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Let' m Loose – The Importance of Off-Leash Walks for Pet Dogs

Sandra Foltin[1, *], Udo Ganslosser[2]

[1]Department of Biology, University Duisburg-Essen, Essen, Germany

[2]Institut of Zoology & Evolutionary Research, Friedrich-Schiller-Universität Jena, Jena, Germany

Email address:
sfoltin@web.de (S. Foltin)

[*]Corresponding author

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Abstract: The approximate figure of pet dogs reported in Europe 2020 is 87.5 million. These dogs live mainly either in enclosed properties or their exercise takes place in form of a daily round of walks with their owner, frequently on a leash. The importance of regular exercise for dogs is well known and benefits to physiological and psychological well-being through off leash explorative behavior has been documented. Off leash walks benefit health and welfare because the dog's individual natural gait, social transaction ability and exploration behavior are thereby supported. In this study the behavior of free-ranging (off-leash) pet dogs was assessed whilst walking in familiar and unfamiliar areas with their owner and not being signaled or called to. Data were collected to measure distance travelled and duration dogs spent away from their owner during the walks to determine and compare speed and movement patterns of dog and owner respectively. The roaming behavior of the dogs was measured via GPS. All dogs displayed individual speed and exploration patterns and covered significantly longer distances at significantly higher speed compared to their owners. The majority of dogs, however, remained within a radius of 150 m of their owner all the time. Therefore, while it is inevitable for dogs to be on a leash in some situations whilst sharing our urban environment, safe and enriched areas for off leash activities are strongly recommend to ensure pet dogs' physiological and psychological welfare by being able to explore in their own speed and employing their individual movement patterns.

Keywords: Canine, Dog, Walk, Speed, Exploration, Welfare, Behavior

1. Introduction

Dogs have idiosyncratic exercise requirements to preserve optimal health physiologically and psychologically. Studies demonstrate that dogs that spent more time using their olfaction through regular nosework activity are more optimistic which increases their welfare [1]. Appropriate dog-walking activities are also essential for effective strategies to prevent for instance canine obesity [2] and assist social interactions and aid cognitive as well as behavioural development and wellbeing [1, 3]. Dog proprietorship however does not warrant that owners will on a regular basis exercise their dog(s) [4] and great cultural differences exist regarding the walking regiment. Christian et al., (2013) state that in the US and Australia approximately 60% of dog owners walk their dog with a median duration and frequency of 160 minutes per week [5]. Westgarth et al., (2015) described in concurrence that 40% of Australian dog owners do not walk their dog at all [6]. A survey conducted in the UK established that one in four owners never let their dog off the leash. Furthermore, if off leash, the average dog spends 17 minutes off leash per walk, maximum half the time of the walk [7]. In the UK survey ten percent of the dog owners walked the identical route every day with their dog [7]. Gorsuch (2021) showed in her study that 89.8% of German dog owners walked the similar route every day with their dog, half of the time (53%) at least intermittently on a leash [8]. This limits the sensory input the dog receives and thus may process. Insofar as pet dogs are not able to choose either their daily activities or

the quality of their walks with respect to time, distance and cognitive input it is important to consider the opportunities offered by the owner to express natural behaviours necessary for the dogs' welfare. These include autonomous movement, initiative taking, to have choices for instance where and what to explore and to make decisions of what or whom to approach or to avoid [1, 9].

What has clearly been shown are the negative health effects of collar use and leash tension forces wielded by dog and owner whilst walking the dog on a leash [10-13] and a concomitant unnatural gait pattern resulting from subsuming its walking speed to that of the owner whilst on a leash [12]. Undoubtedly, off leash pet dogs chasing wildlife is a sensitive subject. It is however quite difficult to find reliable facts and statistics regarding wildlife killed by dogs in Europe. People often assume that pet dogs display hunting behavior when out of sight and legislation in a number of countries prescribe leashed dogs [14]. In this study video cameras were used on the (larger) dogs to document their off leash behavior and potential wildlife effects.

Evidently the domestic dog inspired numerous scientific activities, but research on pet dog walks primarily focused on relevant aspects of health effects for the owner [15], epidemiology [16], or has been conducted in enclosed areas or laboratory settings [17, 18]. The intention of this study was to gather data about the actual exploratory activities of off-leash pet dogs. It was hypothesized that the distance and speed of the walks varied between owner and dog based on physiological and biomechanical factors. Additionally, the different walking patterns were moreover being influenced by motivational factors, i.e. the dogs' interest to explore.

This is of particular importance because of the strict regulations and prejudices currently existing and their implications for domestic pet dogs, specifically their physical and psychological welfare and the impact on cognitive abilities and functions by being frequently walked on a leash [19-21].

As far as could be ascertained, no research has in fact been done to establish how pet dogs in fact do behave whilst off the leash, unrestricted and not called or signalled to while walking in an unenclosed area.

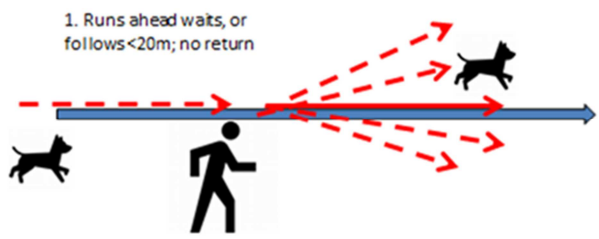
2. Materials and Methods

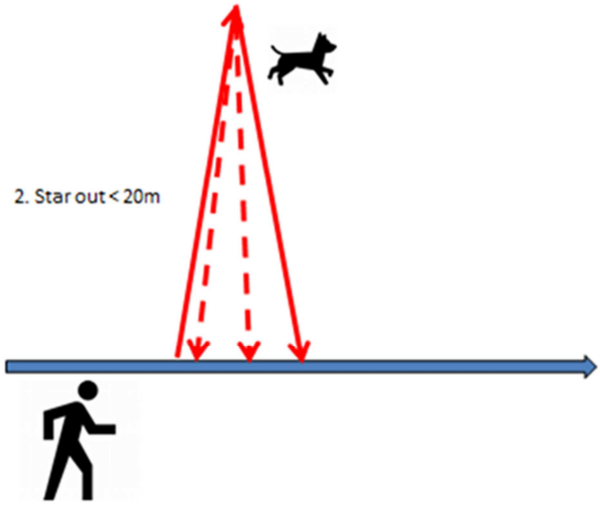
GPS data were collected on trials (n = 3145) of off-leash, free ranging, freely exploring domestic pet dogs (n=30) of different breeds, size, sex and age (Table 1) while walking with their owners on four consecutive walks in two familiar and two unfamiliar areas in North Rhine Westphalia, Germany (n=120).

Table 1. *All dogs, pure breed or mixed breed, sex (m/f) and size large, medium or small (shoulder height).*

Pure breeds n=20	>60cm	<60cm	<40cm
Size	Large	Medium	Small
Sighthounds n=9	Borzois n=3 (# 26m,28f,30f)	Whippets n=3 (# 11m,24f,13f) Silken Windsprite n=1 (# 8m)	Italian Greyhound n=2 (# 19f,25m)
Herding dogs n=2	Collies n=2 (# 1f,29f)		
Hunting/Sporting dogs n=4	Standard Poodle n=1 (# 3m)	Labrador Retriever n=2 (# 2f,22f)	Miniature Pinscher n=1 (# 14f)
Toy breed n=2			Pugs n=2 (# 10f,21f)
Working group n=3	Rhodesian Ridgeback n=2 (#6m,17f)	Perro de Aqua Espanol n=1 (# 18f)	
Mixed breeds n=10	>60cm	<60cm	<40cm
	Great Dane Mix (#4m)	Husky Shepard Mix (# 5m)	Terrier/Chinese Crested Mix (# 27f)
	Mastiff Mix (# 12m)	Labrador Mix (# 7m)	
	Greyhound Mix (# 23f)	Perro de Aqua Espanol Mix (# 9)	
		Pastor Mallorcin Mix (# 15f)	
		Collie-Shepherd Mix (# 16m)	
		Labrador Mix (# 20m)	

Compared were the total walk data and additionally any travel beyond a minimum distance of 20m away from the owner. Latter was recorded as a run, and seven different travelling patterns were distinguished for each run (each travel >20 m). 1. Dog runs ahead and waits/follows; 2. star; 3. loop; 4. loop+star; 5. Mix forms: runs ahead & loop; 6. Mix forms: runs ahead & star; 7. Runs parallel then meets owner, see Figure 1 for pictogram.





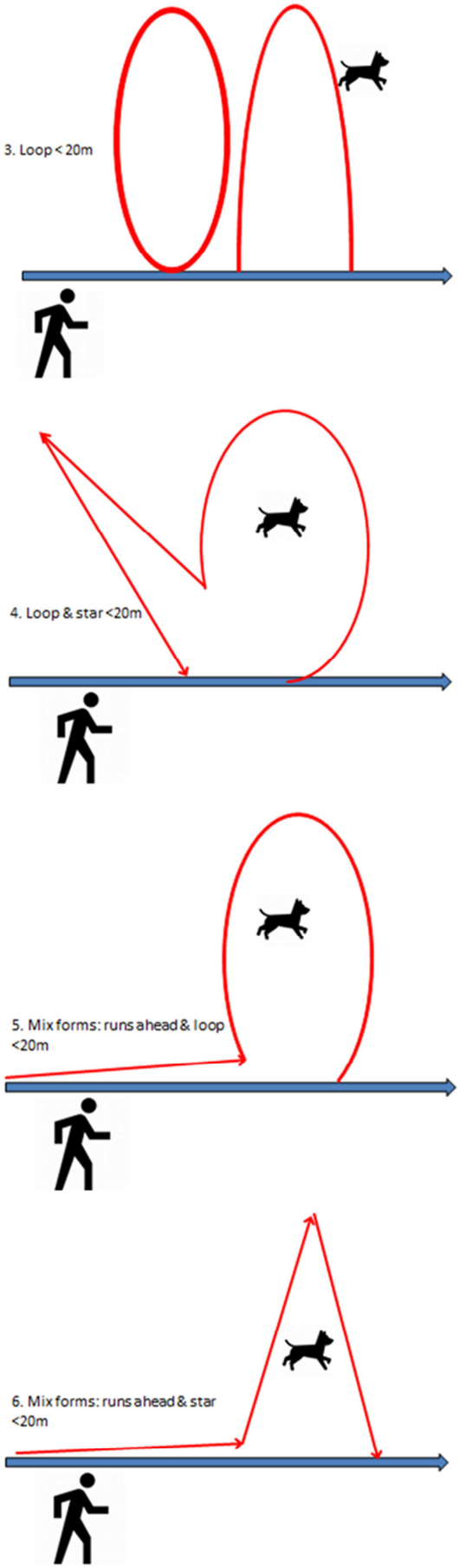


Figure 1. *Pictogram illustrating the seven different travelling patterns.*

Lengths of the walks depended on age and physical ability of the dog, the average length was mean 89 min. +/- 24 min per walk; Median 81 min with a lower quartile of 73 min., and an upper quartile of 97 minutes per walk.

Eighteen owners participated, fifteen female (83%) and three male (17%). Eighty-three percent of the owners had more than one dog. Out of the 30 dogs eight belonged to a single dog household owner, 22 to a two or more dog owner – in this group ten owners accounted for 22 dogs. The median age of the dogs was 63.5 months, with a range from 9 month to 142 month. Forty percent of the dogs were male (n=12), of which 75% were neutered and 60% were female (n=18), of which 72% were spayed. Thirty-three percent (n=10) of the dogs were mixed breeds (the breed description of the owner was used) and 67% (n=20) of the dogs were pure breeds as defined by FCI (Fédération Cynologique Internationale) with breed certificates, see Table 1. All dogs must have lived with their owner at least six month prior to participation and no dogs used for professional hunting purposes could partake. Teams were acquired through the utilization of internet and social media. As we had to meet in person all participants lived in Germany.

The GPS used were a Garmin Astro® 320 and the dog collars DC™ 50, and T5 Mini, Garmin International Inc., Kansas, USA. Data were then analyzed using the software Garmin BaseCamp™ 4.5.2.1. The dogs were monitored through a GPS collar (Garmin T5 and DC™ 50) and the owner carried a hand held GPS device (Garmin Astro® 320) to determine the distance between dog and owner. The margin of error for the Astro® 320 is within +/- 3.65 m. Dog collar details: The DC™ 50 weighs 289g (sender; antennae and collar); the size is (B x H x T): 9 x 4.9 x 4.6 cm; distance of recording is up to 14.5km. The T5 weights 198g (sender; antennae and collar); size (B x H x T): 8.9 x 4.4 x 4.7 cm; distance of recording up to 12km. The Video camera used was a Garmin VIRB® Elite. Size: (H x B x T): 32 mm x 53 mm x 111 mm; weight 170g. Datatype: MP4; 1080p-HD-Video: 1920 × 1080; 30 fps. Video data were also displayed on Garmin BaseCamp™4.5.2.1. The camera, however, was only used on the larger dogs as it was too heavy and difficult to attach to the small dogs. Main interest here was to establish whether dogs were hunting prey. Wind speed and direction was measured with an anemometer (Technoline EA-3000) and a handheld compass. Ambient temperature was also recorded therewith. Fifty-one factors of interest (Table 2) were recorded for each trial.

Table 2. *51 parameters data collected for each run.*

Dogs	Name	Breed	Sex	Age	No. of trials/ runs <20m	Health	Did dog get lost	Animal sighting
Time	Day/month/year	Total time owner walk Total time dog walk Time moving/ Pausing time owner Time moving/ Pausing time dog	Starting time Owner walk/ dog walk/each run End of walk owner/ dog walk/each run	Time at owner	Time point of return	Time out-bound	Time inbound	Time difference inbound/ outbound
Distance	Total distance owner walk	Total distance dog walk Total distance of each run < 20m	Distance entire round	Distance out-bound	Distance inbound	Distance between point of return and start	Distance between point of return and owner meet	Distance difference
Environment	Latitude/ longitude	New/Known area	Animal sighting tracks	Wind	Location	Temperature	Weather	
Direction	Travelling patterns dog	Direct/shortest way to owner	Same or new route on return Traceback own route	Azimuth point of return–start	Azimuth Point of return	Azimuth Starting point	Azimuth anticipation Azimuth Point of alignment	
Speed	Owner average speed overall and each run	Dog average speed overall and each run	Mean speed total walk/each run	Dog Maximum/ minimum speed total/ each run	Mean Speed travelling out	Mean Speed return route	Speed differences inbound/ outbound	Step frequency dog

Trials were performed in wooded areas, preferably with dense underbrush to prevent visual contact. If two dogs from one owner participated data from both dogs were used individually as each dog collected data on its respective collar. Solely uninhabited areas, without roads or major pathways, were visited. The owner was not to whistle or call or offer any other kind of acoustic or visual signal.

Descriptive analysis was performed calculating number of valid measurements (n), mean (m), median, quartiles and standard deviation (SD). Relationships were plotted using scatterplots, bar charts, boxplots or mean +/- 95% confidence interval. Nonparametric tests were used for inductive statistics. Mann-Whitney U Test was used to compare two independent samples, Wilcoxon test for dependent samples of ordinal data. Also randomization (or permutation) tests were applied for comparison of dependent or independent groups of interval scaled data. All tests were performed two-tailed on a 5% level of significance. Standard Bonferroni correction of p-values < 0.05 was applied in case of multiple testing. Two-tailed tests were performed unless otherwise denoted. SPSS version 25, IBM Inc. was used for analyzing the data. StatKey (http://www.lock5stat.com/) was used for performing randomization tests using a simulated sample of size n= 5000.

3. Ethical Approval

The study was observational and the dogs were neither physically nor psychologically harmed in the course of the study. The dogs did not undergo any physical intervention (e.g. blood or saliva sampling). The owners were informed of the steps of their participation, affirmed that they were voluntarily participating in the study, and knew that they could stop at any time. Owners did not know the working hypothesis of the study.

4. Results

In this study all dogs that participated, independent of sex, age, size, reproductive status or breed, found and returned to their owner in familiar as well as unfamiliar environments consequent to having moved at least 20 m away from their owner without being called. The majority of dogs remained within a 150 m radius of their owner at all times. One third (Group 3) explored at least once beyond 350 m. Group 3 dogs were the ones with the highest return speed and a direct return route, indicating awareness of owner location. None of the video monitored dogs (including Group 3) pursued prey whilst exploring. All dogs, independent of age, breed or size, walked significantly further Table 3 and faster compared to their owner Table 4.

Table 3. *Comparison total distance of owner walk and total distance dog walks as well as difference in walking distance dog and owner in meter.*

	n	mean	median	Q25	Q75	SD	p-value (Wilcoxon Test)
total distance owner walk in m	120	5894	5300	4900	6200	1827	
total distance dog walk in m	120	7488	6700	5850	8700	2202	
Difference_walking_distance in m (dog-owner dyad)	120	1596	1000	400	2300	1600	<0.001

Length of trials (runs >20 m) varied greatly, therefore three groups were established to determine travelling patterns in more detail and describe difference between the dogs more specifically: The majority of dogs travelled a maximum

distance of 150 m away from the owner (13 of 30 dogs =43% Group 1); eight (27%) of the dogs displayed a range away from the owner between >150 m and <350 m (Group 2); nine of the 30 dogs (30%) had at least one run >350 m away from the owner (Group 3). The maximum distance travelled by one dog was 2100m. Between the three groups differences between familiar and unfamiliar area maximum travelling distance could be observed Figure 2.

Table 4. *Median walking speed of the owner and the respective dog(s) of one owner; difference in km/h; Group of each dog (1, 2 or 3) and over all speed difference.*

Dog n=30	Group 1 <150m range; Group 2 >150 - <350m range; Group 3 >350m	Owner	owner average walking speed in km/h			dog average walking speed in km/h			Speed difference owner – dog in km/h		
			median	Q25	Q75	median	Q25	Q75	median	Q25	Q75
Amanda	1	H.M.	4.3	4.3	4.3	5.1	5.0	5.3	-0.6	-0.7	-0.4
Wantje	1	H.M.	4.3	4.3	4.3	4.8	4.8.0	5.0	-0.5	-0.7	-0.5
Amy	2	S.S.	4.5	4.3	4.6	6.2	6.1	6.4	-1.5	-1.9	-1.4
Nele	1	S.S:	4.5	4.3	4.6	5.6	5.5	5.7	-1.1	-1.4	-0.9
Arthur	2	V.B.	4.6	4.5	4.7	6.2	6.1	6.4	-1.6	-1.8	-1.5
Balin	1	H.N.	4.3	4.1	4.5	4.9	4.5	4.9	-0.5	-0.6	-0.5
Balou_Mix	3	C.B	4.2	3.8	4.4	7.8	7.6	76.8	-3.4	-4.6	-2.8
Lili	1	C.B.	4.2	3.8	4.4	4.1	3.8	4.3	-0.9	-1.2	-0.8
Balou_RR	1	C.C.	4.3	4.2	4.3	5.3	5.1	5.4	-1.0	-1.2	-0.8
Luna	2	C.C	4.3	4.2	4.3	5.7	5.5	6.1	-1.5	-1.8	-1.1
Bill	3	S.L.	4.2	4.0	4.4	7.6	7.3	8.3	-3.4	-4.3	-2.9
Kaito	3	S.L.	4.2	4.0	4.4	4	3.9	4.2	-2.1	-2.6	-1.6
Lou	3	S.L.	4.2	4.0	4.4	4.0	3.9	4.1	-2.3	-2.6	-1.9
Dr. Pepper	1	S.M.	4.3	4.2	4.4	5	4.9	5.2	-0.7	-1.0	-0.5
Raiya	3	S.M.	4.3	4.2	4.4	4	4	4	-3.5	-4.2	-2.7
Emma	1	A.S.	4.6	4.3	5	5	5	5.3	-0.6	-0.7	-0.4
Zlata	2	A.S.	4.6	4.3	5	5.2	5.1	5.7	-0.6	-1.2	-0.4
Mala	1	A.S.	4.6	4.3	5	5	4.8	5.1	-0.2	-0.3	0.0
Freya	1	N.P.	5.0	4.4	5.1	5.7	5.6	6.1	-0.7	-1.0	-0.6
Honey	3	D.S.	4.1	3.7	4.8	6.8	6.4	7.4	-2.8	-3.7	-1.6
Kimi	2	M.K.	4.2	3.9	4.7	6.2	5.4	6.8	-1.8	-2.9	-0.7
Nina	2	M.K.	4.2	3.9	4.7	6.3	5.5	6.9	-1.9	-3.1	-0.8
Lea/Emma	2	E.M.	4.8	4.5	4.9	6	5.6	6.3	-1.4	-1.9	-0.7
Manja	1	A.U.	5	4.4	5.1	5.5	5.1	68	-0.8	-1.2	-0.5
Raffaele	3	A.U.	5	4.4	5.1	6.4	5.6	7.4	-1.5	-2.9	-0.9
Marley	3	G.B.	4.7	4.5	5.1	9.7	9	9.8	-4.8	-5.3	-3.9
Tamina	3	G.B.	4.7	4.5	5.1	8.3	7.6	8.3	-3.4	-3.9	-2.5
Molly	1	N.B.	4.9	4.6	5.2	5.5	5.2	6	-0.8	-0.9	-0.6
Odin	1	A.W.	4.4	4.1	4.4	4.6	4.4	4.8	-0.4	-0.4	-0.2
Thorin	2	A.A.	5.1	4.9	5.2	5.8	5.6	6.2	-0.9	-1.0	-0.7
Total			4.4	4.2	4.7	5.7	5.2	6.6	-1.1	-2.3	-0.7

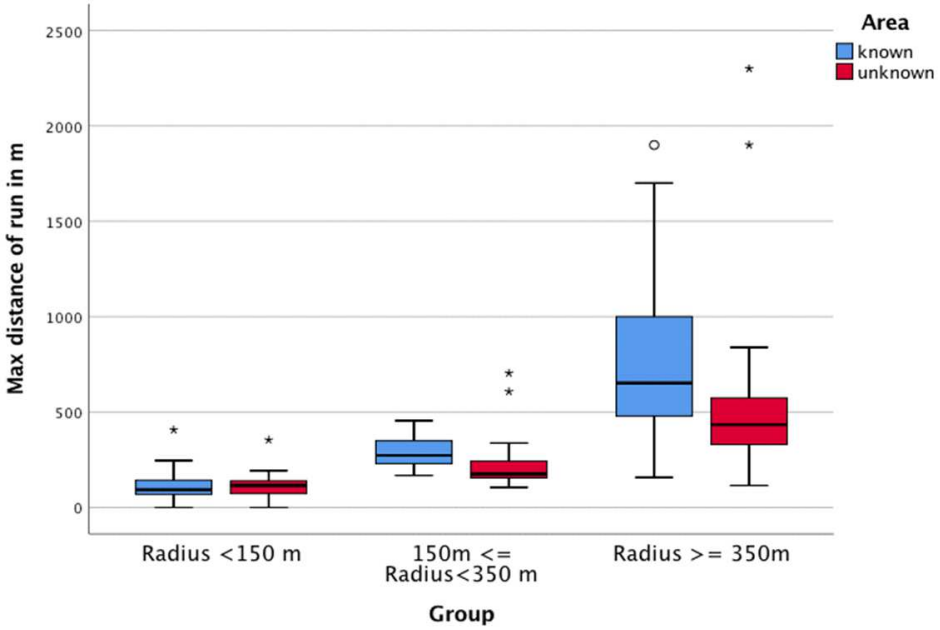


Figure 2. *Maximum distance in meter of all runs >20 m, for Group 1, 2 and 3 in known (blue) versus unknown (red) area.*

In Group 1 (radius <150 m) the median of the maximum distance was 92,5 m in known and 115 m in unknown areas, respectively. In Group 2 greater differences in maximum median distance covered became apparent: 50% of the walks of dogs in this group had a maximum distance of 272 m in known and 175 m in unknown areas. Most pronounced was the difference in Group 3 (radius >350 m): here the maximum median distance in known areas was 652 m compared to 434 m in unknown areas. The 75% quartile in this group is reduced from 1000 m in known to 574 m in unknown areas. The difference was not significant however.

Looking at the total walking distance between owner and dog data established that 50% of the dogs displayed a median difference in total walking distance to their owner of 1000 m, with a lower quartile of 400 m and an upper quartile of 2300 m difference between owners and dog distance walked This corresponds to a forty-three percent increase. The distance difference traversed was significantly larger for dogs compared to owners ($p<0.001$). Dogs of all three groups covered larger distances than their owners, Table 3.

Results also indicated significant speed difference between the dogs and owners and dogs ($p<0.001$; Wilcoxon Test).

The mean speed of owners was 4.4 +/- 0.4 km/h compared to 6.0 +/- 1.2 km/h of the dogs. Results were independent of the group (1, 2 or 3) the dogs belonged to or factors like age (Spearman correlation coefficient, r =-0.256; p=0.01), size (Table 4) or exploration patterns. Overall 50% of the owners displayed a walking speed of less than 4.4 km/h. 50% of the dogs displayed a walking speed of less than 5.7 km/h. The higher quartile of owner walking speed was 4.7 km/h; compared to the dogs travelling speed of 6.6 km/h. Speed differences could also be established between the three groups, with Group 3, the dogs with the largest radius, displaying the highest speed differences compared to their owners, Figure 3.

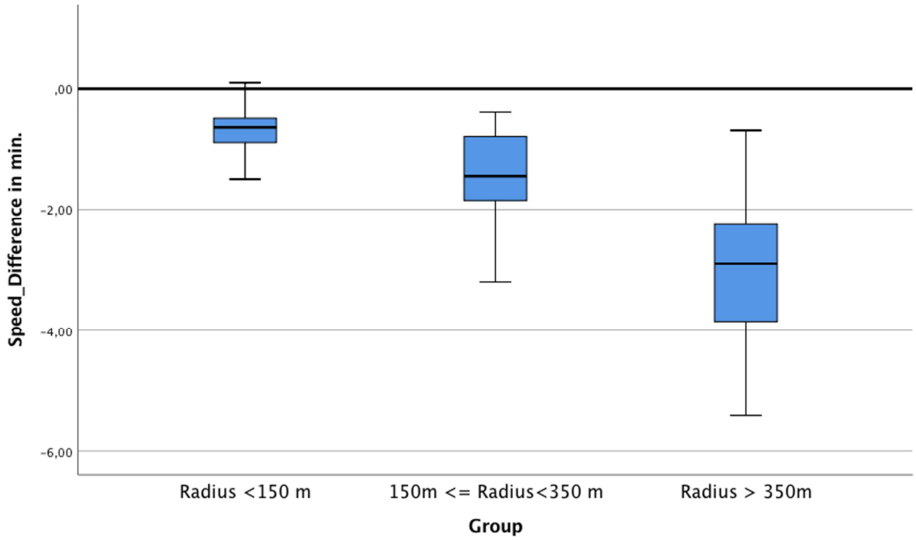


Figure 3. *Speed difference owner-dog dyad, Group 1, 2 and 3 in minutes.*

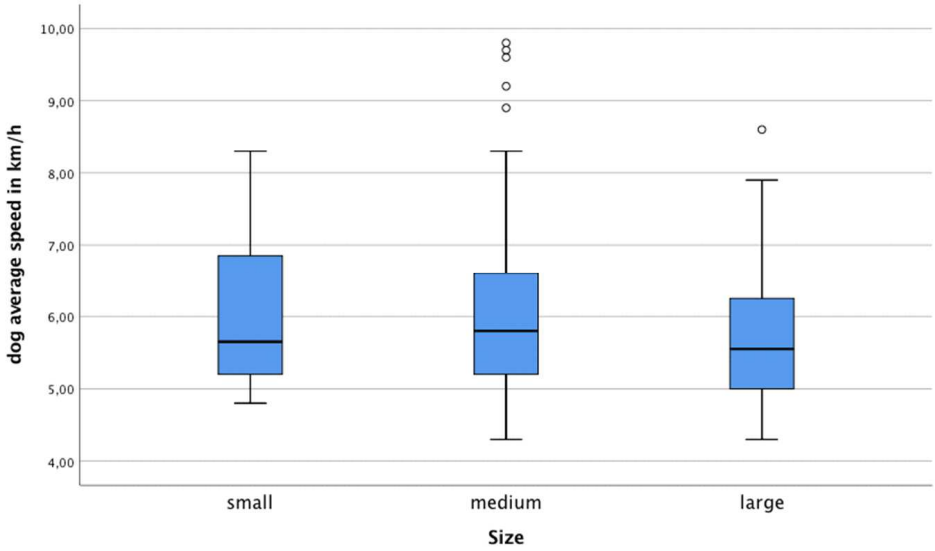


Figure 4. *Speed of dogs in relation to size of dogs in km/h.*

To analyze whether the size of the dog had an effect on the speed traversed the data were evaluated accordingly. The dogs were separated in three groups: Dogs >60 cm shoulder heights (large n=11); dogs <60 cm >40 cm shoulder heights (medium n=13) and dogs < 40 cm shoulder heights (small n=6). Between small size dogs (<40 cm), medium size (between 40 cm and 60 cm) and large dogs (>60 cm) no differences in average dog speed could be observed (p=0.449, Kruskal-Wallis Test), see Figure 4.

Great variation could be observed between the 30 dogs. The overall speed during the walks in addition to their speed and exploration patterns differed intraspecifically (Figure 5). Some dogs exhibited generally a low average speed during all walks independent of breed or size (e.g. Balin, Great Dane Mix: mean 4.8km/h / -0.3km/h). Some dogs travelled over all at very high speed, for instance Marley (Labrador Mix, mean 9.4km/h / -0.7km/h, max speed 50 km/h) and one group of dogs displayed a high speed variance, thus these dogs alternated between very fast as well as moderate or slower runs: e.g. Bill, Labrador Mix: mean 7.8km/h/ - 0.8km/h max speed 42 km/h. see Table 3, Figure 5.

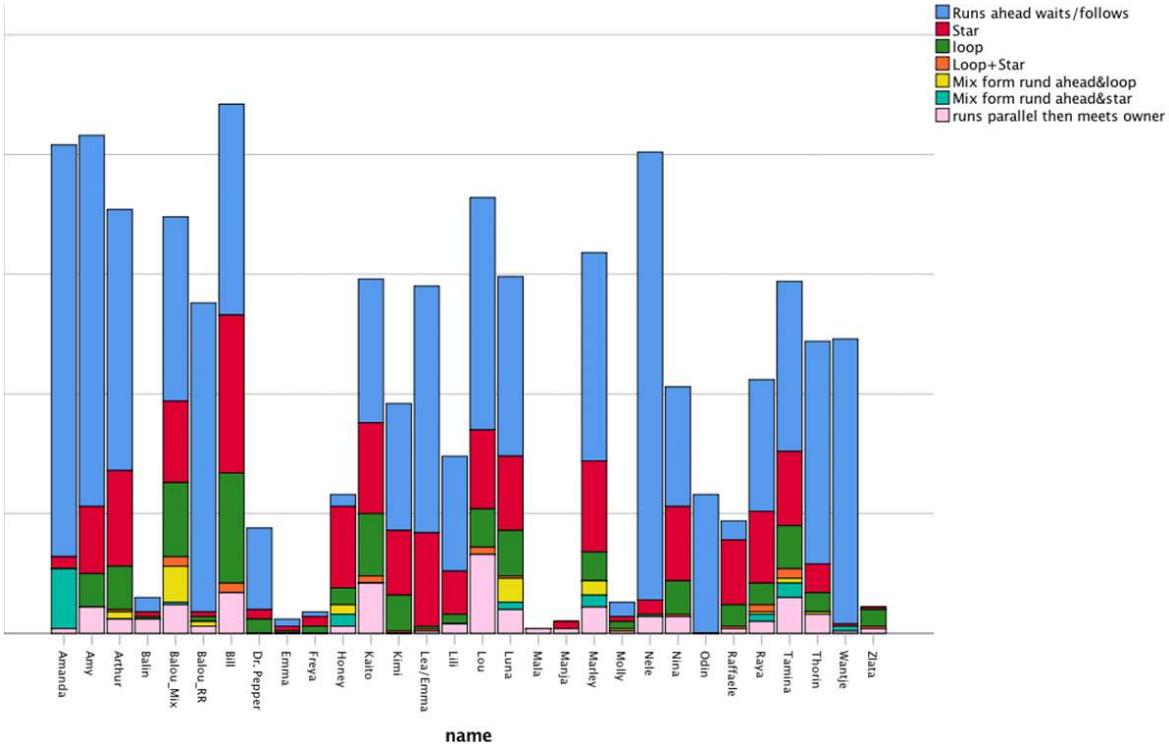


Figure 5. *Absolute number of runs >20 m subdivided by the seven patterns of the runs, as displayed by each dog.*

Between the duration of the travelling rounds significant linear correlations were observable between dogs of one owner. High values of one dog were correlated with high values of the other dog(s) Figure 6. In every team a leader or initiating dog with a more extensive time range could be observed.

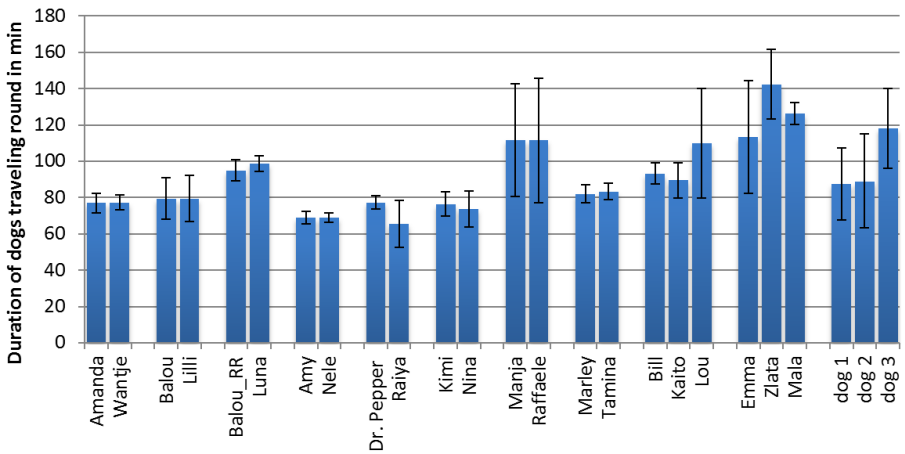


Figure 6. *Duration of dogs over all travelling round between and within dos belonging to one owner, in min.*

5. Limitations

Prior to the discussion of the results, some limitations of this study should be considered. More women than men owner participated which may have had an impact on the dog-owner relationship and the results. Only owners participated which normally also walked their dogs in comparable areas off leash and all dogs could have been called back, as they had been trained. Only German teams participated and in other countries results may have been different based on divergent walking behaviors. Therefore future studies in other countries would be useful for validating the key findings.

The sample size was relatively low in this study, partly caused by the very time-consuming walks. In any case, a more comprehensive study would be beneficial (preferably involving more participants from non-European countries), especially including even more dog breeds based both on the artificial (FCI) and genetic clustering. Finally, the scope of this study was limited by the way in which the teams were acquired—the utilization of internet and social media has its benefits; however, potential participants could also be left out because they do not use these means of communication.

6. Discussion

The walking behavior of dog owners varies depending on factors like country, culture and the occasions existing to walk with their dog [for a review see, 4]. The days of free roaming dogs that may wander around unrestrained during the day (or night) are long gone in most industrialized countries including Germany. Even though no specific statistics are currently available, people habitually assume that (their) dog(s) will chase wildlife when out of sight and thus many dog owners keep their pet on a leash, not only in urban environments but also in rural or wooded areas. The video footage of the participating dogs herein found no incident of chasing wildlife. On the contrary, most of the dogs travelled consistently on human made path or used at most wildlife tracks. This may be due to faster and easier roaming modes or learned ambulatory behavior whilst with their owner. Studies show that dogs could hardly survive by hunting live prey, and that there is no evidence of dog populations being self-sustaining through hunting [22]. The primary form of dog foraging worldwide is scavenging, and the majority of dogs feed on food scraps discarded by humans [22]. In general dogs are not successful hunters, and very few exceptions survive and maintain their population through hunting [22]. The niche of scavengers does not require the complex skills that hunting live prey does and most studies agree that pet dogs no longer possess survival traits like successful hunting skills [22, 23]. In this study all dogs returned on all walks, no matter the number and distance of their runs, to their owner, even when not called or signaled to and most of them remained within a 150 m radius of their owner, exhibiting exploration pattern one: they ran back and forth on the owner path (62%) Figure 2. All dogs covered longer distances and travelled at higher speed on the respective walks compared to their owners Table 3, Table 4. In this study great intraspecific speed differences and walking idiosyncrasies could be observed including roaming variances in that a number of dogs were always fast (or slow) and some dogs displayed great speed variation on their exploratory runs (slow, moderate and fast) Table 4, Figure 5. In concurrence, Ladha et al., (2017) presented that dogs moved significantly further during off-leash than on-leash walks (32% greater distance) demonstrating an extensive range of step frequencies and great variance in the number of steps taken [24].

These results may raise welfare concerns as on leash walking may compromise the opportunity for dogs to elect their own pace and select their own points of interest to explore as owner walking speed is over all lower (Table 3) and the range of exploration is limited to the length of the leash. This is furthermore indicated by the fact that dogs take significantly longer to walk the identical route off leash than on leash [25]. Providing a dog with daily off leash exercise may be a precaution so the dog is less susceptible to psychological conditions such as depression [26]. In addition it assists in maintaining the dog at a healthy weight. Feddersen-Petersen (1997) proposed two hours off leash walking time per day for a healthy medium size adult dog [27]. Particularly in the urban environments, the opportunities of running free are frequently restricted to park areas with a high risk of parasite transmittance [16] and few cognitive challenges, as these areas are often overcrowded small, fenced in, barren spaces without trees or other mental and/or emotional stimulation [28]. Environmental enrichment and sensory stimulations however promote the cognitive development of dogs [29] and encourage exercise. To explore novel environments is essential for animals in order to collect information about features of their surroundings [30] and it assists them to collect different input [31] either through individual assessment [32] or by intra- or interspecific observational learning. The exploration behavior of dogs is clearly influenced by their prior learning and experience [33] and being always on a leash may inhibit their learning and development due to more restrictive walking patterns and limited exposure to information [5, 25]. One possibility to explore is through olfactory information which could also be seen on the video coverage. Studies show that more sniffing behaviors are performed whilst off the leash, suggesting that stimuli that promote sniffing are less accessible when on a leash [1, 25]. Westgarth et al., (2010) found the median duration dogs spent sniffing whilst off leash was 16% compared to 4% while on a leash [25]. Duranton & Horowitz (2019) postulated that permitting dogs to spend more exploration time by means of olfaction through nose work activity makes them more optimistic [1]. Presenting dogs with additional opportunities to explore off leash, in their individual time and pace to express for instance their natural olfactory foraging behavior improves

their emotional state and benefits cognitive processes such as attention, memory and positive judgement of a perceived situation [1]. Exploration requires dogs to problem solve, to analyze their environment and to make choices accordingly. [34] proposed that an owner who assists the dog's attempts to self-reliantly and independently deal with problems increases self-assurance in their dogs. It also enhances the social owner - dog interaction [25]. Owner wellbeing is also been promoted through regular dog walks [35, 36]. Rehn et al., (2017) postulated that on-leash usage significantly impacts the attention dogs' pay to their owners [37]. Dogs off the leash looked at their owners more frequently and with longer gazes compared to dogs that were kept on a leash. All studied parameters: gaze length; gaze frequency; and looking time of dogs' attention were found to be significantly higher for off-leash than on leash dogs. The capability to have choices and to be autonomous is essential in welfare [9] and may be offered to dogs through increased off leash activity in safe environments.

7. Conclusion

Distance traversed and walking speed differs significantly between owner and dog whilst out walking. Not only founded on physiological and biomechanical factors, but also strongly influenced by the dogs individual explorative behavior. However, even though the distance traversed was significantly greater, most pet dogs remained within a 150m radius of their owner at all times and essentially ran back and forth on the travelled path. These factors support the argument to allow dogs off leash in more areas. Results herein might be valuable to establish suitable areas where off leash dog walking is permitted. Furthermore the data may assist dog-trainers to acquire supplementary information about exploratory behaviour of pet dogs and strengthen dog-owner interaction. It may also benefit in designing walking areas, as dog walking is a popular method for increasing human physical activity and health. In order to engage in a high quality activity for both participants off-leash walks in safe areas with enrichment and cognitive challenging surroundings for the dogs are recommended.

While it may be inevitable in various circumstances and settings for dogs to be on a leash for their own safety and while we may subject them to this restriction, it is important to keep in mind the numerous detrimental effects on their physiological and psychological welfare. Owners should be cognizant of the immense danger of tension forces exerted by pulling the dog through the leash by the collar and also of the benefits associated with off leash walks by allowing the dogs to explore the world at their own pace.

Compliance with Ethical Standards

Non-invasive observational studies on dogs are allowed to be done without any special permission in Germany German according to the Animal Welfare Act 2013.

Conflict of Interest

The authors declare there are no conflicting interests.

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