

Dog attention and cooperation with the owner: preliminary results about brachycephalic dogs

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Abstract: Neoteny is one way of achieving paedomorphosis, where somatic development is slowed down, but sexual maturity stays on ancestral time-course, resulting in a sexually mature descendant adult that is relatively juvenile with respect to its immediate ancestor.

The neoteny thus interferes on many aspects of the biology of the dog, giving rise to many canine breeds differing in physical and behavioral characteristics.

Dogs with brachycephalic or dolichocephalic morphology are considered less trainable than mesomorphic breeds. Brachycephalic breeds are considered neotenic because the development of the muzzle is blocked at a very early stage with respect to the final result of the wolf.

The aim of the research was to determine whether there is a difference between brachycephalic and dolichocephalic breeds with regard to the motivation to cooperate with the owner.

For the research have been used 17 dogs, divided into 2 groups (brachycephalic and dolichocephalic). The two groups of dogs were subjected to two behavioral tests. The first consisted in the recovery of food from a container fitted with a cap, while the second was to recover the food tied to a rope and positioned in a wire mesh cage.

Statistical analysis of the data showed a significant difference between the dogs of group 1 and group 2.

The dogs in group 2 turn a greater number of glances to the owner in test 1 ($Z=2.39$; $p=0.017$) and in test 2 ($Z=2.39$; $p=0.017$). Regarding the latency of the gaze, a statistically significant difference is detectable in test 1 where the dogs of group 1 take more time to turn the gaze to the owner ($Z=2.26$; $p=0.024$) than those of group 2. Instead a statistically significant difference with respect to the latency of the look in the second test between the two groups of animals ($Z=1.88$; $p=0.060$) does not exist.

The results of the present study seem to support the hypothesis that brachycephalic dogs show a different behavior compared with dolichocephalic ones; they in fact turn a lower number of glances to the owner and have a longer latency to look him when unable to complete the task. The dog trainability seems, therefore, to be affected by the morphological selection conducted in the past on different breeds.

However, given the small number of subjects tested, further researches will need to provide new evidence to support the hypothesis that the brachycephalic dogs are less trainable than dolichocephalic, at least with regard to the execution of specific tasks.

Key Words: brachycephalic, neoteny, dog, behavioral test, trainability.

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Introduction

Throughout thousands of years of domestication, dogs have been selectively bred for characteristics which humans have found desirable, first of all for “infantile” features of adult morphology and behavior (Coppinger et al., 1987; Mariti et al., 2013, Gazzano et al., 2013). This preservation of behavioral and/or morphological juvenile characteristics in the adulthood, best known as paedomorphosis (Gould, 1977), is obtained by an evolutive mechanism named heterochrony.

Heterochrony is defined as a change in the timing rate of developmental events, relative to same

events in the ancestors (Sheldon, 1993). Neoteny is one way of achieving paedomorphosis, where somatic development is slowed down, but sexual maturity stays on ancestral time-course, resulting in a sexually mature descendant adult that is relatively juvenile compared to its immediate ancestor (Shaffer, 2013).

The neoteny thus interferes on many aspects of the biology of the dog, giving rise to many canine breeds differing in physical and behavioral characteristics. Dogs have been, in fact, classified as dolichocephalic (long skulls), mesocephalic (moderate skulls), or brachycephalic (broad skulls), based on calculated cephalic index, a ratio between skull width and length (Helton, 2009).

In addition to the physical differences between the breeds there are also considerable differences in behavior. Trainability of the dog is one of the aspect of canine behavior more studied (Helton, 2009, 2010; Coren, 1994; Ley et al., 2009; Rooney & Bradshaw, 2004; Serpell & Hsu, 2005).

Coren (1994) sustains that dog breeds can be ranked high (for example Australian Cattle Dogs, Labrador Retrievers, and German Shepherds) or low in trainability (for example Greyhounds, Mastiffs, and Staffordshire Bull Terriers). Dogs with brachycephalic or dolichocephalic morphology are therefore considered less trainable than mesomorphic breeds.

Brachycephalic breeds are considered neotenic because of the development of their behavior and of some parts of their body (e.g. the muzzle) is blocked at a very early stage compared to the final result of the wolf (Coppinger et al., 1987).

Undoubtedly dog trainability is based both on the ability to maintain its attention on the owner and on its motivation to cooperate with him.

The aim of the research was to establish whether there is a difference between brachycephalic (neotenic) and dolichocephalic (not neotenic) breeds with regard to the motivation to cooperate with the owner.

Materials and methods

For the research 17 dogs were used, divided into 2 groups: group 1 consists of 9 animals with neotenic, brachycephalic morphology and group 2 of 8 dogs with not neotenic, dolichocephalic morphology, reported in Table 1.

The average age of the dogs in group 1 was 30.44 ± 12.24 months, while that of dogs in Group 2 was 30.87 ± 1.16 . All animals attended a basic training.

The two groups of dogs were subjected to two behavioral tests, carried out in a room of 4x4 m that was familiar to the animals.

Table 1. Composition of two dog groups utilized in the research.

Group 1: Neotenic dogs				Group 2: Non neotenic dogs			
	Breed	Sex	Age		Breed	Sex	Age
1	Boxer	F	36	10	Cirneco	F	18
2	Perro de Presa Canario	M	20	11	Cirneco	F	24
3	American Staffordshire	F	24	12	Dobermann	F	13
4	Boxer	M	48	13	Siberian Husky	M	48
5	Cane Corso	F	28	14	Siberian Husky	F	24
6	Cane Corso	F	36	15	Weimaraner	M	36
7	Mastino Napoletano	M	16	16	Belgian Shepherd	M	24
8	Rottweiler	F	18	17	Akita-inu	F	60
9	Boxer	F	48				

The first test consisted in the recovery of food from a container closed by a lid. Before the execution of the experiment, the dog was trained to retrieve a piece of food hidden in a cylindrical plastic container (40 cm h, r 20 cm), with a lid. The dog came into the room with the owner that kept him on a leash and put him in position "sit". The researcher, after having obtained the dog's attention, stood at 2 m distance from the animal, in front of the container and dropped a tidbit in it, covering it with the cap. The dog could easily move the cap with his nose or paw to eat the food.

After having put the cap, the researcher stayed away without looking at the dog. Then the owner freed the dog from the leash and sent it to the container, remaining on the sidelines, without interacting with the animal.

The acquisition phase of learning was considered completed when the dog could swallow the treat within 20 s from the moment it was released from the leash, in the 80% of the trials.

After the acquisition phase the dog was tested under the same experimental conditions but the experimenter, after dropping the treat in the container, fitted tightly it with the lid so that the dog was not able to open it by himself. From the moment the dog was freed from the leash, two minutes were timed: during this time, the first look at the owner and the number of glances towards him were noted.

In the second test, the task of the dog was to recover the food tied to a rope and positioned in a wire mesh cage. To get the food, the dog had to pull the rope with his mouth or his paw, sliding it between the net of the cage. The dog came into the room with the owner who kept him on a leash and put him in position "sit".

The researcher, after having obtained the dog's attention, placed a piece of food, attached to the rope, inside the cage, positioned 2 m away from the animal. 50 cm of the rope were out of the cage to permit the dog to catch it.

The experimenter withdrew from the scene and the owner freed the dog from the leash, sending it to the cage, without interacting with the animal until the end of the trial. The acquisition phase of learning was considered completed when the dog was able to get the food within 40 s from the moment it was released from the leash in the 80% of the trials.

After the acquisition phase the dog was tested under the same experimental conditions but the experimenter, this time, blocked the rope to the mesh network so that the dog was not able to pull it out. From the moment the dog was freed from the leash two minutes were timed; during this time, the first look at the owner and the number of glances towards him were noted. Data statistical analysis was performed using the nonparametric Mann-Whitney test.

Results

The results of test 1 and 2 are reported in tables 2 and 3.

Statistical analysis of the data showed a significant difference between the dogs of group 1 and group 2.

The dogs in group 2 turn a greater number of glances to the owner in test 1 ($Z=2.39$; $p=0.017$) and in test 2 ($Z=2.39$; $p=0.017$). Regarding the latency of the gaze, a statistically significant difference is detectable in test 1 where the dogs of group 1 take more time to turn the gaze to the owner ($Z=2.26$; $p=0.024$). Instead no statistically significant difference was noted between the latency of the glance in the second test between the two groups of animals ($Z=1.88$; $p=0.060$).

Discussion

The domestic dog (*Canis familiaris*) has undergone strong morphological selection during domestication, since it descended from the wolf approximately 100,000 years before present (Vilà et

al., 1997) or more recently (Klüttsch & Savolainen, 2011). While domestication of the dog may have occurred at this time, it is likely that morphological divergence from the wolf occurred only 10,000-15,000 years ago (Morey, 1994; Vilà et al., 1997), with many of the present morphotypes having an even shorter history.

There is evidence that this focus on morphology may have led to unexpected behavioural changes in the dog. For example, selection for different coat colours in Cocker Spaniels (Podberscek & Serpell, 1996) and Labrador Retrievers (Haupt & Willis, 2001) has led to differences in the likelihood of these dogs showing aggressive behaviour, suggesting selection for morphological traits may have consequences, often unforeseen, on behaviour.

Even a particular aspect of behavior such as trainability seems to be affected by the morphological selection conducted in the past on different dog breeds (Coren, 1994).

The results of the present study seem to support this hypothesis. The dogs of neotenic breeds tested in this research show a different behavior compared with not neotenic ones; they in fact turn a lower number of glances to the owner and have a longer latency to look him when unable to complete the task.

Table 2. Number of glances and latency time of first look toward the owner during the first behavioral test.

Group 1: Neotenic dogs			Group 2: Non neotenic dogs		
Dog	N° glances	Latency of first glance (s)	Dog	N° glances	Latency of first glance (s)
1	1	37	10	3	16
2	2	113	11	4	58
3	4	47	12	5	14
4	2	10	13	3	15
5	2	70	14	4	14
6	4	70	15	10	6
7	5	22	16	5	13
8	1	38	17	6	19
9	2	78			
Mean	2.56	53.89	Media	5.00	19.38
D.S.	1.42	31.86	D.S.	2.27	16.04

Table 3. Number of glances and latency time of first look toward the owner during the second behavioral test.

Group 1: Neotenic dogs			Group 2: Non neotenic dogs		
Dog	N° glances	Latency of first glance (s)	Dog	N° glances	Latency of first glance (s)
1	2	20	10	2	50
2	2	71	11	3	88
3	3	21	12	2	34
4	2	39	13	4	37
5	2	20	14	6	23
6	2	32	15	11	43
7	5	13	16	6	22
8	1	8	17	6	36
9	1	26			
Mean	2.22	27.78	Mean	5.00	41.63
D.S.	1.20	18.68	D.S.	2.98	20.93

As far as one might suppose neotenic dogs demonstrate generally greater dependence from the attachment figure (mother or owner) for their behavioral infantilism, the results of this research are not surprising.

Brachycephalic breed were specialized for fighting. Moreover cephalic index correlates with the distribution of ganglion visual cells in dogs' retinas (McGreevy et al., 2004). High ganglion cell densities mark areas in the retina that are particularly acute. More dolichocephalic dogs have horizontal bands of high ganglion cell density and appear to be visually acute along the horizon. Instead more brachycephalic dogs have something more analogous to a human fovea, a circular zone in the center of the retina, and appear more visually acute for a central target. Brachycephalic dogs, when the size of the dog is controlled for, can also generate greater bite forces (Ellis et al., 2009).

Apart from these physical characteristics, the dog's ability to maintain his grip and his tenacity in completing a task, essential elements for a fighting dog, has been selected.

These facts can then be a first explanation of the results of this research: human selection has produced dogs with extreme tenacity, to the detriment of motivation to cooperate with the owner.

Because the selection for fighting has not been conducted on all neotenic existing breeds, we cannot exclude that this particular behavior is not present in dog breeds without a history of this type.

This fact could explain the differences of our results respect to data obtained by Gacsi et al. (2009) who found brachycephalic dogs (also of none-fighting breeds) utilize the human point gesture better than dolichocephalic breeds.

Another possible explanation can be derived from the behavioral level of maturity of the neotenic dogs involved in this study. The ability to cooperate with the owner, tested in this experiment, could be negatively influenced by the infantilism of these dogs that do not reach an adult social behavior. Cooperation and coordinated activity of the herd are perhaps the best examples of a fully matured social behavior. We cannot therefore exclude the possibility that the behavioral neoteny is also reflected on this aspect of social behavior, altering its activation threshold.

Finally, we can exclude the possibility that the behavioral differences observed between dogs are learned because all the animals have followed a similar training. However, given the small number of subjects tested, further research will be needed to provide new evidence to support the hypothesis that the brachycephalic dogs are less trainable than dolichocephalic ones, at least with regard to the execution of specific tasks, verifying whether the selection for fighting of some breeds can have modified their cooperativity with the owner.

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Capacità di attenzione e di cooperazione del cane col proprietario; risultati preliminari sui cani brachicefali

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Sintesi

La neotenia è un modo per realizzare la pedomorfosi, un processo evolutivo che consiste nell'ottenere il rallentamento dello sviluppo somatico ma non di quello sessuale. Effetto della neotenia è quindi l'avere animali sessualmente maturi con un aspetto più giovane rispetto ai loro antenati.

Gli studi sull'addestrabilità del cane hanno dimostrato che le razze brachimorfe e quelle dolicomorfe sono meno addestrabili di quelle mesomorfe. Le razze brachimorfe sono considerate neotenuche in quanto lo sviluppo del muso è bloccato ad uno stadio molto iniziale rispetto al risultato finale che si ha nel lupo.

Alla base dell'addestrabilità di un animale vi è sicuramente la sua capacità di mantenere l'attenzione sul proprietario e la motivazione a collaborare con esso.

Scopo della ricerca è stato quello di verificare se esiste una differenza tra razze neotenuche e non per quanto riguarda la motivazione a cooperare col proprietario.

Per la ricerca sono stati utilizzati 17 cani, divisi in 2 gruppi: il gruppo 1 formato da 9 animali con morfologia brachimorfa, neotenuca ed il gruppo 2 da 8 cani con morfologia dolicomorfa, non neotenuca.

L'età media dei cani del gruppo 1 era di $30,44 \pm 12,24$ mesi mentre quella dei cani del gruppo 2 di $30,55 \pm 15,01$.

I due gruppi di cani sono stati sottoposti a due test comportamentali.

Il primo test consisteva nel recupero di cibo da un contenitore dotato di coperchio. Il cane era addestrato a recuperare un bocconcino nascosto in un contenitore cilindrico di plastica, munito di tappo. Dopo una fase di acquisizione che consisteva nell'addestrare il cane a recuperare un bocconcino di cibo da un contenitore chiuso con un tappo facilmente amovibile, il cane era testato nelle stesse situazioni sperimentali ma lo sperimentatore, dopo aver fatto cadere il bocconcino nel contenitore, lo chiudeva saldamente col coperchio in modo che il cane non fosse in grado di aprirlo autonomamente. Dal momento in cui il cane era liberato dal guinzaglio erano cronometrati 2 minuti durante i quali era rilevato il tempo in cui l'animale indirizzava il primo sguardo al proprietario ed il numero di sguardi rivolti al proprietario.

Nel secondo test il compito del cane era quello di recuperare del cibo legato ad una corda e posizionato all'interno di una gabbia di rete metallica. Per ottenere il cibo, il cane doveva effettuare una trazione sulla corda con la bocca o la zampa facendola scivolare tra e maglie della rete della gabbia. Nella fase di acquisizione, che precedeva quella sperimentale, il cane entrava nella stanza insieme al proprietario che lo tratteneva al guinzaglio e lo metteva in posizione "seduto". Lo speri-

mentatore, accertatosi di avere l'attenzione del cane su di sé, collocava il cibo, legato alla corda, dentro la gabbia, posizionata a 2 m di distanza dall'animale, facendo fuoriuscire 50 cm di corda. Lo sperimentatore si ritraeva in disparte e, a quel punto, il proprietario liberava il cane dal guinzaglio e lo inviava verso la gabbia, restando anch'egli in disparte, senza interagire con l'animale. Dopo la fase di acquisizione il cane era testato nelle stesse situazioni sperimentali ma lo sperimentatore, dopo aver posizionato il cibo legato alla corda all'interno della gabbia, bloccava la corda ad una maglia della rete in modo che il cane non fosse in grado di estrarla autonomamente. Dal momento in cui il cane era liberato dal guinzaglio erano cronometrati 2 minuti di tempo durante i quali era rilevato il tempo in cui l'animale indirizzava il primo sguardo al proprietario ed il numero di sguardi rivolti al proprietario.

L'analisi statistica dei dati è stata effettuata utilizzando il test non parametrico di Mann-Whitney.

L'analisi statistica dei dati ha evidenziato una differenza statisticamente significativa tra i cani del gruppo 1 e quelli del gruppo 2.

I cani del gruppo 2 rivolgono un numero maggiore di sguardi al proprietario nel test 1 ($Z=2,39$; $p=0,017$) e nel test 2 ($Z=2,39$; $p=0,017$). Per quanto riguarda la latenza dello sguardo una differenza statisticamente significativa è rilevabile nel test 1 dove i cani del gruppo 1 impiegano più tempo a rivolgere lo sguardo al proprietario ($Z=2,26$; $p=0,024$) rispetto a quelli del gruppo 2. Non esiste invece una differenza statisticamente significativa per quanto riguarda la latenza dello sguardo nel test 2 tra i due gruppi di animali ($Z=1,88$; $p=0,060$).

I risultati della presente ricerca sembrano avvalorare l'ipotesi che anche un particolare aspetto del comportamento come l'addestrabilità risenta della selezione morfologica condotta in passato sulle diverse razze canine. I cani delle razze neoteniche testati nella presente ricerca mostrano un comportamento diverso rispetto alle razze non neoteniche, rivolgendo un numero inferiore di sguardi al proprietario e presentando una latenza di sguardo più lunga quando impossibilitati a portare a termine il compito oggetto della prova.

Insieme alle caratteristiche morfologiche necessarie per un cane da combattimento (muso corto, mascella potente, arti corti, cute spessa), è stata anche selezionata la capacità di mantenere la presa e la tenacia nel portare a termine un compito, elementi essenziali anche questi per un cane combattente. Questa può essere quindi una prima spiegazione dei risultati di questa ricerca: la selezione umana potrebbe aver portato all'estremo la tenacia del cane, a scapito della motivazione a collaborare con il proprietario, rendendo quindi questi animali meno addestrabili di altre razze.

Poiché non tutte le razze neoteniche e dolicomorfe sono state selezionate per creare cani combattenti, un'ulteriore ricerca dovrà chiarire se questa riduzione della motivazione a collaborare col proprietario, riscontrata in questa ricerca, sia limitata a razze di cani brachimorfi con una storia di selezione per il combattimento o si ritrovi anche in altre razze brachimorfe e neoteniche.

Un'altra possibile spiegazione potrebbe risiedere nella neotenia comportamentale che potrebbe riflettersi anche sul comportamento sociale, alterandone la soglia di attivazione.

È infine da escludere che le differenze comportamentali siano di origine appresa in quanto tutti gli animali avevano seguito un percorso educativo simile. Tuttavia, dato l'esiguo numero di soggetti testati, ulteriori ricerche saranno necessarie per fornire ulteriori prove a sostegno dell'ipotesi che i cani brachicefali siano meno addestrabili di quelli dolicocefali, almeno per quanto riguarda l'esecuzione di particolari compiti.