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ScienceDirect
Behavioural Processes 78 (2008) 449–454
BEHAVIOURAL PROCESSES
www.elsevier.com/locate/behavproc

Does training make you smarter? The effects of training on dogs' performance (*Canis familiaris*) in a problem solving task

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Received 29 January 2008; received in revised form 22 February 2008; accepted 29 February 2008

Abstract

This study investigates the influence of training experiences on dogs' performance in a problem solving task, namely opening a box to obtain food. One hundred and eighteen dogs allocated to two different groups according to their training experience (no/basic training vs high level training) were tested. In each group the dogs saw the researcher manipulating either the paw-pad or the lid, prior to being allowed free access to the apparatus. No effect of the locus of manipulation was observed. However, there was a strong effect of training on the dogs' performance regardless of manipulation condition. Compared to untrained dogs, highly trained dogs were more successful in opening the box and spent significantly more time interacting with the apparatus; whereas untrained dogs spent significantly more time looking back at their owners and the researcher.

These results indicate that high levels of training improve dogs' problem solving ability, with dogs appearing to be more proactive in the their interaction with novel objects.

Keywords: Dog; Problem solving; Training

1. Introduction

Studies on the domestic dog have increased noticeably in the last 10 years, especially those concerning the dog's cognitive abilities and comprehension of human communication (Call et al., 2003; Collier-Baker et al., 2004; Hare and Tomasello, 2005; Osthaus et al., 2005; Schwab and Huber, 2006). Dogs have thus been shown to be highly proficient at following human referential gestures such as pointing (McKinley and Sambrook, 2000; Soproni et al., 2002; Brauer et al., 2006) and to learn via observation both from a human and a canine demonstrator in a number of situations (Pongrácz et al., 2001, 2005; Kubinyi et al., 2003; Topál et al., 2006; Range et al., 2007).

However, despite the fact that many pet dogs in everyday life undergo training programs ranging from basic obedience to participation in high level competitive activities (agility, working trials, schutzhund, etc.), comparably few studies have investigated the effect of training on dogs' lives and behaviour.

A number of studies have looked at the potential relationship between training experiences and the prevalence of behavioural problems, with mixed results. On the one hand, Voith et al. (1992) found no effects of obedience training on the likelihood of dogs showing problem behaviours and Podberscek and Serpell (1997) found that the type of training had no significant effect on their levels of aggression. On the other hand, Bennett and Rohlf (2007) found a negative correlation between training engagement and problem behaviours with trained dogs being more obedient and friendly, less aggressive towards strangers, family and other dogs and less nervous and prone to excessive barking. Similarly Kobelt et al. (2003) found a negative correlation between obeying commands and excessive nervousness and excitement, whereas both Clark and Boyer (1993) and Jagoe and Serpell (1996) found a decrease in behavioural problems following obedience training. Finally, Hiby et al. (2004), looked at the relationship between training methods and behavioural problems and found that owners of dogs trained

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0376-6357/$ – see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.beproc.2008.02.022

using punishment based methods or a combination of punishment and reward reported their dogs exhibiting significantly more problematic behaviours than owners of dogs trained using a reward-based method alone. Particularly there was a correlation between the use of punishment and an increased incidence of separation-related problems. Furthermore, reward-based methods of training, but not punishment based methods, positively correlated with ratings of the dogs' obedience in a number of different tasks.

A few studies have looked at factors affecting training success; for example Fukuzawa et al. (2005) report that non-verbal cues such as orientation and distance from the dog affect obedience of verbal commands; Meyer and Ladewig, 2008 showed that dogs trained once a week learn a given shaping exercise in significantly fewer training sessions than dogs trained five times a week and Smith and Davis, 2008 found that clicker-trained dogs learn an operant conditioning task as fast as a food-only-reward group of dogs, however extinction of the learned behaviour was significantly slower in clicker-trained compared to the food-only-reward trained dogs.

A topic which has so far received very little attention is the potential relationship between the training experience on the one hand and the dogs' cognitive abilities and comprehension of human communication on the other. Osthaus et al. (2003) found that clicker-trained dogs were faster in solving a string pulling task than non-trained dogs, whereas a recent study conducted by our own group showed that highly trained dogs are less prone to follow their owners' misleading indications in a food choice task than untrained dogs (Prato Previde et al., 2008).

In the current study, we presented trained vs untrained dogs with a problem solving task consisting of a food-box which could be accessed by either pressing a paw-pad or opening the lid with the muzzle. Before testing, dogs in both groups saw the researcher manipulate either the paw-pad or the lid, both to encourage dogs to interact with the apparatus and to assess whether dogs would preferentially open the box using the same part manipulated by the experimenter. Given Osthaus et al. (2003) we hypothesized that, overall, trained dogs would be more successful in the problem solving task than untrained dogs.

The translated version of Hsu and Serpell's (2003) C-Barq questionnaire, designed to evaluate a dog's behaviour in a number of situations and to highlight the presence of specific behavioural problems, was also used. A study conducted by Svartberg (2002) showed that dogs scoring higher on the 'boldness trait' (i.e. high on playfulness, curiosity and lack of fear) in a standardized behavioural test (the "dog mentality assessment" DMA) exhibited a better performance in a number of working trials requiring both obedience training and some degree of independent problem solving (such as tracking, searching, etc.). In a subsequent study, the same author (Svartberg, 2005) related the C-Barq questionnaire to the DMA and suggested that boldness (a DMA trait previously related to high performance in working trials) showed a highly negative correlation with non-social fear and stranger-fear and a more moderate positive correlation with trainability. Accordingly, we hypothesized that dogs successful in our problem solving task would score significantly higher in trainability and lower in the two fear categories of the C-Barq questionnaire.

2. Materials and methods

2.1. Subjects

118 dogs were tested (57 males and 61 females) age range between 6 months and 10 years (mean age = 3.87 years, S.D. = 2.62), 78 pure-breed (see Appendix A) and 40 mixed-breed.

Dogs were allocated to two groups according to their training experience. The Untrained Group included 62 dogs (30 males, 32 females) with either no formal training or having experienced only a basic training course (typically 10 lessons to learn the basic commands and how to walk on a loose leash). The Trained Group included 56 dogs (27 males, 29 females) with either current or past participation in high level training: 25 agility-trained dogs, 20 schutzhund trained dogs, six dogs trained in search and rescue on land and water, three dogs engaging in retriever working trials and two dogs trained in freestyle performances, with some dogs carrying out more than one activity.

Within each group dogs were randomly assigned to either the paw-pad or the lid condition.

2.2. Apparatus

The testing apparatus consisted of a commercially available yellow and blue plastic feeding box ('Slurp' – Mega srl, Bologna) 30 cm long (including the paw-pad) 20 cm wide and 12 cm high, which could be opened by pressing a paw-pad or nosing the lid; the box was securely fixed to a heavy wooden board (55 cm × 55 cm) placed within the testing area (see Fig. 1).

2.3. Questionnaires

Two questionnaires were used in the study. One questionnaire was specifically designed to provide background information

Fig. 1. The testing apparatus.

about the dogs (i.e. the dogs' characteristics, origin, living conditions, training experience and method) and the second questionnaire was the translated version of Hsu and Serpell's C-BARQ (2003). This questionnaire identifies a total of 11 subcategories, seven of which have been convalidated as diagnostic categories (stranger-directed aggression; owner-directed aggression; dog-directed aggression/fear; stranger-directed fear; non-social fear; separation-related behaviour; attachment/attention seeking) and the remaining four refer to specific experiences in the dogs' life (trainability; chasing; excitability; touch sensitivity). Of these subcategories we chose to focus on trainability, and the two fear categories (non-social and stranger-fear) to test our hypothesis.

2.4. Procedure

The testing took place in three different locations (of comparable sizes i.e. 10 m^2), according to the dog owners' availability. A relatively bare testing room at the Institute of Psychology of the University of Milan; an outdoor enclosed testing area at a dog training school (Bologna) and a similar outdoor testing area on the University of Parma campus. The chosen areas were all unfamiliar to the dogs. The behaviour of the dog and its owner during testing was video-recorded using a wide angle video camera positioned on a tripod located in one corner of the testing area (Fig. 2).

Prior to testing the owner was asked to enter the testing area with their dog who was allowed to freely explore the environment whilst the experimenter showed the owner the apparatus to ensure the dog was not already familiar with it, described the procedure to the owner and gave him/her the two questionnaires to fill in. In order to be sure that the dogs would be sufficiently motivated to perform the task, which involved obtaining food, the owners were requested to not feed their dogs in the 4 h prior to testing. In addition, the palatability of the food used was always evaluated by offering the dog a few pieces prior to testing. The owners were asked to remain seated approximately 30 cm behind the apparatus (out of sight of their dog when the latter was interacting with the box). Furthermore, throughout the test owners were asked to ignore their dogs, even if the latter sought their attention.

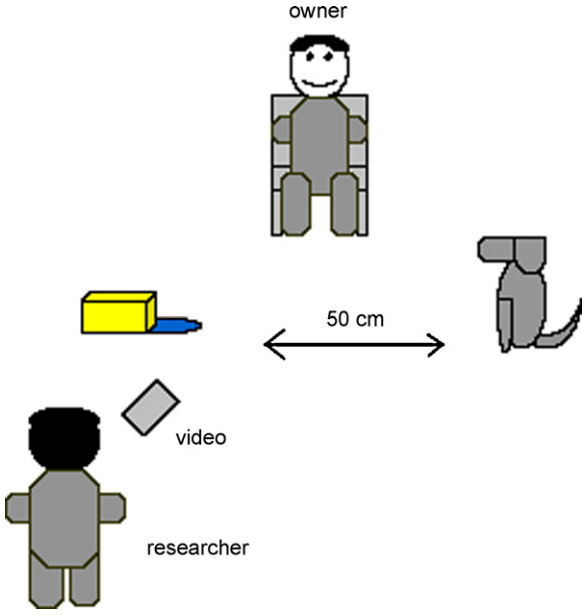

Fig. 2. The experimental setup.

Familiarization phase: All dogs saw the researcher drop a piece of food in the open box and were then verbally encouraged to take it. This was repeated three times. Dogs who did not take food from the open box were excluded from the study.

Manipulation phase: In the paw-pad condition dogs saw the researcher place food in the box and manipulate the paw-pad. In the lid condition, dogs saw the researcher place a piece of food in the box and manipulate the lid. If the dog was not looking at the researcher, she would call its name to gain its attention. In both conditions, the manipulation lasted 15/20 s.

Test phase: Dogs were allowed to freely move around the testing area and interact with the apparatus as they wished for a maximum of 2 min. During this phase the two people present (researcher and owner) ignored the dog completely.

2.5. Data collection and analysis

The Observer XT software package (Noldus Information Technology) was used to record the dogs' behaviour during testing. An observer blind to the subject's condition group (trained vs untrained) recorded the proportion of time spent carrying out the following behaviours in each trial: (1) Interaction with the apparatus, i.e. any physical contact with the apparatus including sniffing; (2) orientation to a person, i.e. orienting the body and/or head towards either the owner or the researcher; (3) orientation to the apparatus, i.e. orienting the body and/or head towards the box, without being physically in contact with it; (4) other, i.e. all other behaviours which typically consisted in walking around/exploring/sniffing the room and lying or sitting down with no particular orientation to either person or apparatus. The 'other' category also included when the dog was out of sight of the camera. Latency to open the box was also calculated. Thus, to summarize, for each dog we considered: success/failure in opening the box; latency to open the box; and the proportion of time spent carrying out each of the above-mentioned behaviours.

Chi-square tests were used to evaluate the number of dogs failing or succeeding in opening the box according group and condition. The Mann–Whitney test was used for between-group comparisons. Statistical tests were two-tailed and the α-value was set at 0.05.

3. Results

Of the 118 dogs tested eight (six females and two males) were excluded from the analysis because they did not take food from the open box prior to testing. Interestingly all these subjects were in the Untrained Group. This left us with 54 dogs in the Untrained Group and 56 dogs in the Trained Group.

Overall 50 dogs (45%) successfully opened the box with a mean latency of 65 s (range 1–119 s; S.D. = 42.59); 15 dogs

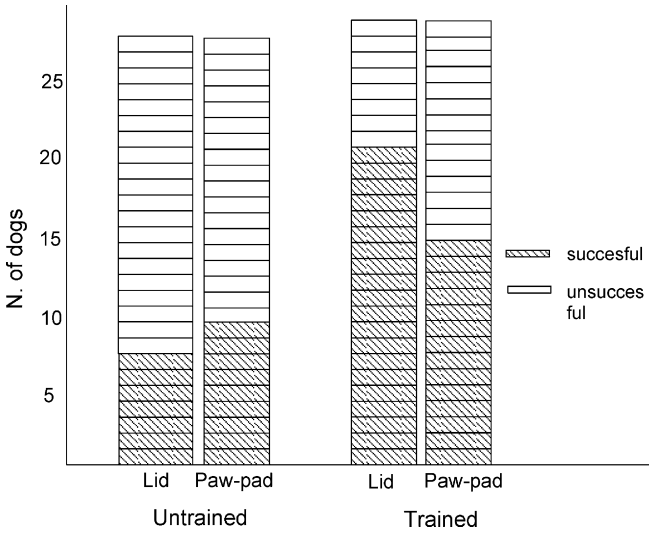

Fig. 3. The number of trained vs untrained dogs successfully opening the apparatus in the paw-pad vs lid condition.

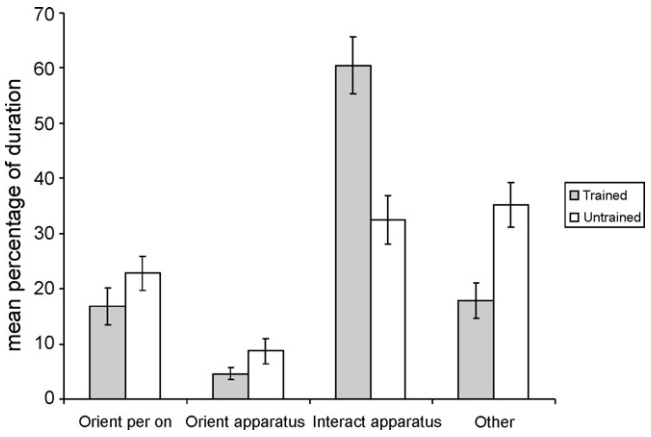

Fig. 4. The percentage of testing time trained vs untrained dogs spent carrying out each behaviour analysed.

opened the box by pressing the paw-pad, whereas 35 pushed the lid open with their muzzle.

There was no significant difference in the number of dogs successfully accessing the apparatus in the paw-pad vs lid condition ($\chi^2 = 0.59$; df = 1; $p = 0.44$), nor were there significant differences in the behavioural variables analysed (Mann–Whitney test $n_1 = 55$, $n_2 = 55$: orientation to apparatus, $z = -0.01$, $p = 0.99$; Interaction with apparatus, $z = 0.77$, $p = 0.44$; other $z = -1.07$, $p = 0.28$; orientation to person: $n_1 = 27$, $n_2 = 27$, $z = 1.34$, $p = 0.18$). Furthermore, considering only dogs who successfully opened the apparatus there was no significant difference in the latency to open the apparatus between the paw-pad vs lid condition (Mann–Whitney $n_1 = 23$, $n_2 = 27$: $z = -0.78$, $p = 0.47$) nor in the use of the paw-pad vs lid to open the apparatus ($\chi^2 = 1.43$, df = 1, $p = 0.23$). In fact the vast majority (70%) of dogs opening the box simply pushed the lid open with their noses and were equally distributed between the paw-pad (18 dogs) and lid (18 dogs) condition.

However, regardless of condition, significantly more dogs in the Trained Group successfully opened the box than in the Untrained Group (successful Untrained $n = 16$ vs Trained $n = 34$; $\chi^2 = 11.37$; $p = 0.0007$, Fig. 3). Furthermore, trained dogs spent significantly more time interacting with the apparatus (Mann–Whitney test: $n_1 = 56$, $n_2 = 54$, $z = -3.68$, $p = 0.0002$, Fig. 4) and significantly less time engaged in 'other' behaviour (Mann–Whitney test: $n_1 = 56$, $n_2 = 54$, $z = 3.5$, $p = 0.0005$) than the untrained ones. Untrained dogs however, spent significantly more time oriented towards a person than trained dogs (Mann–Whitney test: $n_1 = 56$, $n_2 = 54$, $z = 2.22$, $p = 0.026$) whereas groups did not differ in time spent oriented towards the apparatus (Mann–Whitney test: $n_1 = 56$, $n_2 = 54$, $z = 1.49$, $p = 0.17$) (Fig. 4).

The two most represented categories in the Trained Group were: agility (25) and schutzhund (20) trained dogs, thus an analysis was carried out to evaluate potential differences between these two groups in their opening success rate. However, no such difference emerged ($\chi^2 = 0.18$, df = 1, $p = 0.67$). Similarly, the number of successful dogs in the three locations were comparable ($\chi^2 = 3.37$; df = 5; $p = 0.64$), as was that between indoor and outdoor tested dogs ($\chi^2 = 1.9$; $p = 0.17$).

3.1. C-BARQ questionnaire

The completed C-Barq questionnaire was available only for 95 dogs (out of the 110 tested). Of the dogs with a completed questionnaire, 43 successfully opened the apparatus and 52 did not.

A Mann–Whitney test was carried out to compare these two groups on scores obtained in the trainability, fear of stranger and non-social fear categories of the C-Barq questionnaire. Successful dogs obtained a significantly higher score in trainability (Mann–Whitney $n_1 = 52$, $n_2 = 43$: $z = -2.54$, $p = 0.01$) and a significantly lower score in stranger-fear (Mann–Whitney $n_1 = 52$, $n_2 = 43$: $z = 2.11$, $p = 0.03$); no difference emerged in relation to the non-social fear category (Mann–Whitney $n_1 = 52$, $n_2 = 43$: $z = 1.34$, $p = 0.18$). There was however no significant difference between trained and untrained dogs on the trainability (Mann–Whitney $n_1 = 42$, $n_2 = 53$: $z = 0.14$, $p = 0.89$), stranger-fear (Mann–Whitney $n_1 = 42$, $n_2 = 53$: $z = -0.76$, $p = 0.45$) and non-social fear (Mann–Whitney $n_1 = 42$, $n_2 = 53$: $z = -1.32$, $p = 0.18$) scores.

4. Discussion

The current study set out to investigate the effects of the training experience on the dogs' performance in a problem solving task. Overall, we found that, regardless of manipulation condition, trained dogs interacted significantly more with the apparatus and were more successful in accessing the box than untrained dogs.

All the trained dogs tested, were (or had been in the past) involved in training for different activities (e.g. agility, schutzhund, retriever, search and rescue). However, none of these activities directly relate to a problem solving task such as the one presented in the current study. McKinley and Sambrook (2000) found that dogs trained as working retrievers were

more successful in following the human pointing gestures than untrained dogs. However, this is not surprising since following the handlers' directional indications is part of retriever training. In our case, as in Osthaus et al. (2003), there was no direct relationship between the dogs' training experience and the task presented in the study. However, in both cases highly trained dogs performed significantly better than dogs with only basic or no training at all. There are a number of factors in the dogs' training experience which may have resulted in an increased problem solving capability.

One possibility is that trained dogs acquire a specific 'learning to learn' ability that may be largely absent in the average pet dog population. In the current sample of dogs, the types of high level training the dogs underwent were very different. However, all the dogs' training included positive reinforcement methods i.e. obtaining either food or a preferred toy when exhibiting a correct response. Thus, the highly trained dogs were used to the idea of trying out a number of behaviours to obtain a reward. This kind of experience may induce a more proactive type of approach to novel problems, such as the one presented in our study. In a previous study (Prato Previde et al., 2008) we found that whereas there was no difference between trained and untrained dogs when they had to independently choose between a small and large quantity of food, highly trained dogs were less inclined than untrained dogs to follow their owners when the latter tried to convince them (vocally and by bodily orientation) that the visibly smaller quantity of food was better than the large quantity. Thus, the trained dogs were less dependent on their owners and more confidently solved the task ignoring their misleading information.

Further confirmation of a more proactive/independent approach by trained dogs is that they interacted with the apparatus significantly more than pet dogs, whereas the latter looked back at their owners or the researcher significantly more. A study by Miklósi et al. (2003) showed that compared to socialized wolves, dogs were equally successful in two independent problem solving tasks (i.e. removing a lid from a bin and pulling a rope to obtain food), although when the tasks were made to be impossible dogs quickly looked back at humans whereas socialized wolves did not. In our study pet dogs, being generally unused to solving problems on their own, may have perceived the task as "impossible" and thus looked back to their human companions for further information or help, whereas highly trained dogs set out to independently investigate the novel object, quickly discovered the solution and had no need to look back at humans for help.

A further aspect which needs to be addressed, is the relationship between training and a dogs' personality/characteristics and how this may relate to problem solving abilities. A study by Fuchs et al. (2005) showed that training at an early/juvenile stage of the dogs' development is associated with greater self-confidence and nerve stability (as assessed in the standard German shepherd behavioural test used for breeding approval in Switzerland). Furthermore, Svartberg (2002) found a positive relationship between the boldness dimension of the DMA and success in working trials.

Our study revealed no relationship between levels of training and the C-Barq factors considered (trainability, stranger-directed fear, non-social fear) but showed a significant correlation between trainability and lack of stranger-fear on the one hand and a better performance in the problem solving task on the other. Taken together these results suggest that other factors, aside from being trained, which may be related to the dogs' personality may influence the problem solving ability. Svartberg (2005) showed that trainability positively correlates with playfulness suggesting that this may be a factor influencing problem solving success.

Finally, the last 10 years have seen an extraordinary increase in the number of studies carried out to investigate the dogs' cognitive abilities; the current study suggests that it is important to take into consideration the dogs' prior training experience when selecting study subjects, since this variable may significantly influence results.

Acknowledgements

This research was supported by funds from PRIN 2006 to Emanuela Prato-Previde, by a doctoral grant to Sarah Marshall-Pescini from the same University and by funds from PRIN 2006 to Paola Valsecchi. We thank Marco Poli for allowing us to carry out the work in the Institute of Psychology and for his continuous support, and to Laura Sabbadini, Giulia Pedon and Elisabetta Ponzo for their invaluable help in data collection. Finally, we would like to thank all the owners and dogs that participated as volunteers. This research complies with the current Italian laws on animal welfare.

Appendix A

Pure-bred dogs included in the study were: 15 German shepherds; 7 Golden Retrievers; 8 Labrador Retrievers; 2 Flatcoat Retrievers; 1 Cheasapeake Retriever; 4 Terranova; 7 Border Collies; 2 Australian shepherds; 1 Australian cattle dog; 2 Shetland; 4 Beagles; 7 Boxer; 2 Doberman; 3 Argentinian Dogo; 3 Rottweiler; 1 Russian terrier; 1 Carlino; 2 Pincher; 1 Cavalier Kings Charles Spaniel; 1 Epagnol Breton; 1 Fox terrier; 1 Poodle, 1 Dogue de Bordeuex, 1 Jack Russel terrier.

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