



Can environmental temperature influence shelter dogs' behavior? A pilot study

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Abstract: Many dogs world-wide spend a large part of their lives in rescue shelters, and many studies have investigated their behavior, with the primary aim of improving their quality of life. There are many factors which can affect or influence, the results of these studies. Some of these may be controlled by human intervention such as: environmental enrichment, feeding procedures, and shelter management. Others are independent from human influence such as environmental temperature, humidity, or meteorological phenomena. Therefore, in the present pilot study, we investigated whether ambient temperature and relative humidity could affect the behavior of shelter dogs. Twenty-one dogs housed in a North Italian rescue shelter were observed using an instantaneous focal animal rule every 15 seconds for 15 minutes, repeated on four days at intervals of at least 5 days. Official data regarding temperature and humidity were obtained from the Veneto Regional Agency for Environmental Prevention and Protection. Generalised Estimated Equations were run for inactivity, locomotion, vocalisation, exploration, maintenance behaviors, and resting. The dogs' gender, (estimated) age, duration at the shelter, temperature, and relative humidity were included in the model as possible predictive factors. Male dogs were recorded as vocalising more often than female dogs ($p=0.011$). Dogs who had been longer than 5 years in the shelter were recorded exploring more often than dogs who had been in the shelter less than 5 years ($p=0.004$), and dogs were recorded exploring less often in higher environmental temperatures ($p=0.004$). No other significant effects were found. Given the importance of exploratory behavior in monitoring the effects of environmental enrichment programs, the results of the present study suggest the importance of controlling for environmental temperature when studying environmental exploration in shelter dogs.

Key Words: age, exploratory behavior, permanence in shelter, gender, temperature.

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Introduction

Many dogs world-wide spend a large part of their lives in rescue shelters and a sizeable number of studies have evaluated the effect of various strategies on the behavior of dogs in shelters with the aim of improving the well-being of the dogs (Propopova & Gunter, 2017). Increasing the expression of perceived positive behaviors, (such as not barking, approaching the front of the cage, appearing friendly) may increase the likelihood that a dog might be adopted and this has often been an additional aim of these studies (Herron et al., 2014; Bright & Hadden, 2016; Propopova & Gunter, 2017). Many studies propose enrichment programs to facilitate achieving these goals (for a review see Gunter & Feuerbacher, 2022). As for any enrichment program (Newberry, 1995; Mellen & McPhee, 2001), including those for shelter dogs, it is important that the effects of the putative enrichments are monitored in order to verify that what is offered is indeed enriching (Gunter & Feuerbacher, 2022). Although alternative measures have been used (e.g., Uccheddu et al., 2018), the most widespread approach to monitoring such effects is to observe the behavior of the animals in their usual environment, comparing periods without enrichment to others in which the enrichment is offered (e.g., Propopova & Gunter, 2017; Gunter & Feuerbacher, 2022). However, many factors can influence the behavior of dogs, and animals in general, in their en-

closure, the most obvious being climatic variables. Therefore, the aim of the present pilot study was to investigate whether some variables including ambient temperature and relative humidity could affect the behavior of shelter dogs in their usual environment.

Animals, Materials and Methods

Ethical Statement

This study is exempt from ethical committee assessment under Italian Law because no changes were made in the husbandry of the animals enrolled. Researchers limited their activity to the observation of animals in the shelter context.

Animals

Dogs enrolled in this study were neutered shelter dogs that entered the shelter at least 6 months before the observations. A clinical and behavioral examination was completed by a veterinarian before the selection for each animal; only healthy animals, with an acceptable Body Condition Score, and not showing overt signs of out of context aggression were enrolled. Twenty-one animals satisfied inclusion criteria.

Housing and Husbandry

Dogs enrolled in this study were housed in a North Italian rescue shelter with a capacity of 120 dogs. Dog enclosures included an outdoor area (150 m²) and an indoor area (a 16 m² room with 8 wooden dog houses). The outdoor area surface was mainly grass with a 24 m² concrete surface where another three wooden dog houses were located. The concrete area was covered by a roof, was without walls and was adjacent to the grassed area. The indoor area was beside the roofed outdoor part and both were nearer the access aisle (i.e., the front) than the grassed outdoor part. Enclosures were cleaned daily, in the morning after the dogs were fed. Water was present *ad libitum*, and dogs were fed once a day in the morning.

Study Design

Each dog enrolled in the study was observed using an instantaneous focal animal rule every 15 seconds for 15 minutes repeated on 4 separate days, at least 5 days apart at the same time in the afternoon (16.00hrs) from April to October. The recorded behavioral categories are listed in Table 1.

The same observer carried out all the observations. They took place when the shelter was closed to the public, and when there were no management procedures taking place (cleaning, animal feeding etc.). The observer sat quietly in the aisle between enclosures for at least ten minutes before data collection. Data gathering proceeded only when the dogs were calm and did not exhibit barking or looking at the observer.

The dogs were thus observed during their routine behavior in the shelter, without change in their management and housing due to the study.

Official data regarding temperature and humidity for each trial date were obtained from the Veneto Regional Agency for Environmental Prevention and Protection (Agenzia Regionale per la Prevenzione e Protezione Ambientale del Veneto - ARPAV), and the mean values for that day were used.

Table 1. working ethogram used.

| Behavior | Description |
|---------------|--|
| Exploration | The dog is gathering information from the environment, or at least appears to do so, mainly using vision (the dog looks intently at the object/structure/floor) or olfaction (the dog approaches the object/structure/floor with his/her nose and inhales and exhales rapidly and repeatedly). |
| Inactivity | The situation in which a dog does not appear to move (apart from breathing) and does not obviously stare or sniff at something |
| Locomotion | The dog moves through space by means of a rhythmic activity of his/her four legs, remaining on the same horizontal plane. |
| Lying | The dog is in latero-lateral or latero-sternal recumbence, independently from the position of the head and the activity performed (i.e., the dog is not standing or sitting) |
| Maintenance | The dog is eating, drinking, defecating, urinating or self-grooming |
| Vocalizations | The dog emits a sound/sounds using his/her upper respiratory tract in what appears to be an intentional way |
| Other | Any other behavior |
| Out of sight | The dog is not visible, or not visible enough to assess his/her behavior |

Statistical methods

A Generalised Estimated Equation (GEE; Poisson distribution) was run for each behavior listed in table 2 with gender of the dog (two levels: male vs female), (estimated) age of the dog (in years), permanence at the shelter (two levels: <5 years vs >5 years), environmental temperature (degrees °C), and relative humidity (percentage), as possible predictive factors. The target variable was the number of sample points in which the dog had shown that behavior during each 15 minute observations (i.e., 60 sample points per observation).

Results and discussion

The features of our dog sample are described in Table 2. We collected the data of twenty-one dogs (9 female, 12 male) aged 5-17 years (mean age 9.1 ± 3.6 years). Seven of these had been in the shelter for more than 5 years. During observation days, temperatures varied between 7.6°C and 25.2°C, and relative humidity from 63% to 98%.

Table 2. dogs involved in the study and their characteristics.

| Dog | (Italian) name | sex | age (years) | Duration of stay (days) |
|-----|----------------|-----|-------------|-------------------------|
| 1 | Anna | f | 5 | 492 |
| 2 | Cannella | m | 6 | 720 |
| 3 | Chow | m | 8 | 461 |
| 4 | Elicottero | m | 7 | 2050 |
| 5 | Hayla | f | 11 | 2294 |
| 6 | Husky vecchio | m | 12 | 1663 |
| 7 | Labrador nero | m | 8 | 671 |
| 8 | Malinois | f | 15 | 1829 |
| 9 | Mortadellone | m | 9 | 1412 |

| | | | | |
|----|--------------------------|---|----|------|
| 10 | Nera focata zampe focate | f | 6 | 2345 |
| 11 | Nerina | f | 10 | 597 |
| 12 | Whisky PT | m | 2 | 436 |
| 13 | Schnautzer | f | 12 | 2163 |
| 14 | Spina coda topo | f | 12 | 2345 |
| 15 | Spina faccia bionda | f | 10 | 793 |
| 16 | Spina grigia | f | 12 | 793 |
| 17 | Spino cinghiale | m | 11 | 467 |
| 18 | Spino magrino | m | 6 | 884 |
| 19 | Spinotto nero | m | 5 | 589 |
| 20 | Tigratino | m | 7 | 1828 |
| 21 | Volpino bianco e nero | m | 17 | 671 |

Dogs were recorded as inactive in 69.2% of the sample points (64.3% lying down). Locomotion was shown only in 9.8% of the sample points and exploratory behaviors were recorded in 5.3%. Maintenance behaviors were shown in 4.4%, with differences among dogs and within the different observations of the same dog. Vocalising was recorded only in 2.3% of the sample points.

Shelter dogs being mostly inactive agrees with what is described in other studies conducted in Italian shelters (Dalla Villa et al., 2013; Normando et al., 2014), where dogs spent most of their time in an inactive state. Dalla Villa et al. (2013) found shelter dogs were inactive for 90% of their time, even when housed in groups. These data were confirmed by Normando et al. (2014), who pointed out that shelter dogs spent 55% of the total scans resting. This inactive state, “awake but motionless” (Harvey et al., 2019), was described by other authors (Raudies et al., 2021) and it has been linked to compromised welfare by (Harvey et al., 2019; 2020), although in their study, it represented only 2.8% of scans recorded in the studied shelter dogs. Conversely, resting/sleeping behavior during daylight (similarly recorded in 2.8% of scans) has been linked to enhanced welfare in shelter dogs in Owczarczak-Garstecka & Burman (2016) using a similar paradigm to that used by (Harvey et al., 2019; 2020), suggesting the importance of careful definition of the variables to be investigated at least when “inactive” behaviors were investigated. In the current study, however, given the large size of the enclosures, in many instances (for example when the dogs' eyes could not be seen), we could not discriminate with certainty, whether the dog was asleep or just lying down motionless, so both had to be grouped into the “inactive” category.

The results of the inferential statistical analyses are shown in table 3. Dogs who had been more than 5 years in the shelter were recorded exploring more often than dogs who had been in the shelter less than 5 years ($p=0.004$). This finding disagrees with Wells et al., (2002) who found a decrease in activity levels over time, such as dogs that were housed for more than five years in the shelter spent more time at the back of their kennels and spent more time resting. Conversely, in our study, this category of dogs were more explorative. On a much shorter time scale, Cozzi et al., (2016) also noted a reduction of inactivity in dogs with increased time spent in the shelter. The only difference which we found between dogs housed in the shelter for less than five years and those housed for a longer time was in exploratory behavior. Wells et al., (2002) however noticed an influence of length of shelter stay also on barking, finding that dogs housed in the shelter for a shorter time spent less time barking.

Table 3. results of the GEE analyses. *stands for <0.05, ** for <0.01; *** for <0.001.

| Behavior | Sex (df=1) | Duration in kennel (df=1) | Age (df=1) | Temperature (df=1) | Humidity (df=1) | Intercept (df=1) |
|---------------|------------|---------------------------|------------|--------------------|-----------------|------------------|
| Exploration | 0.2 | 8.2** | 1.7 | 8.5** | 0.2 | 0.2 |
| Inactivity | 1.3 | 0.1 | 0.1 | 0.8 | 0.1 | 81.8*** |
| Locomotion | 1.0 | 0.02 | 2.4 | 0.2 | 3.7 | 0.2 |
| Lying | 0.4 | 0.6 | 0.7 | 0.4 | 0.4 | 88.6*** |
| Maintenance | 0.8 | 1.1 | 3.9 | 1.7 | 0.9 | 0.1 |
| Vocalizations | 6.5* | 0.3 | 0.5 | 1.3 | 0.0 | 0.0 |

In our sample, time spent barking was influenced only by gender ($p=0.011$); male dogs barked more than females, in agreement with Bradshaw et al., (1996), who found that the components of reactivity were rated higher in males than in female dogs. Indeed, the dogs enrolled in our study barked mainly in response to issues occurring near the shelter, such as people passing by. These differing results could be due to many disparate factors, including to the huge variety of structures and management styles which different shelters have (Barnard et al., 2016). In this regard, it is worthwhile mentioning that the size of the enclosures of the shelter in which the present study was conducted is unusually large for Italian shelters and that the indoor or covered area was at the front not at the back, as is common in other structures.

In the present study, dogs were also recorded exploring less often as the environmental temperature increased ($p=0.004$). It is well known that environmental temperature conditions some physiological processes in mammals such as sleep (Hardin et al., 2019), food intake (Beale et al., 2018) in addition to behavior and especially activity levels; indeed, other studies confirmed our findings both in dogs (Oppenheimer & Oppenheimer, 1975; Ruiz-Izaguirre et al., 2015) and wolves (Theuerkauf et al., 2003) at different latitudes. In the current study, however, environmental temperature did not significantly affect any of the studied behaviors, apart from exploration. Age and relative humidity did not have any effect on the studied behaviors.

Conclusions

There are many factors which can influence the behavior of shelter dogs, and animals in general, in their enclosures, some of which have received little scientific attention. This pilot study examined the effects some variables, including temperature and relative humidity (two environmental features, which do not appear to have been studied yet), might have on the behavior of twenty-one shelter dogs. Dog gender was confirmed to influence reactivity and time spent in the shelter to influence exploratory behavior, although the latter in the opposite direction to that which is already published (Wells et al., 2002). Interestingly, the dogs were recorded exploring less often as environmental temperature increased. This finding, if confirmed by further, possibly multi centric, studies, could be relevant to welfare, given the importance of exploratory behavior in monitoring the effects of the environmental enrichment programs that are used to improve shelter dog welfare. Failure to control for temperature when monitoring behaviors of dogs in their enclosures for the effects of enrichment programs could bias results, as temperature may affect the willingness of the animals to interact with the environment, including any enrichment provided.

References

- Barnard S., Pedernera C., Candeloro L., Ferri N., Velarde A., Dalla Villa P. Development of a new welfare assessment protocol for practical application in long-term dog shelters. *Vet. Rec.* 2016; 178(1): 18. <https://doi.org/10.1136/vr.103336>
- Beale P.K., Marsh K.J., Foley W.J., Moore B.D. A hot lunch for herbivores: physiological effects of elevated temperatures on mammalian feeding ecology. *Biol. Rev.* 2018; 93(1): 674-692. <https://doi.org/10.1111/brv.12364>
- Bradshaw J.W.S., Goodwin D., Lea A.M., Whitehead S.L. A survey of the behavioral characteristics of pure-bred dogs in the United Kingdom. *Vet. Rec.* 1996; 138(19): 465-468. <https://doi.org/10.1136/vr.138.19.465>
- Bright T.M., Hadden L. Safewalk: Improving enrichment and adoption rates for shelter dogs by changing human behavior. *J. Appl. Anim. Welf.* 2016; 20(1): 95-105. <https://doi.org/10.1080/10888705.2016.1247353>
- Cozzi A., Mariti C., Sighieri C., Gazzano G. Behavioral modification in sheltered dogs. *Dog Behav.* 2016; 2(3): 1-10. <https://doi.org/10.4454/db.v2i3.38>
- Dalla Villa P., Barnard S., Di Fede E., Podaliri M., Candeloro L., Di Nardo A., Siracusa C., Serpell J.A. Behavioral and physiological responses of shelter dogs to long-term confinement. *Veterinaria Italiana.* 2013; 49(2): 231-241. <https://doi.org/10.12834/VetIt.2013.492.231.241>
- Gunter L., Feuerbacher E. 2022. Canine enrichment. In: DiGangi B.A., Cussen V.A., Reid P.J., Collins K.A. (Eds.), 2022. *Animal Behavior for Shelter Veterinarians and Staff*, II edition, pp. 263-287. Wiley Blackwell, River Street, Hoboken, NJ 07030, USA.
- Harding E.C., Franks N.P., Wisden W. The temperature dependence of sleep. *Front. Neurosci.* 2019; 13: 1-16. <https://doi.org/10.3389/fnins.2019.00336>
- Harvey N.D., Moesta A., Kappel S., Wongsangchan C., Harris H., Craigon P.J., Fureix C. Could greater time spent displaying waking inactivity in the home environment be a marker for a depression-like state in the domestic dog? *Animals.* 2019; 9(7): 420. <https://doi.org/10.3390/ani9070420>
- Harvey N. D., Moesta A., Wongsangchan C., Harris H., Craigon P.J., Fureix C. Investigating putative depression-like states in the domestic dog: Does greater time spent displaying waking inactivity in the home kennel co-vary with negative judgment of ambiguity? *Appl. Anim. Behav. Sci.* 2020; 230: 105025. <https://doi.org/10.1016/j.applanim.2020.105025>
- Herron M.E., Kirby-Madden T.M., Lord L.K. Effects of environmental enrichment on the behavior of shelter dogs. *J. Am. Vet. Med. Assoc.* 2014; 244(6): 687-692. <https://doi.org/10.2460/javma.244.6.687>
- Mellen J., McPhee M.S. Philosophy of environmental enrichment: Past, present and future. *Zoo Biol.* 2001; 20(3): 211-226. <https://doi.org/10.1002/zoo.1021>
- Newberry R.C. Environmental enrichment: Increasing the biological relevance of captive environments. *Appl. Anim. Behav. Sci.* 1995; 44(2-4): 229-243. [http://dx.doi.org/10.1016/0168-1591\(95\)00616-Z](http://dx.doi.org/10.1016/0168-1591(95)00616-Z)
- Normando S., Contiero B., Marchesini G., Ricci R. Effects of space allowance on the behavior of long-term housed shelter dogs. *Behav. Processes.* 2014; 103:306-314. <https://doi.org/10.1016/j.beproc.2014.01.015>
- Oppenheimer E.C., Oppenheimer J.R. Certain behavioral features in the pariah dog (*Canis familiaris*) in West Bengal. *Appl. Anim. Ethol.* 1975; 2: 81-92. [https://doi.org/10.1016/0304-3762\(75\)90067-X](https://doi.org/10.1016/0304-3762(75)90067-X)
- Owczarczak-Garstecka S.C., Burman O.H. Can sleep and resting behaviors be used as indicators of welfare in shelter dogs (*Canis lupus familiaris*)? *PLoS One.* 2016; 11(10): e0163620. <https://doi.org/10.1371/journal.pone.0163620>. PMID: 27732667; PMCID: PMC5061428.
- Protopopova A., Gunter L.M. Adoption and relinquishment interventions at the animal shelter: a review. *Anim. Welf.* 2017; 26(1): 35-48. <https://doi.org/10.7120/09627286.26.1.035>
- Raudies C., Waiblinger S., Arhant C. Characteristics and welfare of long-term shelter Dogs. *Animals.* 2021; 11(1): 194. <https://doi.org/10.3390/ani11010194>
- Ruiz-Izaguirre E., van Woersem A., Eilers K.C.H.A.M., van Wieren S.E., Bosch G., van der Zijpp A.J., de Boer I.J.M. Roaming characteristics and feeding practices of village dogs scavenging sea-turtle nests. *Anim. Conserv.* 2015; 18(2): 146-156. <https://doi.org/10.1111/acv.12143>
- Theuerkauf J.R., Jędrzejewski W., Schmidt K., Okarma H., Ruczyński I., Śnieżko S., Gula R. Daily pat-

- terns and duration of wolf activity in the Białowieża Forest, Poland. *J. Mammal.* 2003; 84(1): 243-253. [https://doi.org/10.1644/1545-1542\(2003\)084<0243:DPADOW>2.0.CO;2](https://doi.org/10.1644/1545-1542(2003)084<0243:DPADOW>2.0.CO;2)
- Uccheddu S., Mariti C., Sannen A., Vervaecke H., Arnout H., Gutierrez Rufo J., Gazzano A., Haverbeke, A. Behavioral and cortisol responses of shelter dogs to a cognitive bias test after olfactory enrichment with essential oils. *Dog Behav.* 2018; 4(2): 1–14. <https://doi.org/10.4454/db.v4i2.87>
- Wells D.L., Graham L., Hepper P.G. The influence of length of time in a rescue shelter on the behavior of kennelled dogs. *Anim. Welf.* 2002; 11(3): 317-325.

Acknowledgements

The author wish to thank all who were involved in the larger project which this study was a part of, ARPAV, Paola Valsecchi, the management and the staff of the shelter, and, in particular, Piera Piantoni. This study is dedicated to her and to all the animals which she cared for and helped during her, very sadly, too short, life.

La temperatura ambientale può influenzare il comportamento dei cani da rifugio? Uno studio pilota

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Sintesi

Molti cani in tutto il mondo trascorrono una parte importante della loro vita nei canili rifugio e molti studi hanno analizzato il loro comportamento, principalmente con l'obiettivo di migliorare la loro qualità di vita. Ci sono molti fattori che possono influenzare i risultati di questi studi. Alcuni di essi sono sotto il controllo dell'uomo, come l'arricchimento ambientale, le procedure di alimentazione e la gestione del rifugio, altri sono indipendenti dalle azioni umane, come la temperatura ambientale, l'umidità e le condizioni atmosferiche. Pertanto, nel presente studio pilota, abbiamo indagato se alcune variabili, tra cui la temperatura ambientale e l'umidità relativa, potessero influenzare il comportamento dei cani ospitati in un canile rifugio. Ventuno cani ospitati in un rifugio del Nord Italia sono stati osservati utilizzando una regola istantanea ad animale focale ogni 15 secondi per 15 minuti, ripetuta in quattro giorni, a intervalli di almeno 5 giorni l'uno dall'altro. I dati ufficiali relativi a temperatura e umidità sono stati ottenuti dall'Agenzia Regionale per la Prevenzione e Protezione Ambientale del Veneto. Sono state eseguite equazioni di stima generalizzate per inattività, locomozione, vocalizzazione, esplorazione, mantenimento e riposo. Il sesso dei cani, l'età (stimata) del cane, la durata della permanenza nel rifugio, la temperatura e l'umidità relativa sono stati inclusi nel modello come possibili fattori predittivi. I cani maschi sono stati registrati più spesso vocalizzare rispetto alle femmine ($p=0,011$). I cani che erano rimasti per più di 5 anni nel rifugio sono stati registrati esibire comportamento di esplorazione più spesso rispetto ai cani che erano rimasti nel rifugio per meno di 5 anni ($p=0,004$). I cani sono stati registrati esibire comportamento di esplorazione meno spesso al crescere delle temperature ambientali ($p=0,004$). Non sono stati riscontrati altri effetti significativi. Data l'importanza del comportamento esplorativo nel monitoraggio degli effetti dei programmi di arricchimento ambientale, i risultati del presente studio suggeriscono l'importanza di controllare la temperatura ambientale quando si studia l'esplorazione ambientale nei cani in canile rifugio.

