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Limitations in the learning of verbal content by dogs during the training of OBJECT and ACTION commands

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ABSTRACT

Dogs have been shown to be able to respond to a variety of forms of verbally based referential communication from people. However, it is unclear how these abilities develop or what a word actually represents to a dog. In 2 experiments, 18 dogs were trained to respond to 2 different verbal commands independently. In 1 experiment, the 2 words were used to directing the dog toward a specific object (OBJECT commands). In the other experiment, the words were intended to direct the dog toward a specific action (ACTION commands). Subjects were then required to undertake a simultaneous discrimination within each type of command in a given context, to assess their representation of the semantic content of the commands. Dogs did not appear to use the content of the verbal command to guide their specific behavior in the initial assessment. Further training in a discrimination context to encourage attention to the verbal command had a variable effect on subjects. Only 1 dog reliably succeeded with the OBJECT commands, but 13 dogs succeeded with the ACTION commands. These results suggest that, in general, pet dogs do not appear to be especially attentive to the verbal content of commands for guiding their responses to spoken commands. This is in contrast to their tendency to use certain visual communicative signals such as gaze and pointing. The results also suggest that dogs might be more predisposed to associate verbal commands with actions rather than objects. These predispositions may not be apparent in many day-to-day interactions with dogs but may explain some apparently anomalous behavior and are important to appreciate if we wish to maximize the efficiency of training to verbal commands.

Introduction

People and dogs share not only the same environment but also a range of routines and activities where communication is key for successful operation. Dogs appear to be a species very well adapted to integration within the human environment, and it is reported that people talk to their dogs in a wide range of contexts (Boltz, 1989 cited in Mitchell et al, 1999). Communication seems to be an integral element of most human-dog relationships, and evidence that dogs can respond appropriately to communication provided by humans has led to a common assumption that their responsiveness is due to their ability to understand the words people use in communication (Pongracz et al, 2001; Ramos et al, 2006).

The "word" is a fundamental unit within human language, with different types of word serving quite different functions. Nouns refer to objects or concepts, verbs refer to actions, and it is thought that the different constructs within nouns and verbs may be learned in people using different mechanisms (Hirsh-Pasek and Golinkoff, 2006). How words are learned by humans is still a matter of some debate (Golinkoff et al., 2000), but it seems to require understanding at 2 levels that change with development and emerge from a combination of experience and inborn biases. At the first level, there are 3 fundamental principles, which are built upon established associative processes: (a) reference (i.e., words symbolize objects, actions, and events); (b) extendibility (i.e., words refer to more than the single original referent; they refer to categories); and (c) scope (i.e., words refer to a whole entity and not to parts of it or its attributes). The second level is composed of more cognitively complex principles, which allow the more rapid

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acquisition of language upon the bedrock established through first-level processes: (a) conventionality (i.e., the words we use should match the words other people use for communication to happen), (b) categorical scope (i.e., words label taxonomic categories), and (c) novel name-nameless category (i.e., new words map onto unnamed entities). Thus, despite a tendency to refer to word learning as a simple process of association, it seems to involve a range of complex cognitive abilities. Whether dogs have these or not remains questionable. According to Bloom and Markson (1998), some of the necessary requirements for word learning are shared by many other species (such as object categorization), but others are unique to humans (such as the use of syntactic cues).

Although humans frequently use words in their interactions with dogs, and dogs can respond appropriately to communication composed of words, it is not clear whether their responsiveness is comparable to word understanding in the same sense as it occurs in humans. A command word could be perceived as part of a complex multimodal signal by dogs (Mills, 2005) as it is often accompanied by various other predictive stimuli, such as changes in posture or action in the sender (Skyrme and Mills, 2009; Tempelmann et al., 2014), and its interpretation may vary with spatial and verbal context (Fukuzawa et al., 2005a; Braem and Mills, 2010) or in response to small phonemic changes (Fukuzawa et al., 2005b; Young and Ruffman 2015). However, Pongracz et al (2003) and Fukuzawa et al., (2005a) both report that a dog's performance decreases to a great extent when commands are delivered via a speaker. Nonetheless, there does appear to be some configural processing of verbal commands because dogs respond to the same command issued by different people, despite changes in its acoustic properties such as changes in pitch and harmonics between individuals. In this regard, it has been found experimentally that the decrement in performance following a phonemic change relates to the acoustic similarity of the change made (e.g., the verbal command "TUM" is similar to "COME" unlike "KUF," and there is less decrease in performance when the former is given in place of the "COME" command—Fukuzawa et al., 2005b).

An early case study concerning the dog Fellow suggested that dogs may have greater difficulty in responding to object-related commands compared to those directing action, in the absence of additional cueing (Warden and Warner, 1928). Nonetheless, it has been shown that some border collie dogs (i.e., Rico, Betsy, Chaser—Kaminski et al., 2004, 2009; Pilley and Reid, 2011, respectively) can respond reliably to hundreds and even thousands of words, referring to different objects. It has been argued that they are able to apply principles such as "the novel-name-nameless category" (whereby novel names can be mapped onto unnamed categories) and "fast-mapping" (the ability to learn the meaning of a new word on the basis of a few incidental exposures) to acquire the name of new objects (Kaminski et al, 2004; Pilley and Reid, 2011). However, the evidence for the use of such human-like abilities by dogs has been challenged. An alternative explanation to fast mapping has been demonstrated in subsequent experiments using necessary conditions outlined by Markman and Abeley (2004) (Kaulfuss and Mills 2008; Cracknell et al., 2008), although the potential for exceptional individuals is acknowledged (Tempelmann et al., 2014). A consistent feature of the documented cases of dogs with extensive object-related "vocabularies" appears to be the early integration of new object labels within a discriminative context during training (e.g., Kaminski et al, 2004, 2009; Pilley and Reid, 2011), and the potential importance of this context in shaping the dog's learning ability appears to have been overlooked, despite growing evidence of the brain developing a wide range of fundamental psychological categories largely as a result of exposure effects and discriminatory experience (e.g., Barrett 2009). It might be the case that in order for object-related words to be learned, they need to be taught in discriminative tasks right from the beginning and as early in life as possible.

The principle of extendibility in relation to object labeling has been shown to occur in the dog, even when training occurs outside of a discrimination learning task (Ramos and Ades, 2012). In the latter case, the dog's performance for the object component was never as high as her performance for the action component despite additional support being provided to aid the object-directed element of a command (Ramos and Ades, 2012). The potential limitations in a dog's use of the semantic content of object labels have not gone unnoticed by owners. In an international survey by Ramos et al (2006), owners generally believed that their dogs could understand words, but only a minority agreed with the statement that dogs could understand that a noun referring to an object could be applied to other objects in the same category. Similarly, Pongracz et al. (2001) reported that although words referring to objects and names were often used in association with actions (e.g., *Find the ball*! *Give me the stick*!) by owners, they believed that most of the dogs' responses were only executed properly in contextually adequate situations. These observations support the suggestion that the learning of verbal, and especially object-related, commands by dogs may be quite different to that which occurs in humans and more limited than is generally supposed. As Bloom (2004) concluded, "it is too early to give up on the view that babies learn words and dogs do not."

The present investigation was therefore undertaken to establish the nature of the learning that occurred by dogs when trained to verbal command referring to either objects or actions to better understand the limitations demonstrated in previous studies. It was hypothesized that if the dogs could learn the intended referential meaning of the command word (i.e., its association with either an object or action), during an initial training process that involved the simple association of command with either a particular object or action, then they should succeed during a subsequent task which required them to discriminate between different types of either object or action. Thus, the specific aims of the present investigation were as follows:

1. To determine if an association between either words and objects, or words and actions, learned in isolation can be used as a point of reference for successful discrimination of the same class of entity (i.e., discrimination from either other learned object or action label associations);
2. To determine if there are differences in the learning and subsequent performance of dogs to words referring to objects versus actions.

Experiment 1—OBJECT commands

What do dogs learn from the association of a word with an object?

Materials and methods

Subjects

The subjects were 18 dogs (15 females and 3 males), ranging in age from 6 months to 10 years, owned by local (Lincolnshire, UK) dog owners. They were recruited through local media coverage and selection was based mainly on the owners' interest and availability. Participants agreed to carry out training sessions with their dogs at home (following the instructions provided) as well as to bring their dogs to the university campus once a week for a training session with the same experimenter for up to 4 months.

The characteristics of each dog are listed in Table 1.

Table 1
List of participant dogs, their characteristics, and OBJECT commands used

Name	Sex	Breed	Age	OBJECT commands
Ripple	Female	Spanish water dog	2 years	"ball", "teddy"
Taffle	Female	Spanish water dog	4 years	"ball", "teddy"
Wys	Female	German spitz	9 years	"bally", "rope"
Kia	Female	Working cocker spaniel	2 years	"bally", "bone"
Luca	Male	Jack Russell	6 months	"bell", "rope"
Spot	Male	Crossbred	1 year	"wragga", "donkey"
Ruby L	Female	Labrador	3 years	"puppy", "bone"
Molly	Female	Labrador	8 years	"teddy", "rope"
Casey	Female	Labrador	5 years	"oinky", "dog"
Poppy	Female	Crossbred	10 years	"grunty", "ball"
Tinker	Female	Crossbred	9 months	"lobby", "ball"
Frances	Female	Poodle	3 years	"teddy", "ball"
Ruby BC	Female	Border collie	4 years	"horse", "ball"
Maddie	Female	Petit basset griffon vendeen	2 years	"teddy", "ball"
Dippy	Female	Staffordshire bull terrier	2 years	"bottle", "tuggy"
Buddy	Male	Border collie	3 years	"chicken", "hog"
Eddie	Male	Crossbred	6 years	"hot-dog", "dumbbell"
Dizzie	Female	Border collie	3 years	"chicken", "hog"

General training procedures

The training sessions at the University of Lincoln were conducted in a dedicated facility (10 m × 8 m) and were arranged from Monday to Thursday, between 9 AM to 5 PM with 1 hour of session given to each dog per week.

Specific training procedures

The owners were advised to select 2 of their dogs' favorite named toys. The objects (i.e., the toys) were then used in 3 consecutive training phases conducted both at the university by the experimenter and at home by the owners; however, only the results obtained at the university were assessed.

Phase A—Play context training. This constituted playful interaction with the dog and one of the objects at any given time. While playing, the trainer said sentences in which the OBJECT command (i.e., the name of the respective object) was emphasized at the end of it. For instance, if the object was a ball we might say: "Oh this beautiful BALL", "Where is your BALL?" and so on. This activity was undertaken within the first 15 minutes of arrival at the University on the relevant training day.

Phase B—Informal training. Using 1 object at any given time, we taught the dogs to undertake the same unnamed action (either a point at the object with its nose or a retrieve) toward the chosen object in response to the OBJECT command by rewarding successive approximations (sometimes using a food lure). Training to point was attempted initially in all cases, but some dogs did not take to this readily and tended to pick the objects up in their mouths. For these subjects, a fetching of the item upon OBJECT command was accepted, as the specific action toward the object was not relevant at this stage but the indication of it.

After between 1 and 5 weeks of training depending on the dog's promptness to indicate the object upon OBJECT command, the training became more formal and the dogs' performance was assessed. One object at any given time was placed on the floor at a 3-m distance from the trainer. The dog remained seated on a mat besides the experimenter (left side) until the OBJECT command (a single word) was delivered and the dog released. The dog was expected to indicate the item by pointing at it with its nose or fetching it (depending on the dog). At least 2 training sessions, one for each OBJECT command, were carried out consecutively on every training day at the university. Each session was composed of 10 trials of the specific OBJECT command.

To determine if some form of reliable association had been formed with the OBJECT commands, the performance of dogs in response to the OBJECT commands was evaluated on each training day visit: a 10-trial session was performed and the criterion for success was a 100% correct response (i.e., indicating the object by pointing it or fetching it upon command) within the session. In each session, only 1 object was available, and its respective OBJECT command was given over 10 separate trials. If the 100% correct threshold was not reached, training sessions were continued for another week and the process repeated until this criterion was met.

An audible "click" followed by a reward (food, treats, petting, and praise) was used for every correct response performed by the dog during training. Incorrect responses (i.e., the dog did not appropriately indicate the object) were followed by the word "no" in a normal volume and intonation, followed by a repetition of the command. If there was a repetition of the incorrect response, the dog was guided by the primary trainer to perform the correct response (i.e., the trainer pointed at the object or got close to it thus motivating the dog to indicate the object). This was done to help maintain the motivation of the dogs during training sessions.

Phase C—Formal training (discrimination task). Once criterion had been reached in phase B, formal training sessions started with the 2 objects simultaneously available in every session and their respective OBJECT commands delivered. In this stage, the dog had to use the information contained within the object command to determine which object it should approach. The 2 objects to which the dog had been trained were placed on the floor 1 m apart (separated by a barrier) at a distance of 3 m from the primary trainer. The dog remained seated on the mat besides the primary trainer (left side) until the command was delivered and the dog released (see Figure 1). The dog was then required to indicate the signaled object using the trained response. This was carried out in sessions of 10 requests (5 for each OBJECT command distributed randomly within the block). Left-right position of the objects was switched randomly according to a predefined schedule. By using a barrier, we forced dogs to make an unambiguous decision as to which object they were choosing, since to indicate a given object they had to enter its respective side of the barrier.

As in the previous phase, an audible "click" followed by a reward was used for every correct response and incorrect responses were followed by the word "no" in a normal volume and intonation, followed by a repetition of the command. The trial response was noted as incorrect, regardless of the dog's subsequent action. If

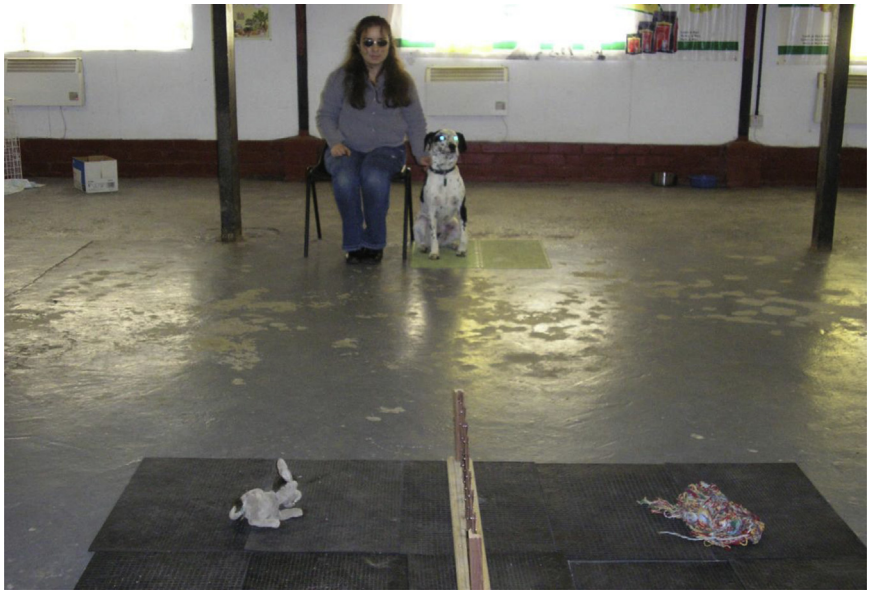

Figure 1. OBJECT commands: formal training (discrimination task: DONKEY on the left, WRAGGA on the right).

there was a repetition of the incorrect response at this time, the dog was guided by the primary trainer to the correct object (i.e., the trainer pointed at the correct object or got close to it thus motivating the dog to indicate the object). This was done to help maintain the motivation of the dogs during the training sessions. These sessions were done in pairs on different occasions until the dog chose the correct object 80% of the time, or until 15 sessions without reaching the criterion had been completed.

Subsequent test procedure

If a dog failed in the discrimination task, it undertook an additional assessment: A "Retention of Initial Knowledge" Test. This test consisted of 2 sessions of the previous phase B—informal training (i.e., one session for each OBJECT command) separated by a short break on the same training day. Specifically, the test sought to determine whether the initial learned response regarding the indication of the object individually presented upon OBJECT command had been retained after the 150 trials of phase C (15 training sessions) of unsuccessful discrimination. The same criterion of 100% correct responses in the 2 training sessions was established for success.

Statistical analysis

As phases A and B were preparation for the discrimination task with the latter testing whether the dogs had associated the verbal commands with a correct object reference, our statistical analysis focuses only on phase C results, although performance in all phases is reported at a descriptive level. The 80% correct response threshold within the first 2 sessions of the discrimination task (phase C) was calculated to be a statistically significant level of response, on the basis of a binomial probability distribution with a Bonferroni correction. Because 18 dogs took part in the task, and each was evaluated individually, a P value less or equal to 0.0027 (0.05/18) was needed for significant individual performance (this equated to at least 16 correct trials out of 20 within the discrimination task).

As a secondary outcome measure, for dogs that completed 15 training sessions (150 discrimination trials) without achieving the threshold for success, we estimated whether their average performance across all sessions exceeded the chance threshold using the same criterion. In addition, to determine whether there was an increase in performance to the OBJECT commands as a result of exposure to the extended discrimination task by those dogs completing 15 sessions, the trials were divided into 3 blocks (i.e., first 50 trials: sessions 1 to 5, middle 50 trials: sessions 6 to 10, and last 50 trials: sessions 11 to 15). The average percentage of correct responses to both OBJECT commands combined was then calculated for each block of trials per dog. A nonparametric test (i.e., Wilcoxon sample sign) was then used to assess pairwise comparisons between blocks. Finally, we evaluated if failure in the discrimination task was associated with a significant preference for a particular object using a chi-squared test.

Results

Play context and informal training (phases A and B)

After between 1 and 5 weeks of presentation of the OBJECT commands, all 18 dogs succeeded in performing with a 100% correct response rate, during 2 consecutive sessions of the individual presentation of the OBJECT commands. Nine dogs learned to point at the object upon the OBJECT command and 9 dogs used a fetch response upon the OBJECT command.

Formal training (discrimination task) (phase C)

None of the dogs initially achieved the criterion for success in the first 2 sessions (i.e., 80% correct performance). Only 1 dog (i.e., Dippy, a 2-year-old female Staffordshire bullterrier whose object commands were BOTTLE and TUGGY) subsequently succeeded following 13 discrimination task sessions.

When the average percentage of correct responses over all training sessions was considered, 4 dogs (Buddy: $P = 0.0001$; $G = 48.25$, Dippy: $P = 0.05$; $t = 2.14$, Kia: $P = 0.004$; $G = 31.75$, Spot: $P = 0.02$; $t = 2.60$) performed significantly above chance. There was no significant difference in the dogs' performance between the first block of 5 sessions and last block, nor between the first and second block, nor second and third block ($P = 0.0574$, $n = 17$; $P = 0.3323$, $n = 18$; $P = 0.4240$, $n = 17$, respectively).

Two of the unsuccessful dogs had an object preference (Casey whose object commands were OINKY and DOG, $P < 0.001$,

χ^2 test = 16.679, DF = 1; Taffle whose object commands were BALL and TEDDY, $P < 0.001$, χ^2 test = 38.679, DF = 1).

"Retention of initial knowledge" test

All 17 dogs that did not succeed at the discrimination task succeeded in the retention test, that is, they showed 100% correct responses in both sessions of the retention test.

Experiment 2—ACTION commands

What do dogs learn from the association of a word with an action?

Materials and methods

Subjects

All owners agreed to volunteer with their dogs for the second experiment (which started after a 2-week break from experiment 1). This experiment involved trying to establish a different type of verbal association using a similar method over a similar period of up to 4 months. Training was undertaken in the same experimental environment at the university.

Specific training procedures

The owners were given 2 unnamed and unfamiliar items (a plastic toy block and an empty can wrapped in tape—the same 2 objects were provided to all participant dogs). The items were then used in the following training procedures that were conducted in a similar way as before both at the university by the experimenter and at home by the owners, with only the results obtained at the university being assessed.

Phase A—Informal training. Each of the items given to the owners was used in combination with a particular ACTION command (i.e., POINT or SIT-BY). For instance, SIT-BY might only be requested in the presence of the can, and POINT only ever requested in the presence of the block. By way of initial training, using 1 unnamed item at a time, we taught the dogs the object-specific action by rewarding successive approximations using a food lure. POINT meant getting close to the item (preferably touching it with the nose) and then returning to the trainer. SIT-BY meant getting close to the item and staying sat beside it. None of the participant dogs had any previous experience with any of the 2 ACTION commands.

This training was carried out within about 4 weeks depending on the dog's promptness to perform the action upon the ACTION command. After this, the training became specific with the dogs' performance assessed as described in the following.

Phase B—Assessment procedure. The assessment procedure was in 2 parts: "Assessment of learning" followed by "Induction of learning" if necessary.

"Assessment of learning": To determine if some form of reliable association had been formed with the ACTION commands, the performance of dogs in response to the ACTION commands was evaluated at the University on each training day visit. Two training sessions, 1 for each ACTION command, were carried out consecutively. For each ACTION command, a 10-trial session using the unnamed item to which the new specific ACTION command had only ever been associated was performed. The criterion for success was a 100% correct response (i.e., performing the respective action for a given ACTION command) within the session. In each session, therefore, only 1 object was available, and its respective ACTION command was delivered across 10 trials.

An audible "click" followed by a reward (food, treats, petting, and praise) was given in accordance with a continuous reinforcement schedule when the dog did the designated behavior for that command. Incorrect responses were followed by the word "no" spoken at a normal volume and intonation, followed by a repetition of the command. If there was a repetition of the incorrect response, the dog was guided by the primary trainer to perform the correct response (i.e., the trainer lured the dog to perform the correct action). This was done to help maintain the motivation of the dogs during the training sessions.

If the dog met the threshold for success, it progressed directly to the Formal Training PHASE C (discrimination task), otherwise it undertook the "Induction of learning" task.

"Induction of learning": Two training sessions, one for each ACTION command, were again carried out consecutively. In the initial 5 trials of the session, the ACTION command was accompanied by a food lure (with the treat on the item in the case of POINT and in the hand of the trainer in the case of SIT-BY). Five trials then followed without any food luring. This training was conducted each week until success was achieved. The criterion established for success was 100% correct response rate to the last 5 trials of each training session (i.e., the trials in which the ACTION commands were delivered without a lure) for both commands. The dog then moved on to the formal training phase C (discrimination task) described in the following.

Phase C. Formal training (discrimination task). Formal training sessions involved both ACTION commands being delivered 5 times in a single session. The 2 objects were placed together on the floor, at a 3-m distance from the primary trainer, one on the top of the other as if it was a "composite item" (which element was above the other varied between dogs). The dog was required to remain seated on a mat besides the trainer (left side) until a command was delivered. A single ACTION command was given, and the dog was released. The dog was then expected to perform the relevant action toward the "composite item" (see Figure 2).

By associating each of the ACTION commands with a specific item during the informal training, we facilitated the creation of a visual stimulus association for the given action. If this occurred, we hypothesized that when they were put together in the discrimination task as a "composite item," some form of visual interference might occur as might have been the case during the OBJECT command discrimination task; for instance, in the case of a dog that had associated the ACTION command POINT with the block and SIT-BY with the can. When the trainer said POINT and the dog moved toward the "composite-item", it could see both a block and a can which were each part of the composite-item. Reinforcement of appropriate responses and correction of errors were as described in the previous phase.

Subsequent test procedure

As with experiment 1, dogs that were still failing the discrimination task after 15 sessions (150 trials) were submitted to a similar "Retention of Initial Knowledge" Test.

Statistical analysis

Statistical analysis was as described for experiment 1.

Results

Informal training and assessment procedure (phase A and B)

After 4 weeks of presentation of the ACTION commands with concomitant use of a food lure, all dogs failed to reach a 100% correct response rate threshold, during 2 consecutive sessions of the ACTION commands for the "assessment of learning." Following the "Induction of learning" procedure, all dogs eventually

Figure 2. ACTION commands: formal training (discrimination task: SIT-BY on the left, POINT on the right).

succeeded in performing at the 100% level of correct responses for both individual ACTION commands sessions.

Formal training (discrimination task) (phase C)

All dogs failed to reach the 80% threshold for performance in the initial discrimination task. However, within the subsequent sessions, 13 dogs reached this threshold before the end of the 15th session.

Ten dogs had average performances significantly above chance levels across the sessions they completed (Casey: $P = 0.003$; t = 6.00, Dippy: $P = 0.05$; t = 2.16, Dizzie: $P = 0.0001$; G = 33.03, Eddie: $P = 0.02$; t = 2.47, Frances: $P = 0.0001$; t = 4.89, Kia: $P = 0.008$; t = 4.80, Luca: $P = 0.006$; t = 3.50, Maddie: $P = 0.04$; t = 2.99, Ruby L: $P = 0.001$; t = 4.96 and Taffle: $P = 0.05$; t = 3.28).

There were no significant differences between the dogs' performance for any 2 blocks of 5 sessions (Wilcoxon signed-rank test, 1 vs. 3 $P = 1.0000$, n = 7, 1 vs. 2 $P = 1.0000$, n = 10; 2 vs. 3 $P = 1.0000$, n = 7).

Three of the 5 unsuccessful dogs appeared to have a response bias as there was a significant association between the correct responses and one of the ACTION commands (Molly—$P < 0.001$, χ^2 test = 109.714, DF = 1; Ripple—$P < 0.001$, χ^2 test = 40.589, DF = 1, Wys—$P < 0.001$, χ^2 test = 32.690, DF = 1).

"Retention of initial knowledge test"

All 5 dogs who failed in the discrimination task also failed to achieve a 100% success in the 2 consecutive sessions of the ACTION commands presented in isolation.

Additional analysis for comparison of experiments 1 and 2: Do dogs appear to be better at responding to action or to object verbal commands?

The percentage of average correct responses by dogs during the discrimination task of OBJECT commands (experiment 1) and ACTION commands (experiment 2) were compared using a t-test for parametric data. In experiment 1, the average correct responses per session was 5.34 (SD = 0.52), and in experiment 2, it was 6.42 (SD = 1.05); this difference was significant (t = 3.64, $P = 0.002$).

The significance of the difference in the number of dogs passing each form of discrimination task (i.e., 1 dog passed in experiment 1 vs. 13 dogs passed in experiment 2) was also assessed using a Wilcoxon signed-rank test ($P = 0.0022$). This showed that significantly more dogs passed the ACTION than OBJECT commands discrimination task.

Discussion

These results support the suggestion that dogs are more predisposed to make associations between words and actions than words and objects. In experiment 2, significantly more (and most) dogs succeeded eventually with the discrimination task and their performance was overall better than in experiment 1. Although there was an order effect, we think it is unlikely that this can explain the results because the tasks were different in the 2 experiments and if anything, exposure to trying to build an object-word association in the first experiment may be expected to interfere with the learning of an action-word association in the second one. It seems that whatever association was formed with the verbal commands during the informal training, it was conducive to success in the discrimination task in the case of the ACTION commands, but not in the case of OBJECT commands. It is also worth noting that in the retention of initial knowledge task, all dogs who had failed the discrimination task successfully performed the required action to the object in experiment 1 but none succeeded in experiment 2. This would suggest that the association that might have become established in the informal training of the object-word association was not broken by its persistent failure to help solve the subsequent discrimination task. A parsimonious explanation for these results is that dogs are semantically predisposed to form action-word associations and that in the first task, rather than learn that the 2 words referred to the specific objects, it might be that they learned 2 words for the same action. This explanation is also consistent with the hypothesized evolutionary pressure that may have come to bear on verbal communication with dogs during domestication, which we suggest have focused more on the control of action rather than definition of a target. The object to which an action needs to be directed is often self-evident (e.g., during hunting, dogs will identify the best game to track, chase, kill, or retrieve). When this is not the case, the object may be preferentially indicated by gestural cues, even remote directional ones, to which dogs are known to be very sensitive (Hare et al., 1998; Hare and Tomasello, 1999; McKinley and Sambrook, 2000; Miklosi et al., 1998; Soproni et al., 2001). Thus, a preferential ability to associate words with actions rather than objects may have been selected for. This would be expected to result in particular biases in the type of referential associations made during semantic learning by dogs, which may not be readily evident except in experiments such as the one reported here.

These results may appear surprising because dogs have been extensively tested successfully in different discrimination tasks (e.g., Tapp et al., 2004) especially with a view to assessing cognitive skills. However, in these cases, words alone are not used as the basis for discrimination, or else learning took place in a discriminative context from the outset (e.g., Kaminski et al., 2004; Young 1991), and such factors may be important aids to the semantic learning process.

An alternative explanation is that the dogs learned the correct verbal associations, but the discrimination task represented a novel context situation compared to the informal training, which impaired performance (Braem and Mills, 2010). For instance, during the discrimination task, both objects were present on the floor (as opposed to only one) separated by a wooden barrier. The dogs' failure might reflect a problem with the first-level principle of extendibility, an inability to apply the previously learned association to a new context (i.e., context-specific learning, McDonald et al., 2001) rather than a failure due to the nature of the referential content of the verbal commands. However, in this situation, we would expect the correct response to emerge with appropriate reinforcement during the continuation of the discrimination task, which was not the case, so this explanation seems unlikely.

Possible strategies that could lead to success during the informal training, but failure in the initial discrimination task described here, relate to the development of a response based on nonverbal contextual cues during the training sessions. During the OBJECT command sessions, dogs could simply learn that they should indicate whatever object was placed on the floor, whereas during the ACTION command sessions, they might learn to habitually repeat whatever action response was initially lured, without attending to the content of the command or necessarily the object present. Alternatively, in the ACTION command sessions, the dogs could use the item on the floor, as a visual cue for a specific action response (e.g., if a block is placed on the floor, then "point" should be performed; if a can is placed then "sit-by" should be performed). In all these cases, the verbal command would simply serve as a nonspecific releasing signal, as they always preceded the release of the dogs to perform their behavior. This would indicate a much greater limitation in the application of the referential principle involved in semantic learning in dogs.

The preparatory training occurred at home and at the university, but, given the results, this did not appear to contribute to their learning of the verbal associations. Thus, although some (e.g., McKinley and Young, 2003) have claimed that socially complex forms of training involving dialog can be used as an alternative method to train dogs to respond to verbal commands such as the names of objects, this study supports the criticism of this method in favor of a simpler mechanism based on stimulus enhancement (Cracknell et al., 2008). Indeed, it may be that the learning of language from exposure to the linguistic term exclusively within dialog, that is, without any physical grounding such as through the demonstration of some differentiating function or physical property (e.g., Fugazza and Miklosi, 2015), requires a degree of symbolic representation (Harnad, 1996), which may exceed the ability of the dog in some contexts. Nonetheless, studies have suggested that dogs can learn abstract associations such as those between visual symbols and actions or objects (Rossi and Ades 2008). However, it might be that there is greater limitation of this ability within aural semantics, that is, the use of language, which is uniquely used by humans.

Although our results suggest a difference in the dogs' responses to OBJECT and ACTION commands, we acknowledge that there was an inevitable difference between the 2 discrimination tasks means they were not identical. In the OBJECT discrimination task, both objects were physically available at the training setting, so, for instance, if the command "ball" was given to a dog and the dog was moving toward the ball to indicate it, the other object (e.g., rope) was visible to the dog as it was placed beside the ball. It is possible that this distracted the dogs. In the case of the ACTION command discrimination task, although separate stimuli were used to try to provide an analogous situation, the 2 responses were not concurrently competing in the same way as the objects were. Nonetheless, by associating each of the ACTION commands with a specific item during the informal training, we enabled the creation of a visual stimulus association for the actions. If this had occurred, then, when they were then put together as a "composite-item," some form of visual interference might have occurred as might have been the case during the OBJECT command discrimination task; for instance, in the case of a dog that had learned the ACTION command "point" in association with the block. When the trainer said "point" and the dog moved toward the "composite-item" to point at it, he could see the can which was part of the composite-item for the action "sit-by" (as the ACTION command "sit-by" would only ever have been associated with the can). However, this would only occur if in fact the dogs had learned visual associations between the specific items and their ACTION commands. If this was not the case, the "composited-item" likely acted merely as an unnamed object toward which dogs displayed the commanded action without the visual interference of the other trained action.

These results also highlight the need for other studies to detail how dogs have been trained to respond to verbal commands. The lack of this information in many other language understanding studies involving dogs (e.g., Kaminski et al., 2004; Warden and Warner, 1928) restricts our ability to evaluate the underlying mechanism to what is being expressed. An interesting exception to this is the learning of over 1000 object labels by Chaser a young border collie (Pilley and Reid, 2011). A potentially key difference in the protocol used in the present study, compared to that used with Chaser, is the variation and intensity of enhancement given to the object and the variety of interactions, which may have an enormous influence (Topal et al., 2014). Dogs are clearly able to learn to respond to people based on an understanding of nonverbal as well as contextual signals (e.g., Kubinyi et al., 2003; Viranyi et al., 2004) and it could be that they apply these skills to respond to people even when word understanding would be a more obvious option to a human.

Whatever the answer, this study may be a further example of a different predisposition in dogs compared to humans when learning to associate words with objects (see van der Zee at al., 2012 for another example). These results may have important practical implications when it comes to general dog training and behavior modification plans in which words are commonly used to guide dogs in their behavior. In these contexts, our expectations for the promptness of their learning and subsequent generalization of performance beyond the training context may be high and unrealistic. Human and dog minds may have different learning predispositions.

Our results also highlight the need for further studies with better controls to elucidate which associations dogs may make in complex learning environments (Gergely et al., 2014; Tempelmann et al., 2014; Gerencsér et al., 2016). For instance, the use of food as a lure and its potential to bias the dog's attention toward the food rather than learning—a phenomenon known as overshadowing (Pavlov, 1927) deserves better investigation. Dogs may benefit from differing training techniques to learn most efficiently to respond to OBJECT as opposed to ACTION commands.

Conclusions

Our results indicate that dogs appear to have difficulty in associating words to objects in a simple associative way during training but have less difficulty in associating words with action responses in this context. These findings are consistent with the suggestion that word learning and comprehension by dogs may be less analogous to the comparable processes in humans than has been claimed (Kaminski et al., 2009). However, we also agree with Bloom and Markson (1998), that word learning is not a result of simple associative learning, but rather that it requires more complex

cognitive abilities (Gergely et al., 2014). Clearly, some dogs show remarkable performance in response to linguistic cues (e.g., Sarris, 1931; Ramos and Ades, 2012; Kaminski et al., 2004, 2009; Pilley and Reid, 2011) and it would be useful to know why that is the case.

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