created using Microsoft Excel (Version 2603, Microsoft 365), were used for graphical representation of results.

Table 1. Definition of behaviours.

Behaviour	Explanation
locating	A search behaviour combined with a simultaneous approach pattern.
freezing	Rigid staring accompanied by a very stiff body posture. It can be adopted from different positions (standing or lying).
pointing	The dog stands on three legs. The head and neck are held level with the back or slightly above or below it. One forelimb is raised and flexed at the carpal joint, as if the dog were pointing at something with its paw. During pointing, the dog looks straight ahead. The stimulus for this behaviour is usually a sound or a movement in the distance that attracts attention. The behaviour may appear frozen briefly.

Table 1. *Cont.*

Behaviour	Explanation
stalking	To creep with a straight back in any gait, in the sense of a stealthy approach: the head is carried at the same level as or lower than the back. The ears are usually erect and directed forward, and the dog fixes its gaze on the object it is stalking. In contrast to a curved body posture, the back is not arched, and the tail is not tucked in.
chasing	Pursuit of the prey animal. Instead of chasing, the so-called "mouse pounce" may be performed, in which a strike with the forepaw is executed during the jump.
grabbing & mouthing	Holding an object with the teeth. An item may also be held in the mouth with repeated readjusting of the grip.

The definitions were adapted from an ethogram of the dog by Spitzley and Elsing [22] to the context of this study.

2.2. Online Questionnaire

An online survey was created working with SurveyMonkey to gather a larger sample of handlers of Magyar Vizslas and Border Collies (questionnaire: Figures S1 and S2). Participants were asked to answer general questions (e.g., age, sex) and behaviour assessment questions using a 5-point Likert scale ranging from 1 = "(almost) never occurs" to 5 = "(almost) always occurs" with "I don't know" as an additional option, which however was excluded from the statistical tests. These questions covered various scenarios, which included the dog's response to a thrown toy, encountering joggers, cyclists, or other fast-moving individuals, and encountering wildlife. Then breed-specific questions were asked, such as whether the Border Collie understood its herding task from the beginning (if it has ever herded) or if the Vizsla knew what to do on a hunt (if it has ever been on a hunt). By participating in the survey, the dog handlers consented that their responses would be collected and stored confidentially. The downloaded questionnaire data were stored on a password-protected personal computer and were accessible only to the researchers. Distribution efforts included sharing flyers among acquaintances, veterinary practices, and dog training schools, promoting the survey on Instagram accounts, and enlisting the help of influencers and Udo Gansloßer's team to reach a wide audience.

In the end, 359 participants took the survey between 1 August and 17 October 2022, thereof 310 persons answered all questions. Of these, 180 were handlers of a Magyar Vizsla and 130 handlers of a Border Collie. The analysis focused on three scaling questions related to fixating, pointing, and chasing behaviour, where we assumed the most differences. For that, the Kruskal–Wallis test (also IBM SPSS Statistics 29.0), which works similar to the U-test but with more variables, was used to compare distinctions between the two breeds. A pie chart was used for graphical representation due to the sufficient sample size.

3. Results

3.1. Results of the Behavioural Observations

The evaluation of test 1—toy throwing shows that no values of the Mann–Whitney U-test (for frequency) or the randomization test (for duration and latency) depict significant differences (Table 2).

In test 2—play rod, the effect of breed on chasing duration was highly significant, indicating distinct differences between the two breeds. Additionally, the frequency of chasing approached statistical significance, suggesting a trend towards breed-specific differences. Border Collies displayed chasing more often and longer than Magyar Vizslas in test 2—play rod. The results for frequency and duration of the behavioural variables recorded in test 2—play rod are shown in Figures 1 and 2, respectively. Table 3 reports the medians, interquartile ranges, and *p*-values for all statistical comparisons.

In test 3—running human, the randomization test displayed a statistical significance for the inter-breed comparison of durations of chasing. In particular, the Border Collie reacted to the running human with more chasing behaviour than the Magyar Vizsla. The results for test 3 are shown in Figure 3, while Table 4 reports the medians, interquartile ranges, and *p*-values for all statistical comparisons.

Table 2. Medians and interquartile ranges (IQRs) of the frequencies, durations, and latencies of behaviours exhibited by Magyar Vizslas and Border Collies, and *p*-values for between-breed differences in test 1—toy throwing. Duration and latency (in seconds) were analyzed using a randomization test, while frequency was analyzed using a Mann–Whitney U-Test. No *p*-values are <0.05, so there are no statistical significances.

Behaviours		Magyar Vizsla—Median (IQR)	Border Collie—Median (IQR)	*p*-Values
locating	frequency	0 (0–1)	0 (0–1)	0.838
	duration	0 (0–15)	0 (0–16.5)	0.981
	latency	0 (0–9)	0 (0–8.5)	0.774
freezing	frequency	1 (0–1)	1 (1–1)	0.625
	duration	3.5 (0–4.25)	3 (1.5–4)	0.400
	latency	0 (0–2.13)	0 (0–1.5)	0.430
pointing	frequency	0 (0–0)	0 (0–0)	0.350
	duration	0 (0–0)	0 (0–0)	0.369
	latency	0 (0–0)	0 (0–0)	0.369
stalking	frequency	0 (0–0)	0 (0–0)	1.000
	duration	0 (0–0)	0 (0–0)	1.000
	latency	0 (0–0)	0 (0–0)	1.000
chasing	frequency	2 (1–2)	2 (1–2)	0.688
	duration	3 (2.75–3.25)	3 (1.5–4)	0.884
	latency	6 (4–10.75)	3 (1.25–3.75)	0.652
grabbing	frequency	1 (1–1.25)	1 (0.5–2.5)	0.900
	duration	/	/	/
	latency	17 (12.75–27)	0 (0–12.25)	0.574

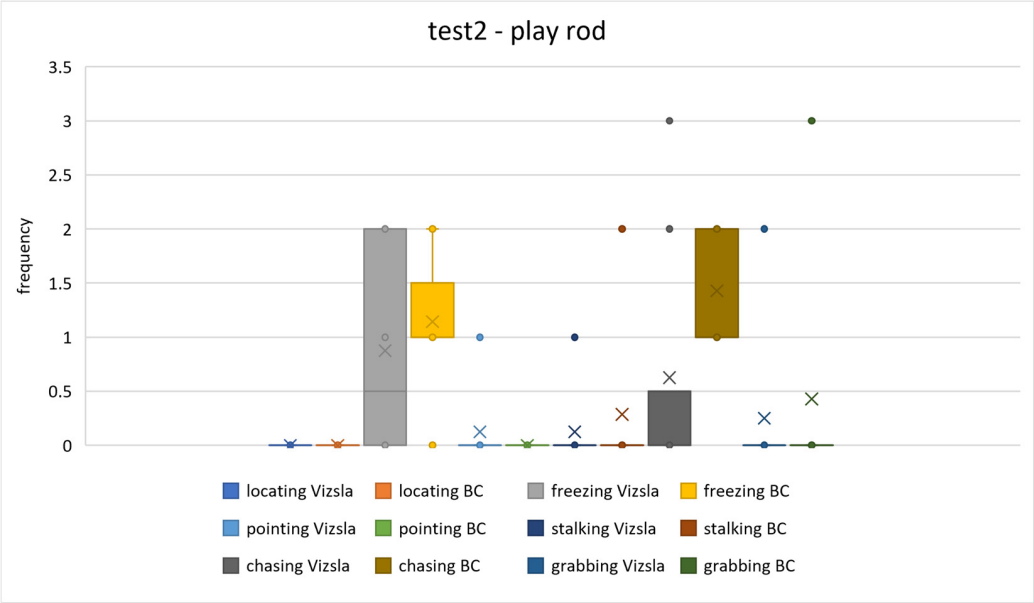


Figure 1. Boxplot showing the frequency of different behavioural patterns in Magyar Vizslas (Vizsla; $n = 8$ dogs) and Border Collies (BC; $n = 7$ dogs) in test 2—play rod. The x indicates the mean. Individual points indicate outliers.

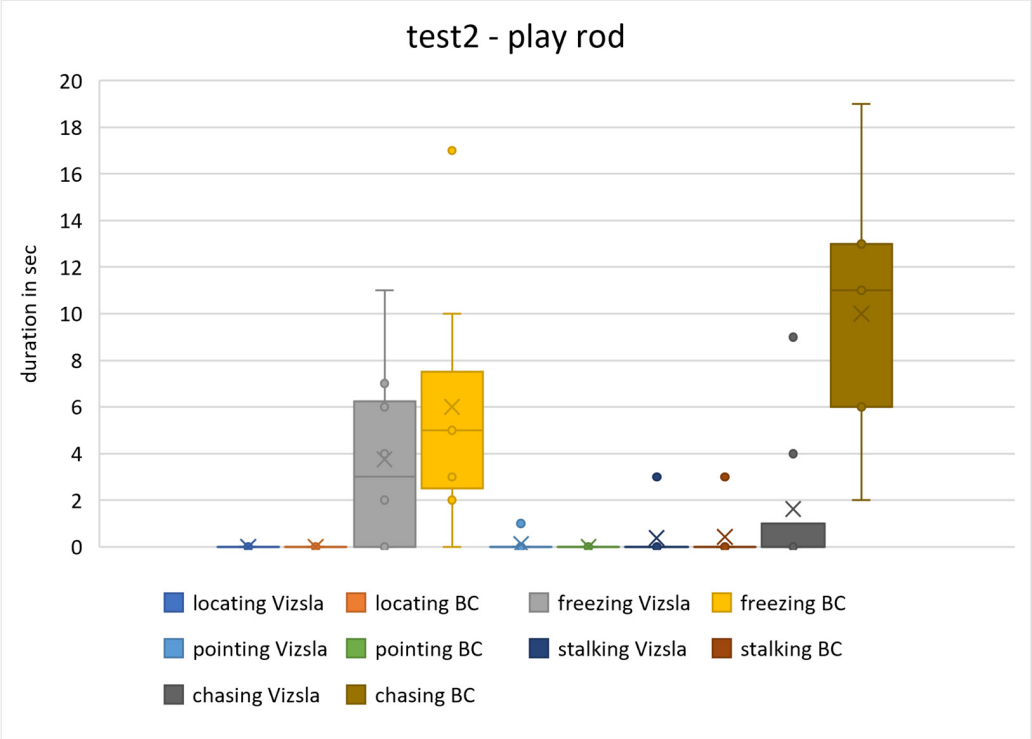


Figure 2. Boxplot showing the duration of different behavioural patterns in Magyar Vizslas (Vizsla; $n = 8$ dogs) and Border Collies (BC; $n = 7$ dogs) in test 2—play rod. The x indicates the mean. Individual points indicate outliers.

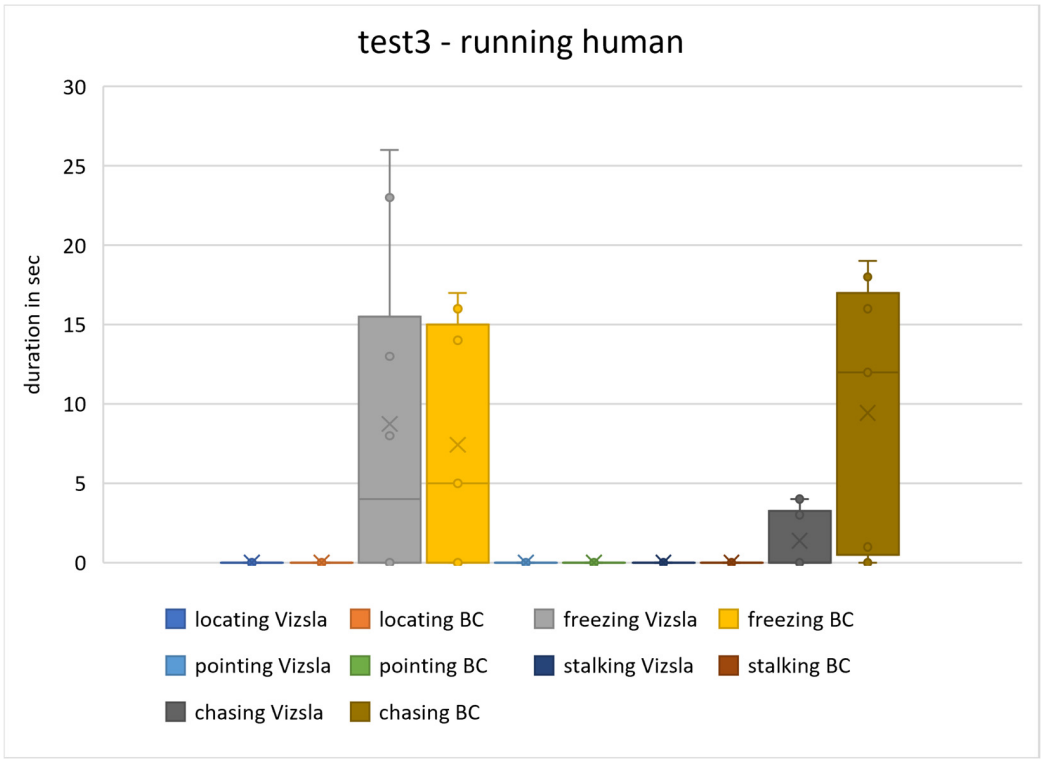


Figure 3. Boxplot showing the duration of different behavioural patterns in Magyar Vizslas (Vizsla; $n = 8$ dogs) and Border Collies (BC; $n = 7$ dogs) in test 3—running human. The x indicates the mean. Individual points indicate outliers.

Table 3. Medians and interquartile ranges (IQR) of the frequencies, durations, and latencies of behaviours exhibited by Magyar Vizslas and Border Collies, and *p*-values for between-breed differences in test 2—play rod. Duration and latency (in seconds) were analyzed using a randomization test, while frequency was analyzed using a Mann–Whitney U-Test. Statistical significance ($p < 0.05$) is marked in blue. The grey marked value shows a statistical trend (*p*-value in the 0.05 to 0.10 range).

Behaviours		Magyar Vizsla—Median (IQR)	Border Collie—Median (IQR)	*p*-Values
locating	frequency	0 (0–0)	0 (0–0)	1.000
	duration	0 (0–0)	0 (0–0)	1.000
	latency	0 (0–0)	0 (0–0)	1.000
freezing	frequency	0.5 (0–2)	1 (1–1.5)	0.540
	duration	3 (0–6.25)	5 (2.5–7.5)	0.392
	latency	3.25 (0–7.13)	4 (0.5–11.5)	0.271
pointing	frequency	0 (0–0)	0 (0–0)	0.350
	duration	0 (0–0)	0 (0–0)	0.369
	latency	0 (0–0)	0 (0–0)	0.369
stalking	frequency	0 (0–0)	0 (0–0)	0.845
	duration	0 (0–0)	0 (0–0)	0.926
	latency	0 (0–0)	0 (0–0)	0.565
chasing	frequency	0 (0–0.5)	1 (1–2)	0.059
	duration	0 (0–1)	11 (6–13)	0.004
	latency	0 (0–2)	8 (5–10.75)	0.098
grabbing	frequency	0 (0–0)	0 (0–0)	0.845
	duration	/	/	/
	latency	0 (0–0)	0 (0–0)	0.735

Table 4. Medians and interquartile ranges (IQR) of the frequencies, durations, and latencies of behaviours exhibited by Magyar Vizslas and Border Collies, and *p*-values for between-breed differences in test 3—running human. Duration and latency (in seconds) were analyzed using a randomization test, while frequency was analyzed using a Mann–Whitney U-Test. Statistical significance ($p < 0.05$) is marked in blue.

Behaviours		Magyar Vizsla—Median (IQR)	Border Collie—Median (IQR)	*p*-Values
locating	frequency	0 (0–0)	0 (0–0)	1.000
	duration	0 (0–0)	0 (0–0)	1.000
	latency	0 (0–0)	0 (0–0)	1.000
freezing	frequency	1 (0–2.5)	1 (0–1)	0.459
	duration	4 (0–15.5)	5 (0–15)	0.795
	latency	4.25 (0–10.25)	0 (0–1.5)	0.187
pointing	frequency	0 (0–0)	0 (0–0)	1.000
	duration	0 (0–0)	0 (0–0)	1.000
	latency	0 (0–0)	0 (0–0)	1.000
stalking	frequency	0 (0–0)	0 (0–0)	1.000
	duration	0 (0–0)	0 (0–0)	1.000
	latency	0 (0–0)	0 (0–0)	1.000
chasing	frequency	0 (0–2)	1 (0.5–1.5)	0.532
	duration	0 (0–3.25)	12 (0.5–17)	0.025
	latency	0 (0–25)	1 (0–3)	0.200
grabbing	frequency	0 (0–0)	0 (0–0)	1.000
	duration	/	/	/
	latency	0 (0–0)	0 (0–0)	1.000

In summary, the results of the behavioural tests especially show differences in the behaviour pattern of chasing, which Border Collies show enhanced in relation to Magyar Vizslas.

3.2. Results of the Online Questionnaire

The first question we evaluated asked for the dog's reaction to a thrown toy, when the dog is not restricted. Question number two requested the reaction to a fast-moving person (e.g., runners, cyclists), and the third question referred to encountering wildlife, both of them with the permission that the dog is as little limited by the handler as possible. We considered the distinctions in staring, pointing, and chasing.

Especially question one (thrown toy) and question three (encountering wildlife) show notable differences (Table 5). There are statistically highly significant distinctions between the two breeds in their pointing behaviour. When encountering wildlife, their reactions also differ statistically significantly in the appearance of freezing behaviour and tendentially also in the occurrence of chasing behaviour. However, we did not further specify wildlife and therefore cannot make any distinctions between the two breeds regarding reactions to specific wild animals. In contrast, no significant differences in the behaviour towards runners and cyclists were visible.

Table 5. *p*-values of the differences between Border Collies and Magyar Vizslas in freezing, pointing, and chasing in the scaling questions of the online survey. The blue marked values are $p < 0.05$, which shows a statistically significant result. When additionally in bold letters, the figures are highly significant ($p < 0.001$). The grey marked value shows a statistical trend (*p*-value in the 0.05 to 0.10 range).

Behaviours	Question 1 (Toy)	Question 2 (Person)	Question 3 (Wildlife)
freezing	0.087	0.336	0.011
pointing	**<0.001**	0.645	**<0.001**
chasing	0.247	0.616	0.061

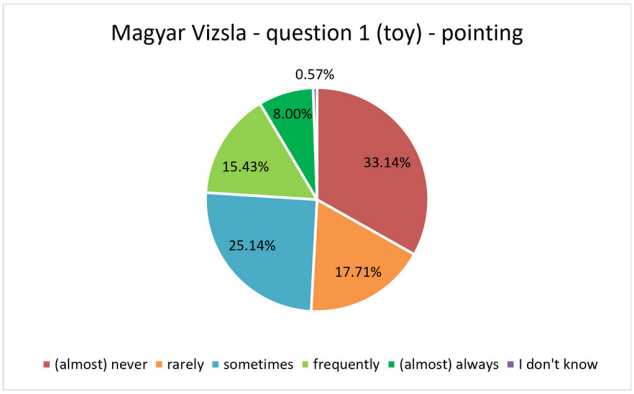
Regarding the question about encountering wildlife (question 3), there is a statistically significant *p*-value ($p = 0.011$) for the differences in freezing behaviour (Figure 4), as the handlers of Magyar Vizslas replied more often that the behaviour "frequently" and "(almost) always" occurs.



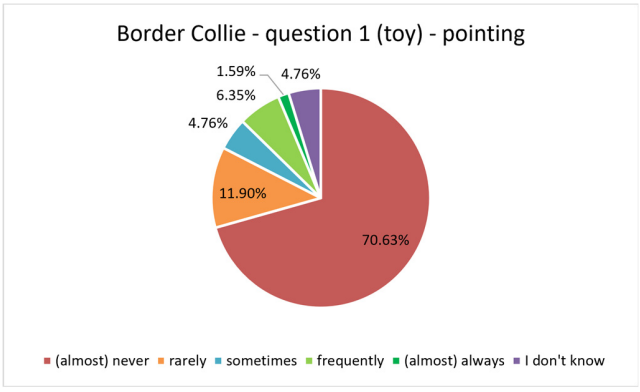
(**a**) (**b**)

Figure 4. Pie charts illustrating dog handlers' responses regarding their dogs' display of freezing behaviour when encountering wildlife (question 3): (**a**) answers of Magyar Vizsla handlers ($n = 180$); (**b**) answers of Border Collie handlers ($n = 130$).

When looking at the pointing behaviour (Figures 5 and 6) of Magyar Vizslas and Border Collies we see highly significant differences, since Magyar Vizslas pointed distinctly more often than Border Collies according to the handlers ($p < 0.001$). In situations with wildlife (Figure 6), the Magyar Vizsla showed the pointing behavioural pattern even more frequently.

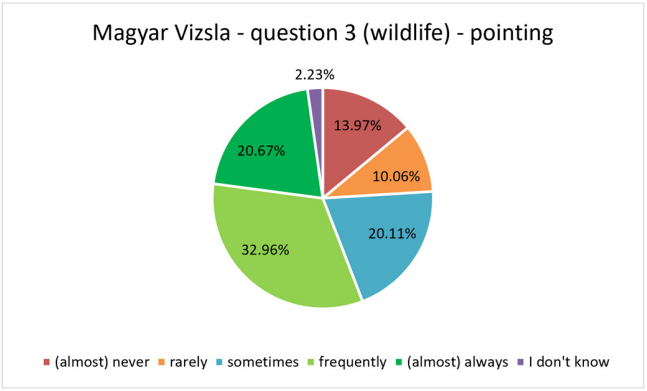


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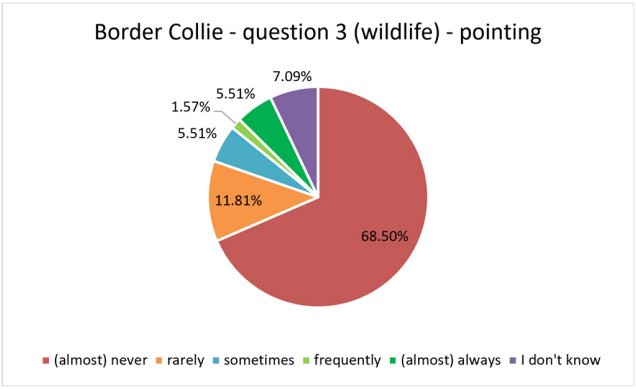


(**b**)

Figure 5. Pie charts illustrating dog handlers' responses regarding their dogs' display of pointing behaviour when a toy is thrown (question 1): (**a**) answers of Magyar Vizsla handlers (n = 180); (**b**) answers of Border Collie handlers (n = 130).



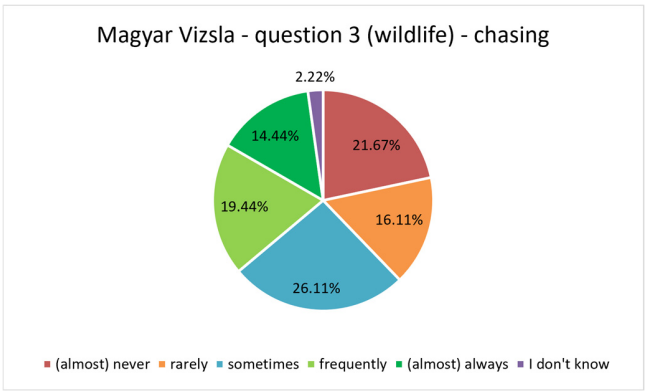
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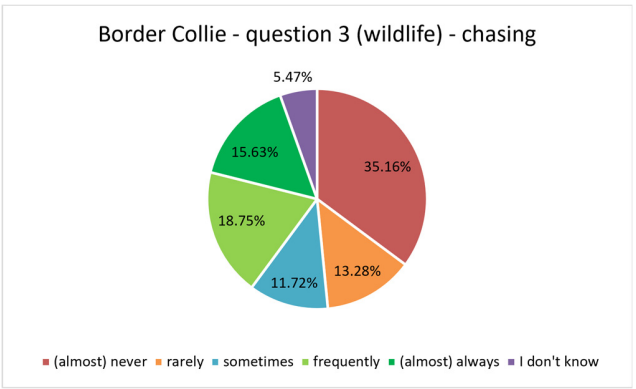
(**b**)

Figure 6. Pie charts illustrating dog handlers' responses regarding their dogs' display of pointing behaviour when encountering wildlife (question 3): (**a**) answers of Magyar Vizsla handlers (n = 180); (**b**) answers of Border Collie handlers (n = 130).

In the analysis of the chasing behaviour (Figure 7), we could not find significant distinctions; however, Magyar Vizslas tended to chase wildlife more often than the Border Collie.



(**a**)



(**b**)

Figure 7. Pie charts illustrating dog handlers' responses regarding their dogs' display of chasing behaviour when encountering wildlife (question 3): (**a**) answers of Magyar Vizsla handlers (n = 180); (**b**) answers of Border Collie handlers (n = 130).

Taken together, Magyar Vizslas exhibited the behavioural pattern of pointing more often than the Border Collies, both in connection with a thrown toy and with wildlife. They showed more freezing in reaction to wildlife as well. Therefore, in this examination it appears that Magyar Vizslas reacted more to wildlife with hunting behaviours, specifically freezing and pointing (and chasing).

4. Discussion

Our main hypothesis was confirmed through behavioural tests and the online survey, which revealed differences in hunting behaviour between Magyar Vizslas and Border Collies, even in the simplified preliminary test situations. In these behavioural tests, Border Collies showed longer (test 2—play rod, and test 3—running human) and more frequent (test 2—play rod) chasing behaviour.

A study by Dutrow et al. (2022) [5], in which they investigated the genetic foundations of the behavioural diversification in dogs, identified ten major canine genetic lineages linked to historical working roles, including herding behaviour, which indicates a genetic predisposition for behavioural patterns like chasing, as a part of herding behaviour. Furthermore, they found that genetic variants driving lineage diversification were mostly non-coding and enriched in neurodevelopmental pathways. Sheepdog-specific loci were especially enriched in axon guidance genes, suggesting herding behaviour is linked to neuronal circuit development. In contradistinction to earlier reports that emphasized morphology, behaviour was found here as a major driver of diversification; therefore, these findings highlight the behaviour's central role in shaping dog lineages [5]. Notably, we observed these results even though none of the Border Collies had been trained as a sheepdog.

In contrast to the results of the behavioural tests, our survey illustrates that Magyar Vizslas display more chasing behaviour in wildlife encounters, but overall, they show a stronger reaction to wildlife than Border Collies. This supports the findings of Dutrow et al. (2022), since they described that the pointer-spaniel group, a breed group that contains the Vizsla, has a significant correlation to the C-BARQ factor "predatory chasing" in contrast to the herding dogs [5]. However, we did not consider whether the Magyar Vizslas had been trained for hunting or were regularly used for hunting in our online survey.

Another hypothesis was that Magyar Vizslas are predisposed to pointing behaviour. This was confirmed by handler assessments in our survey and also observed by Akkad et al. (2015) [23], who investigated the genetic basis of pointing behaviour in pointing breeds (e.g., Large Munsterlander, Weimaraner) by comparing them with non-pointing herding breeds. In their study, a region of extended homozygosity on chromosome 22 was consistently identified in pointing dogs (except for German Shorthaired Pointers) but not in herding dogs, other hunting breeds without pointing behaviour and wolves. They also found that breeds with heterozygous genotypes (e.g., German Wachtelhund) may display trainable but not fixed pointing behaviour, suggesting a gene dosage effect and interaction between genetics, training, and environment [23]. As there were no Magyar Vizsla genomes sequenced in this study, it is impossible to say whether Vizslas show consistent homozygosity for the revealed single nucleotide polymorphisms (SNPs) in the candidate region. Nevertheless, since they are part of the pointer breed group [6], Magyar Vizslas are likely to be at least partially genetically predisposed to pointing behaviour.

However, pointing was barely displayed in our behavioural tests. This could be explained by several factors. First, as we observed, Magyar Vizslas tend to react more strongly to real wildlife than to prey replacements in opposition to the Border Collies. However, we cannot determine if this difference is related to breed-specific characteristics or, for example, to differences in the handlers' use of prey replacements. It is possible that Border Collie handlers were more likely to use prey substitutes in play to manage or redirect

their dogs' chasing behaviour, whereas this may have been less common among Magyar Vizsla handlers, but this was not investigated in our study. Second, pointing behaviour in pointing breeds is often shown particularly at the scent or sound of wildlife [23]. Third, none of the Magyar Vizslas participating in our behavioural tests had been trained in hunting, while we do not know that for the dogs in the survey.

Nevertheless, a study of Morrill et al. (2022) [1] limits our results. They specifically investigated how well breed ancestry predicts individual dog behaviour and found that most behavioural traits are heritable, but despite that, breed explains only about 9% of behavioural variation between individual dogs. They stated that behaviour is highly variable within breeds, because their studies showed that most individual dogs of any breed fall within the average range of the population for all behaviours, that no behaviour was exclusive to any breed nor was predicted reliably by breed at the individual level, and that behavioural traits are polygenic and environmentally influenced. For physical traits (e.g., size, coat type), breed explains much more variation. The Border Collie, for example, has higher heritabilities for pricked ear shape and long fur than for biddability, although it is more biddable than other breeds. The same applies to Magyar Vizslas, which have higher heritabilities for dropped ears and short fur than for pointing [1].

Although the heritabilities for physical characteristics are higher, we still found statistically significant behavioural differences between Magyar Vizslas and Border Collies, probably based on genetic variations. Importantly, it should be emphasized that discrepancies between the two breeds were explored, focusing on across-breed heritabilities, with individual differences within breeds not extensively considered. Yet, exactly these between-breed heritabilities are inherently higher, as MacLean et al. (2019) outlined [11]. The within-breed heritabilities could be examined with bigger samples.

Still, our results match the findings by Bionda et al. (2023) [24], which showed that Italian hunting dogs and shepherd dogs form two clearly distinct genetic clusters, reflecting long-term divergent selection for different working tasks. They found that multiple genomic regions differ significantly between hunting and shepherd dogs, and several of these regions contain genes previously associated with hunting or pointing behaviour, indicating selection for specific elements of the hunting behaviour chain. The study as well as our examinations support the idea that distinct sequences of the hunting behaviour chain are differently emphasized across functional dog groups, specifically hunting dogs and herding dogs [24].

We also need to revisit the study of Parker et al. (2017) [6]. Referring to their cladogram, the Border Collie is more derived than the Magyar Vizsla, which might also help to explain the more complete sequence and more similar thresholds of the elements of the hunting sequence in Magyar Vizslas [6].

Finally, it should be noted that our study could have some issues, since only the differences between Magyar Vizslas and Border Collies were examined. Therefore, it cannot be ruled out that both of them are genetically predisposed to the same behaviour(s). In the further course of our investigation, it would hence be sensible to include more breeds, from the same breed groups as well as from different ones. In addition, none of the Border Collies that had participated in the behavioural tests came from working lines (selected for performance), potentially affecting test outcomes as they would probably show increased herding behaviour and therefore increased freezing and chasing behaviour. Moreover, sample sizes for the behavioural tests were relatively small. In contrast, the online survey covered a larger population, but it relied on subjective handler assessments, raising questions about comparability. The handlers' abilities to evaluate their dog's behaviour could also depend on the length of ownership, which we did not investigate specifically. However, 71.31% of the dogs were acquired from a breeder and 78.83% of the dogs were more than 1.5 years old, suggesting that the majority of handlers have similar preconditions to judge their dog's behaviour

at a comparable level. Although participants in the online survey were asked to assess their dogs' behaviour in situations without any form of restraint, it is unclear whether this was always possible, particularly during encounters with joggers or other fast-moving people.

Another limitation of our study is that we did not collect data on the dogs' training or other aspects of their living conditions. Consequently, these factors could not be considered in our analyses. In future studies, we could therefore include more comprehensive information about the dogs' backgrounds, including their training and living conditions.

5. Conclusions

Genetic predisposition influences a dog's behaviour, since this was important for the development of all the different breeds, which were selected for several tasks in the coexistence with humans. However, "innate" and "learned" behaviours cannot be differentiated completely, because environmental factors have a notable impact, too.

However, differences between different breeds or breed groups are detectable very well as we could illustrate with the Magyar Vizsla, a pointing dog, and the Border Collie, a herding dog, in our preliminary test situations. The survey clarified as well that these two breeds differ in their hunting behaviour.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/pets3040048/s1, Figure S1: original questionnaire; Figure S2: translated questionnaire.

Author Contributions: Conceptualization and methodology, F.B. and U.G.; validation, U.G.; formal analysis and investigation, F.B.; resources, F.B. and U.G.; data curation and writing—original draft preparation, F.B.; writing—review and editing, F.B. and U.G.; visualization, F.B.; supervision, U.G. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: No institutional ethical approval was obtained for the behavioural tests, because the tests were part of the dog keepers' regular everyday sports activities. The tests were conducted as part of a student research project and involved privately owned dogs. The procedures were non-invasive and of short duration, no aversive methods or physical coercion were used, and the dogs were not separated from their handlers at any time. The potential for distress was minimized by limiting the duration of the tests and returning the dogs to their normal activities immediately afterwards. The dog owners were informed about the procedures and the filming of their dogs. The study procedures are described in detail in Section 2.

Informed Consent Statement: Informed consent was given verbally by the handlers of the dogs participating in the behavioural tests. They were informed that the tests would be filmed to be able to analyze the behaviours subsequently. At the beginning of the online survey a disclaimer was provided, stating that all responses would be collected confidentially. By participating in the survey, the questionnaire participants consented to this.

Data Availability Statement: The original data presented in the study are openly available in Zenodo at https://doi.org/10.5281/zenodo.20630132. Video recordings are available from the corresponding author upon reasonable request due to privacy considerations.

Acknowledgments: The authors want to give special thanks to the 15 dog handlers who took the time to participate with their Magyar Vizslas or Border Collies in the behavioural tests. We would also like to thank Carina Kolkmeyer for reviewing and correcting the manuscript and her valuable feedback. During the preparation of this manuscript, the author used ChatGPT (GPT-5.2, OpenAI) to help with the translation from German to English of some passages. The authors have reviewed and edited the output and take full responsibility for the content of this publication.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

BC	Border Collie
SNP	Single nucleotide polymorphism

Appendix A

Detailed graphics of the test setups of the three behavioural tests are displayed in the following.

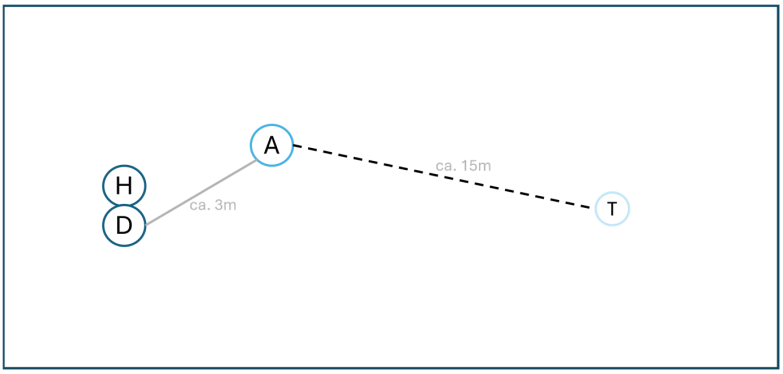


Figure A1. Graphic showing the test setup of test 1—toy throwing with the assistant (A) standing 3 metres away from the dog (D) and its handler (H) and throwing the toy (T) approximately 15 metres away.



Figure A2. Photograph showing the helper with the play rod we used.

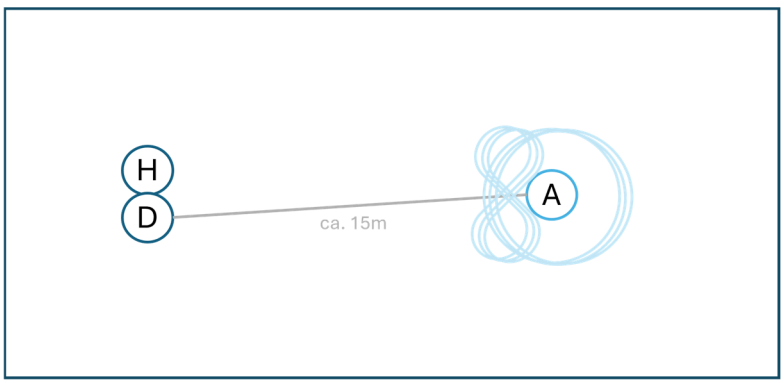


Figure A3. Graphic showing the arrangements of test 2—play rod. The assistant (A) is moving the play rod in a pattern of 2.5 lying figures of eight and 3 circles in an approximate distance of 15 metres to the dog (D) and its handler (H).

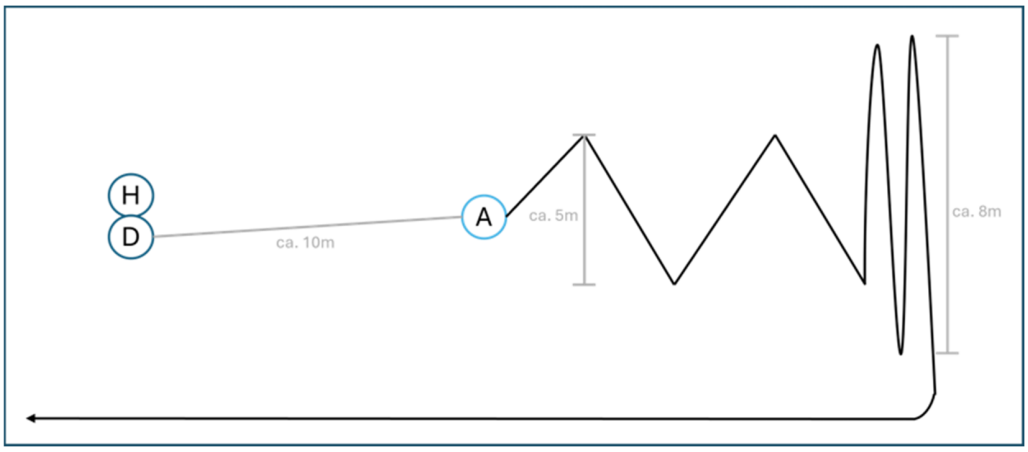


Figure A4. Graphic showing the approximate moving pattern of the assistant (A) in test 3—running human. Starting point is about 10 metres away from the dog (D) and its handler (H).

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