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Applied Animal Behaviour Science 61 (1998) 133–142
APPLIED ANIMAL BEHAVIOUR SCIENCE

Comparison of behavioral and physiological responses of dogs wearing two different types of collars

Philip Ogburn [a,*], Stephanie Crouse [b], Frank Martin [a], Katherine Houpt [b]

[a] *University of Minnesota, St. Paul, MN 55108, USA*
[b] *Department of Physiology College of Veterinary Medicine, Cornell University, Ithaca NY 14853-6401, USA*

Accepted 13 February 1998

Abstract

Physiological and behavioral responses of dogs while wearing two different types of collars were compared: a traditional buckle nylon neck collar, and a newly developed nylon head collar. Before and following tests of obedience training and restraint, measurements were made of blood pressure, heart rate, respiratory rate and pupillary dilation to compare quantitative and qualitative measures of behavior during physiological measurements and during the tests of responses to training. Plasma ACTH and cortisol levels were measured at the conclusion of testing. Results indicated no significant differences in the physiological responses to the two types of collars. There was a trend for physiological responses to diminish during the course of the testing with both collars which indicated a physiological accommodation to handling and training. Evaluation of behavioral responses indicated that during testing dogs were more unruly and disobedient and pulled on the leash while wearing traditional neck collars, but pawed at their noses more and watched the handler less while wearing head collars. The dogs more frequently lowered their heads and ears when wearing the head collar. Owners of dogs wearing head collars may be interested to know that their dogs are not physiologically stressed when the collars are initially applied, despite nose pawing. © 1998 Elsevier Science B.V. All rights reserved.

Keywords: Dog; Training; Head collar; Cortisol; Heart rate

* Corresponding author. Tel.: +1-607-253-3450; fax: +1-607-253-3846; e-mail: kah3@cornell.edu

PII: S0168-1591(98)00113-0

1. Introduction

For many years, people have tried to control and restrain dogs with a leash attached to either a collar around the neck or a harness surrounding the chest and shoulders. Recently several types of halters or head collars have been developed to improve control of a dog's head and muzzle. Control of the head is important, because wherever the head goes, the body must follow. Halters rather than collars are used to guide horses and cows by controlling the head without putting pressure on the front of the throat as it has been traditionally done in dogs.

Head collars are being recommended by animal behaviorists (Landsberg, 1990; Fogle, 1994) because they appear to offer gentle, effective control of the dog. However, there are no controlled studies, only case reports (Beaver, 1994a), and anecdotal evidence of physiological and behavioral responses by dogs to these head collars. Since an animal's response to stress may be detected by changes in heart rate, respiratory rate, blood pressure, plasma cortisol and plasma adrenocorticotrophic hormone (ACTH) (Moberg, 1985), this study was conducted to determine whether there were comparable physiological and behavioral responses in dogs when wearing the traditional nylon neck collars and when wearing nylon head collars during control and restraint. Nylon neck collars were chosen as the standard for comparison because neck collars traditionally have the greatest use and acceptance by dog owners. A secondary purpose was to evaluate obedience training as a stressful event for dogs.

2. Materials and methods

The head collars (Gentle Leader®, Promise®, Alpha-M,) were constructed as follows: 1) a nylon strap fits snugly and high around the neck of the dog, attached to a double D ring at the front of the throat above the larynx and joined by an adjustable buckle immediately behind the ears at the back of the neck; 2) a nylon strap encircles the nose and lower jaw of the dog (nose loop), passes through the double D ring above the larynx and is sewn several inches below the double D ring to hold a circular ring for attachment of a traditional six-foot walking leash. An adjustable slide fits on the nose loop below the double D ring to ensure an appropriate fit for individual dogs and prevent pawing off the nose strap when people are not controlling the dog (Fig. 1).

These head collars are not muzzles because the dogs can open their mouths to eat, drink, bark and bite except when a leash is pulled putting pressure on muscles at the back of the neck and simultaneously closing the mouth. Head collars do not put pressure on the front of the throat as traditional collars do.

Traditional nylon neck collars were constructed of a one-inch nylon strap that fits loosely around the dog's neck, joined together by a metal buckle and having a circular ring attached to hold a traditional six-foot walking leash. When the leash is pulled, pressure is applied to the front of the neck.

Tests were conducted on 26 random source dogs, 13 males and 13 females, conditioned for health prior to inclusion in this study. All were dogs greater than one year of age and weighed between 12 and 24 kg. Because these were random source dogs

Fig. 1. Headhalter: consists of two interconnected loops of nylon, one contacting the back of the neck and the other encircling the muzzle.

of unknown origin, no information was available concerning prior training. The testing was designed to minimize the effect of earlier exposure to training.

Dog housing and testing was performed at the University of Minnesota animal resource facilities. All dogs were subjected to the same feeding practice, brand of dog food, animal care personnel, and cleaning and exercising routines. The floor surface on which the tests were conducted was a non-slip rubber floor mat. Transportation to the testing sites which took less than two minutes was accomplished by using a quiet rubber wheeled, metal-sided transport cage. Testing took place approximately 5 min later.

The same personnel placed the neck collar, head collar, blood pressure cuff, and conducted the training procedures throughout the study. The dogs were not exposed to project personnel or to the physiological equipment used in the study prior to conducting the tests. As far as the experimenters were aware, the dogs had not been exposed to the head collars prior to testing.

Dogs were paired according to similarities of size and type. Each of the 13 pairs became one replicate in a balanced crossover design comparing the head collar (treatment) test to the buckle collar (control) test, using each dog as his own control. In each matched pair, dogs were assigned by coin flip to either the treatment then control or to the control then treatment sequence of tests. The second test occurred 1–2 days after the first test. Each test consisted of a baseline physiological measurement (measurement 1), 3 immediately consecutive exercise procedures, each followed by a battery of physiological measurements (measurements 2–4) and a pause period of 3 min before a final battery of measurements. Each test took approximately 20 min.

The baseline exercise consisted of restraining the dog using only the hands. No collars were applied. The dog was allowed (not forced) to sit or lie quietly, but not stand, in a stable position of his choosing for measurements which were conducted as soon as possible after positioning. The obedience exercises were conducted to determine a dog's response to application and use of the devices during the following exercises. The dog was controlled by a handler with a leash connected to a head collar or neck collar and was encouraged to perform standardized obedience exercises three times. The dog was walked 10 m, made to sit for 10 s, walked for 10 m, made to sit for 10 s, turned clockwise and walked for 10 m toward the measuring area, then was made to sit for 10 s in the designated physiological measurement area prior to measurements. The dog was allowed to sit or lie down while the physiological measurements were conducted. Blood pressure and HR were measured sequentially 3 times during a 1 to 2 min period. The obedience exercises were repeated twice more with physiological measurements made after each exercise. Three minutes after the third obedience test, a final set of physiological measurements was made. Immediately following the final physiological measurement, a blood sample was withdrawn from the jugular vein for determination of plasma ACTH and cortisol levels. Samples were frozen and stored at −70°C until analysis could be performed. Laboratory determination of ACTH (Hegstad, 1990) and cortisol levels was accomplished by radioimmunoassay.

Plasma cortisol concentrations were determined using a commercially available RIA, or radioimmunoassay kit (Coat-A-Count cortisol kit, Cat # TKC02, Diagnostic Products, Los Angeles, CA 90045) without modification. All calibrators, controls, and unknowns were assayed in duplicate. Assay sensitivity, defined as two standard deviations from zero concentration ($n = 7$) was 1.0 ng/ml. Within-assay coefficients of variation in three canine plasma pools were 7.8% (X ± SD = 12.5 ± 1.0 ng/ml), 4.9% (35.5 ± 1.8 ng/ml) and 3.4% (113 ± 7.6 ng/ml.) Between assay coefficients of variation in three canine plasma pools measured in 8 different assays were 9.2% (X ± SD = 22.5 ± 2.1 ng/ml), 13.8% (32.6 ± 4.5 ng/ml), and 6.5% (117 ± 7.6 ng/ml). Recovery of cortisol (1000, 500, 250, 125, and 62.5 ng/ml) added to canine plasma was linear and quantitative (slope = 0.96; $r^2 = 0.997$). Dilutional parallelism was demonstrated by assaying two pools of canine plasma at three dilutions (50, 25 and 12.5 ml) and correcting the measured result for dilution. Corrected mean values (± SD) for the first pool were 35.5 ± 1.8 ng/ml, 37.3 ± 1.1 ng/ml, and 30.4 ± 2.4 ng/ml. Corrected mean values for the second pool were 113 ± 3.4 ng/ml, 117 ± 3.8 ng/ml and 123 ± 5.2 ng/ml.

Blood pressure (BP), pulse rate (PR), respiratory rate (RR), and pupil diameter (PD) were determined. Blood pressure and PR were measured oscillometrically utilizing a programmable vital signs monitor (Dinemap-Critikon). Systolic, diastolic, mean arterial pressures and pulse rates were measured sequentially 3 times over a 1 to 2 minute period. An average (mean) value for each parameter was recalculated by adding individual values together and dividing by the number of measurements (3) over the time period. Care was taken to match the cuff size to limb diameter to assure accurate recordings and pressures were measured in as near to the same posture throughout the testing period. The RR was calculated by visually observing inspiratory thoracic motion for 15 s and multiplying by 4 to obtain the minute rate. Pupillary diameter was measured during the 30 s following measurement of BP, HR and PR. The diameter of the pupil and cornea were measured in mm using a calibrated comparison eye chart. Pupillary size was expressed as a percentage of the corneal diameter (pupil diameter/corneal diameter $\times 100$).

Responses to exercise for the variables BP, PR, RR, and PD are measured as the differences from the baselines at the beginning of each of the dog's two trials. A repeated measures analysis of variance of the balanced crossover design was used to test the statistical significance of effects due to the type of collar, the learning effect of first time through vs. second time through testing, and the persistence of response levels over the sequence of 4 measurement periods per treatment. Plasma cortisol and ACTH measurements were analyzed using a standard crossover analysis of variance.

Behavioral observations were made from video tapes of the 26 subjects. The behavioral measures were either quantitative (every incident displayed during each specific segment of testing was recorded) or qualitative (ranked measure).

The behaviors counted during the physiological measurement were: vocalizations (whining, barking and/or growling), looking at the handler (the number of times a dog looked at the handler's face), and placed into position (the number of times the handler needed to correct the dog's body position during the physiological measurements).

The behaviors counted during the obedience portion were: balks (refusal of the dog to move with the handler), biting or fighting the leash, rearing up and shaking head, biting or pawing the leash, pawing nose (attempts to remove the nose loop of the head collar with paws), dragging behind handler (moving with handler, but with reluctance), pulling ahead of handler (leash is taut, some choking or coughing sounds heard coming from the dog), looking at the handler (same as during physiological measurements) and the number of corrections (number of times dog is corrected with leash or by hand and put back into position).

The scores for exercises 1–3 were added to give a total score for each behavior for each dog for each collar.

These data were analyzed using the Wilcoxon Signed Rank Test comparing collars across all dogs as a group.

At the end of each physiological measurement and each obedience portion of the exercise, the dog was observed for head position (up or down), tail position (wagging, up or tucked), ear position (up or down) and posture (lie, sit, stand, or crouch). A numerical ranking was assigned to each position and posture. The higher the ranking, the more subordinate the dog. See Newton and Lucas (1982) for descriptions of subordinate vs. dominant postures in dogs. These data were analyzed using the McNemar test for scaled data (Conover, 1980). The scores were compared between collars across all dogs by measure.

3. Results

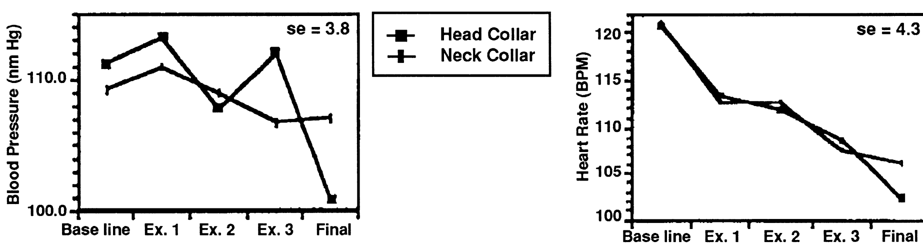
3.1. Physiological

3.1.1. Blood pressure

The mean BP for the sequence of 4 measurements following exercise declined from the baseline measurements by 2.74 mm Hg while wearing a head collar, and 0.86 mm Hg while wearing a neck collar (Fig. 2). This difference is not significant, having an F-ratio less than one. The learning effect for BP was also not significant. There was a highly significant ($F(3\ df,\ 150\ df) = 25.7,\ p \leq 0.02$) drift across successive measurements within trials with overall mean responses ranging from $+1.75$ mm Hg after the first exercise to -6.29 mm Hg at the time of the final measurement. There was no significant interaction between this response and training device type.

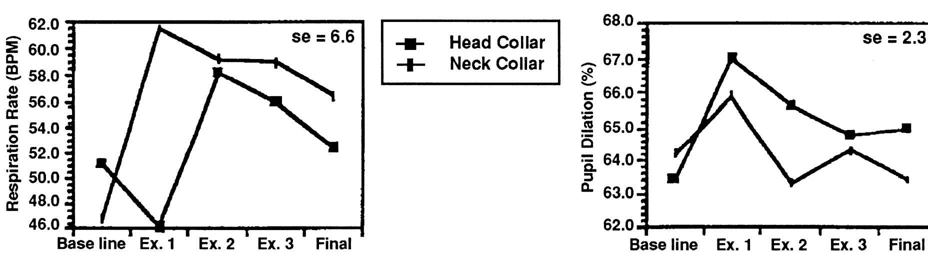
3.1.2. Heart rate

Heart rate was recorded as a difference from baseline and compared in the same manner as BP. As a general response for all dogs, HR declined as the exercises



	Base line	Ex. 1	Ex. 2	Ex. 3	Final
Head Collar	111.2	113.1	107.9	112.0	100.8
Neck Collar	109.3	110.9	109.0	106.8	107.1

	Base line	Ex. 1	Ex. 2	Ex. 3	Final
Head Collar	120.6	113.4	111.9	108.6	102.3
Neck Collar	121.0	112.7	112.6	107.7	106.1



	Base line	Ex. 1	Ex. 2	Ex. 3	Final
Head Collar	51.2	46.2	58.2	56.0	52.5
Neck Collar	46.8	61.5	59.2	58.9	56.4

	Base line	Ex. 1	Ex. 2	Ex. 3	Final
Head Collar	63.4	67.0	65.6	64.8	65.0
Neck Collar	64.2	65.9	63.3	64.3	63.4

Fig. 2. Means of four physiological responses averaged over 26 days at each of five time points in the exercise sequence. SE; Standard error.

progressed. The overall average drop in heart rate was 11.6 bpm when using a head collar and 11.2 bpm when wearing a neck collar. The HR response to collar type was virtually identical (Fig. 2): there was a significant [$F(3,150) = 8.4$; $p \leq 0.05$] and steady fall-off in heart rate across test exercises, ranging from 7.8 bpm drop after the first exercise to 16.6 bpm drop at the final resting measurement. This interaction between the exercise and collar type was not significant.

3.1.3. Respiratory rate

Respiratory response data was evaluated in the same manner as blood pressure (Fig. 2). No significant effect on respiration was observed, for collar type or exercise sequence.

3.1.4. Pupillary dilation

Pupil dilation was measured concurrently with the above responses and was measured as a change of pupil diameter relative to corneal diameter. The percentage of mean pupillary dilation observed in dogs wearing a head collar was 2.0% and was 0.1% when wearing a neck collar (Fig. 2). This difference was not statistically significant ($F(1,24) = 1.5$, $p = 0.22$). The mean response across obedience exercises progressed from 2.7% dilation after the first exercise down to 0.7% dilation after exercise #2 and #3 and 0.2% dilation at the fourth measurement. The exercise effect had a p-value of 0.08 ($F(3,150) = 2.3$) and there was no interaction between collar type and exercise.

3.1.5. ACTH and cortisol

The mean plasma levels of cortisol were 29.6 ng/ml after the head collar tests and 26.6 ng/ml after the neck collar tests. The overall mean plasma levels of ACTH were 72.8 pg/ml after the head collar tests and 70.7 pg/ml after the neck collar tests. The differences were not statistically significant.

4. Behavioral

During the physiological measurements, the subjects looked at the handler significantly more while wearing the neck collar (see Table 1). The subjects placed their ears ($p < 0.03$) and head ($p < 0.01$) in a down position significantly more while wearing the head collar. There was no significant difference between the two collars for the measures of tail and body position.

Table 1
Average number of behavioral responses during physiological testing

Measure	Collar		Z score of mean comparison	p-value
	Neck	Head	z	p
Numerical Scores				
Looking at handler	15.7	5.9	2.405	< 0.01*
Vocalizations	2.0	0.38	1.845	< 0.065
Times placed	10.2	3.0	2.405	< 0.01*

Table 2
Average number of behavioral responses during obedience testing

Measure	Collar		Z score of mean comparison	p-value
	Neck	Head	z	p
Numerical scores				
Biting/fighting leash	0.0	8.2	4.476	$< 0.01*$
Pawing nose	0.0	4.5	3.070	$< 0.01*$
Dragging behind handler	2.6	3.5	0.308	> 0.075
Pulling ahead	5.6	0.0	3.306	$< 0.01*$
Corrections by handler	2.4	2.4	0.739	> 0.46
Looking at handler	14.1	7.2	3.733	$< 0.01*$

During the obedience portion of the testing, the subjects looked at the handler significantly more while wearing the neck collar and held their ears ($p < 0.01$) and heads ($p < 0.003$) in a down or lowered position significantly more while wearing the head collar. The subjects also held their body in a crouched position significantly more ($p < 0.007$) while wearing the head collar during the obedience exercises. There was no difference in the tail position between collars.

While wearing the neck collar, the subjects were significantly more unruly based on the posture and position ranking, and had to be placed into position more often, and pulled ahead of the handler. While wearing the head collar, the subjects fought the leash and pawed at their noses significantly more than while wearing the neck collar. There was no significant difference between the collars for the measures of vocalizations, dragging behind the handler and corrections made by the handler (Table 2).

5. Discussion

The postures of the dogs differed markedly with the type of collar. When wearing the head collar the dogs' heads and ears were lowered—signs of subordination or fear in dogs (Newton and Lucas, 1982). Overall, the dogs were more unruly and disobedient when wearing the nylon neck collar and had to be repeatedly repositioned for physiological measurements. While wearing the head collar, the dogs behaved in a more obedient and subordinate manner, but fought the leash and pawed at their noses.

A few studies in dogs have attempted to assess the stress response related to exercise (Hetts et al., 1992) and housing (Hubrecht, 1993) but no data have been published regarding behavioral training stress related to training methods. Situational factors such as age, sex, breed, and environment, can have an influence on how animals respond to the experience of training. This study has attempted to minimize the extraneous influences of these factors by utilizing each individual as its own control and by subjecting each dog to equal exposure and testing regimes.

Increases in sympathetic nervous activity and plasma ACTH and cortisol have been documented in animals under a variety of stressful circumstances (Moberg, 1985; Rushen, 1991). The adrenergic effect related to excitement, fear, pain or similar stressors is well known and mediated initially through the sympathetic nervous system. If stress persists, hypothalamic secretion of corticotrophin releasing factor stimulates the release of trophic hormones, particularly ACTH from the anterior pituitary. ACTH in turn causes an increase in secretion of corticosteroids into the circulatory system. These neurohumoral fluctuations assist physiological adaptation of the animal to an applied stress. In order to evaluate the physiological effects of training methodology, we chose to evaluate the results of those neural and endocrine alterations indirectly by analyzing changes in HR, BP, RR, PD, ACTH and cortisol.

Results of this study indicated that dogs restrained and controlled by a non-traditional nylon head collar exhibit no significant difference in HR, RR, BP, PD, plasma ACTH and cortisol values from dogs restrained and controlled by a traditional nylon neck collar. From the evaluation of results over the course of time devoted to testing, there was a trend for measured values of BP, HR, RR, and PD to diminish toward the end of the test. These responses suggest an accommodation to handling and control during the testing periods. These responses did not differ with the type of collar.

The head collar was designed to put maximum pressure on the back or scruff of the neck, with no pressure at the front of the throat from the neck strap, when the leash is appropriately pulled or tightened by the handler. Dogs respond to this pressure at the back of the neck as if it were to mimic signals of dominance in canine communication between two wolves (Mech, 1975) or two dogs who may put pressure on the back of the neck with head, teeth and paws in trying to establish or maintain leadership status in the hierarchy.

When the leash is pulled appropriately, the nose loop tightens to put pressure around the dog's nose and lower jaw, to close the mouth and control the direction of the head. This pressure around the muzzle appears to simulate the muzzle bite—mouth of a dominant wolf or dog around the muzzle of a subordinate—to communicate dominance and acknowledge submission (Schenkel, 1967; Mech, 1975).

This head collar is not a muzzle. Properly fitted, it allows a dog to open its mouth to eat, drink, pant, bark and bite, except when the leash is pulled to simultaneously tighten the neck and nose strap. The major pressure is at the back of the neck because the pulling exerts a straight-line force. Minor pressure is applied around the nose and lower jaw because the pulling force is reduced and limited by the acute angle (approximately 30 degrees) between the placement of the nose strap and the leash when pulled to control the head which is followed by the body.

Dogs also have strong instincts to pull against pressure; e.g., witness the common sight of dogs pulling forward, against the pressure of a neck collar when people walk their dogs on a leash. Pressure applied to the neck in this manner can compromise the airway (larynx, trachea) when dogs forge ahead against a leash. Conversely, head collars are designed to place major pressure at the back of the neck when the leash is pulled appropriately and cause dogs to pull back, not forward in response to the pressure at the back of the neck. Head collars use a dog's innate responses to pull back against pressure, instead of forward, and help prevent pulling ahead when a person is trying to walk a dog. Most dogs appear to respond quickly to these signals of leadership by handlers. However, as indicated in the results of this study, some dogs resist these instinctive signals of dominance and human leadership by trying to remove the head collar by pawing at the nose strap, and fighting the leash. These are natural responses of some dogs that want to resist control.

In clinical practice, the head collar has been prescribed to owners who present their dogs for treatment of behavior problems, most commonly, pulling on the lead while walking, excessive barking, jumping on people, chewing, failure to come when called and in some dominance problems with the owner (Houpt et al., 1996) or family members (Landsberg, 1990; Fogle, 1994). If appropriately used, it also may be helpful in managing a common problem, a dog's aggression toward strange dogs while in the presence of its handler. This head collar has been used by animal behaviorists as a part of a more complex treatment program in dogs with aggressive behavior although the manufacturer does not recommend this in general use (Landsberg, 1990; Beaver, 1994b).

The behavioral response of these laboratory dogs under controlled conditions, indicate that their behavior was more controlled and subordinate while wearing the nylon head collar than while wearing the nylon neck collar. This head collar design appears to be an effective means of restraint and may be useful in managing behavior in combination with other behavioral or pharmacological techniques (Beaver, 1994a).

The behavioral responses of these laboratory dogs, under controlled conditions, indicate that overall dogs were more unruly and disobedient when wearing the nylon neck collar compared to behaving in a more subordinate manner and under better control of the handler while wearing the nylon head collar.

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