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More than just a word: non-semantic command variables affect obedience in the domestic dog (*Canis familiaris*)

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Abstract

Dogs were initially trained to respond reliably to 'sit' and 'come' commands, when these were issued randomly in a variety of contexts. Then in a first experiment, the posture of the person giving the command, eye contact and the mode of delivery of the command were varied. Performance declined significantly when a tape-recorded version of the command was used and when the eyes of the experimental trainer were obscured with sunglasses when using the tape, but not when the sunglasses were used with the oral command. In a second experiment, the distance and position of the experimental trainer relative to an opaque screen were changed. Performance declined when the experimental trainer stood approximately 2.5 m away and was partially obscured by a screen. Response to the sit but not come command declined when the experimental trainer turned her back on the dog prior to issuing the command at this distance, but not when the experimental trainer subsequently stood behind the screen at this distance. The results suggest that non-verbal features moderate responsiveness to the command, and that this effect may depend partly on the dog's familiarity with the command possibly within a given context and the perceived proximity of the commander from the dog.

Keywords: Behaviour; Cognition; Dog; Learning; Stimulus generalisation; Training

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1. Introduction

Training describes the techniques used to ensure that learning comes about in a predictable way in response to human intervention (Mills, 2002). The theory behind the popular practice of dog training is well established (e.g. Reid, 1998) but there has been remarkably little work examining the actual training process. Training requires the effective transfer of information between two different species. The information transferred depends not only on the physical characteristics of the command signal but also its context. The importance of non-verbal signals during verbal exchanges is widely recognised in the human (Burgoon et al., 1996) and during training, good trainers recognise that they issue more than an oral command. Posture, eye contact and movement may also be relevant to the response elicited. It is well known that the eyes play an important role in canid communication. Gazes may be exchanged between individuals during vocal interactions, and the direction of these may affect the subsequent responses (Bradshaw and Nott, 1995). Barriers to communication during training may relate to problems with the clarity of the signal sent or the interpretation of the message received. In order for a message to be clear, signals relating to the same message should be congruent and unambiguous. As far as the physical properties of a command are concerned, the command stimulus is not a simple discriminative stimulus. It varies in pitch, tone, expression, and context from one occasion to another. Gender, age, individual voice characteristics, feeling, emotion, and environment all affect the auditory information provided (Burgoon et al., 1996). Thus, the dog must be able to discriminate specific key elements of the command from more variable elements. A dog's hearing frequency range is between 47 and 44,000 Hz, and they are very sensitive to high frequencies (Heffner, 1983, 1998). Given the importance of auditory cognition in determining the response, the dog makes to a command, there has been surprisingly little work on the subject (McConnell and Baylis, 1985; McConnell, 1990; Kowalska, 1997; Kowalska et al., 2001).

Therefore, the aim of this experiment was to evaluate the effect of changes to the auditory properties of a command and the context of its presentation on obedience performance in a variety of dogs. In the first experiment, the effect of varying different signals relating to the delivery of the message was assessed, whilst in the second, the effect of physical factors relating to the spatial relationship between the experimental trainer and the dog was considered.

2. Materials and methods

In order to examine the effect of command and its context on performance in the dog, experimental subjects were initially trained to reliably perform 'come' and 'sit' responses on command from a 'stand and stay' position in the presence of the experimental trainer. Reliability was said to have been achieved when the dog performed at least 17 correct responses out of a series of 20 commands (85% response rate). Experimental tests began with subjects in the 'stand and stay' position and the commands 'sit' and 'come' were then given according to a predetermined schedule. The response of subjects and the time taken for subjects to achieve the 85% threshold level of response reliability was then measured for each test. The same experimental trainer (MF) was used throughout the study.

2.1. Experiment 1—effect of different signals relating to the delivery of the message on obedience

In this experiment the effect of the experimental trainer's body posture (standing versus seated), eye contact (no glasses versus blackened glasses) and command source (live command versus a recording of it) on obedience performance in the dog was examined.

2.1.1. Animals

Six pet dogs were used as experimental subjects, none of which were owned by the experimental team. Three were of mixed breed, one an English Springer spaniel, one a Border collie, and one a Golden Retriever. One was female and five were male. Age ranged from 1.9 to 6 years. All dogs had received basic training by their owners and were familiar with the commands 'sit' and 'come' prior to the start of the trial.

2.1.2. Training room

For each training session, the dog was brought from its day kennel at the university to a dedicated training room, with a floor area measuring 2 m $\times$ 2.7 m. The room consisted of an open space with a single chair.

2.1.3. Training procedure

Training was organised into five trials which required the dog to perform with the 85% success rate described above to the two commands 'sit' and 'come' before it could proceed to the next trial. Training in a given trial was conducted in blocks of 10 exercises (five 'sit' and five 'come' arranged randomly within the session). There were four blocks each day, two in the morning (09:30–12:00) and two in the afternoon (13:30–16:00). Dogs were allowed a short rest between each morning and afternoon block, in order to ensure the maintenance of performance to the commands. A dog did not proceed to the next trial until both command responses reached criterion (criterion being at least 17 correct responses out of 20 exercises in a day).

The experimental trials controlled for human body posture, eye contact and the form of delivery of commands. At the beginning of each experimental training trial, the experimental trainer gave the standard 'stand and stay' command to the dog, before any training was started.

In trial 0, the experimental trainer stood in front of a chair and gave the command to the dog. In trial 1, the experimental trainer sat on a chair to restrict other body signals when presenting the commands. In trial 2, the experimental trainer wore black glasses whilst sitting on the chair as before. Black glasses eliminated eye contact between the experimental trainer and the dog. In trial 3, the experimental trainer remained seated on the chair but removed the black glasses and commands were presented from a tape recording of the experimental trainer's voice played on a tape-recorder (SANYO: Compact Cassette Recorder, M–1100C). The tape-recorder was placed on the chair behind the experimental trainer in order to prevent the dogs from recognising when the tape-recorder was operated.

Table 1
Structure of the five training tasks used in experiment 1

Trial no.	Context of command presentation		
	Seated	Black glasses	Tape-recording
0			
1	+		
2	+	+	
3	+		+
4	+	+	+

In trial 4, the experimental trainer wore black glasses sat on the chair, and used the tape-recorder. Details of the trials are summarised in Table 1.

2.1.4. Statistical analysis

The following measures were collated: the percentage of correct responses in each session within each trial and the number of sessions required to reach the criterion for that trial. Initial analysis assessed the effect of dog and treatment trial on the number of sessions to reach criterion. The decline in performance between the end of one trial and the start of another was assessed using a Wilcoxon signed-ranks test on the percent of correct responses in the last day of one trial and the percent correct responses in the first day of the next trial.

2.2. Experiment 2—effect of spatial factors surrounding the delivery of the command on obedience

2.2.1. Animals

Subjects were 10 pet dogs, including three dogs used in the previous experiment. Two were German Shepherd dogs (one female, one male), three Rhodesian ridgeback (three female), one an English Springer spaniel (male), and four mixed breed (two female, two male). Age ranged from 10 months to 7 years. All dogs had received basic training by their owners to the sit and come commands.

2.2.2. Training room

For each training session, the dog was brought from its day kennel on the university site to an experimental room (10 m × 25 m). The experimental room consisted of an open space with a gridded training area floor measuring 2.76 m × 3.5 m (Fig. 1). The grid was marked on the floor with insulating tape, and there was a screen (*H*: 2.7 m × *W*: 1.26 m) on the line of demarcation between zone D0 and zone E0.

2.2.3. Training procedure

In this training, a bridging stimulus (a clicker or flash light) was introduced together with a food reward. A clicker was preferably used but if a dog was startled unduly by the sound of a clicker, the experimental trainer used a flashlight instead of the clicker ($n = 3$).

All dogs were trained individually to respond to the ‘stand and stay’ command at a fixed position (zone A0) with the dog and the experimental trainer facing each other. Once the

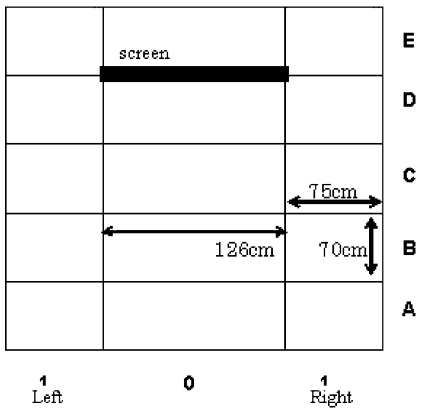


Fig. 1. Plan of the training area used in Experiment 2. A screen (H: 270 cm × W: 126 cm) was set on a line of demarcation between zone D0 and zone E0 during all experimental procedures. Dogs were required to 'stand and stay' in zone A0. In the trials, the position of the experimental trainer was shifted step by step to zone C0, D0, D1 (both sides), E1 (both sides), and finally E0.

dog had learnt the command 'stand and stay' completely, the training trials were started. Training was conducted in sessions of 40 exercises, divided into blocks of 10 exercises (five 'sit' and five 'come' arranged randomly within the session). Both commands were presented without obvious emotion as a 'neutral' emotional cue. There were four blocks each day, two in the morning (09:30–12:00) and two in the afternoon (13:30–16:00). Dogs were allowed a short rest between each morning and afternoon block, in order to maintain the performance of the dogs in response to the commands. Training was organised into five trials, which required the dog to perform with an 85% success rate to two commands, 'sit' and 'come' before it could proceed to the next trial. As in the first experiment, if a dog reached criterion for one command, the dog would not proceed to the next trial until the other command response also reached criterion. Both commands continued to be presented randomly at this time.

The experimental trials controlled the experimental trainer's standing position (i.e. command presentation position). At the beginning of each experimental training trial, the experimental trainer gave the 'stand and stay' command to the dog from a fixed position (zone A0), before any training was started.

In trial 1, the experimental trainer stood facing the dog in front of the screen at close range (zone C0). In trial 2, the experimental trainer stood facing the dog in front of the screen at a short distance (zone D0). In trial 3, the experimental trainer stood to the side of the screen (zone D1). In trial 4, the experimental trainer stood behind and to the side of the screen (zone E1). In trial 5, the experimental trainer stood in zone E1, but turned away from the dog (i.e. the dog saw the back of the experimental trainer). During trials 3, 4, and 5, the experimental trainer stood on the right or the left side of the zone according to a predetermined random sequence. In trial 5, the dog's starting position was checked by a small mirror (14 cm × 9 cm), which was set up on a table (80 cm above the floor) to the side of the experimental trainer outside the training area. In trial 6, the experimental trainer hid behind the screen completely (zone E0), and checked the dog with the mirror as in trial 5. The mirror was located on the left, outside of the training area.

2.2.4. Statistical analysis

A Wilcoxon signed-ranks test explored the differences in the number of exercises which it look for a command to reached the criterion in each trial. Data collected in response to both commands were also analysed on a percent correct basis, i.e. the percent correct on a given day within a given trial. The number of days required to reach the criterion for that trial was also recorded. Initial analysis assessed the effect of dog and treatment trial on number of sessions to reach criterion by using an ANOVA. The decline in performance between the end of one trial and the start of another was assessed by using a Wilcoxon signed-ranks test on the percent of correct responses in the last day of one trial and the percent correct responses in the first day of the next trial.

3. Results

3.1. Experiment 1

3.1.1. Time taken to reach criterion for each command

For both commands, there was a statistically significant difference in the number of training sessions required to reach criterion in the different training trials (ANOVA: 'sit', $F[4,29] = 12.37$, $p < 0.001$; 'come', $F[4,29] = 11.89$, $p < 0.001$), however, dog was not a significant factor ('sit', $F[5,29] = 1.59$, $p = 0.21$; 'come', $F[5,29] = 1.90$, $p = 0.14$). The number of training sessions required for dogs to reach the criterion in training trial 3 (tape issued commands whilst seated without glasses) was significantly greater than the other training trials for both commands, i.e. trial 0–3, 1–3, 2–3, and 4–3 (Tukey, $p < 0.05$) (Table 2).

Table 2
Number of training sessions to reach criterion within each training trial for each dog

Dog	Training trial no.				
	0	1	2	3	4
'Sit'					
A	6	2	3	9	3
B	6	1	3	4	5
C	4	3	3	13	3
D	1	1	1	12	5
E	5	3	1	10	6
F	11	1	2	18	7
'Come'					
A	6	2	3	9	3
B	6	1	2	4	5
C	4	3	3	13	3
D	1	1	1	12	6
E	5	3	1	10	6
F	11	1	2	20	8

Table 3
Change in error rate between the end of one trial and the start of the next

Dog	Trial transition			
	0–1	1–2	2–3[a]	3–4[a]
'Sit'				
A	0	0	+6	+5
B	0	+2	+11	+2
C	+4	+2	+14	+4
D	0	+1	+11	+3
E	+2	0	+20	+4
F	−1	−1	+9	+7
'Come'				
A	0	+1	+9	+3
B	0	+4	+11	−1
C	+2	0	+20	+4
D	−1	+1	+11	+5
E	−1	−1	+19	+2
F	0	+1	+8	+6

[a] $p < 0.05$, Wilcoxon signed-ranks test.

3.1.2. Transition between training levels

The difference between the number of errors in the last session of one trial and the first session of the next for each dog across the five trials is shown in Table 3.

For both commands there was a significant increase in the number of errors between trial 2, in which the experimental trainer wore black glasses whilst sitting on a chair and trial 3, in which the experimental trainer remained seated, removed the black glasses, and issued commands via a tape recording ($T = 21$, $p < 0.05$ for both), and between trials 3 and 4—glasses on ('sit' $T = 21$, $p < 0.05$, 'come' $T = 19$, $p < 0.05$).

3.2. Experiment 2

3.2.1. Time taken to reach criterion for each command

The number of training sessions in each training trial for each dog (Table 4) did not differ significantly for either the 'sit' (ANOVA: $F[5,59] = 0.51$, $p = 0.765$) or 'come' ($F[5,59] = 1.58$, $p = 0.185$) commands. Dog was a significant factor for the 'come' ($F[9,59] = 2.21$, $p < 0.05$) but not the 'sit' ($F[9,59] = 1.37$, $p = 0.231$).

3.2.2. The transition to new training trial

The difference between the number of errors in the last session of each trial and the first session of the next for each dog across the six trials is shown in Table 5. There was a significant increase in the number of errors between trial 3, in which the experimental trainer stood to the side of the screen (zone D1) and trial 4, in which experimental trainer stood beyond the screen, but did not hide behind the screen ('sit', $T = 43$, $p < 0.05$; 'come', $T = 49$, $p < 0.01$). There was also a significant increase in the number of errors between trials 4 and 5, in which the experimental trainer stood behind the screen (zone E1) for the 'sit' command ($T = 52$, $p < 0.01$), but not for the 'come' command ($T = 19$, $p = 0.322$).

Table 4
Number of training sessions to reach criterion within each training trial for each dog

Dog	Training trial no.					
	1	2	3	4	5	6
'Sit'						
A	1	1	1	1	1	1
B	1	1	1	1	2	1
C	1	1	1	1	1	1
D	1	1	2	2	2	1
E	6	1	3	3	1	2
F	2	1	1	1	2	2
G	1	1	1	1	1	2
H	1	1	1	6	2	1
I	2	1	1	2	1	5
J	1	4	1	1	2	2
'Come'						
A	1	1	1	1	1	1
B	1	1	1	1	1	1
C	1	1	1	1	1	1
D	1	1	1	1	1	1
E	1	1	2	1	1	2
F	1	1	1	1	5	2
G	1	1	1	1	1	1
H	1	1	1	2	1	1
I	2	1	1	1	4	5
J	1	1	1	1	1	1

4. Discussion

The introduction of transcribed (tape recorded) commands caused a significant decline in performance and this is in agreement with earlier studies using recorded commands (Fukuzawa et al., 2000, 2002; Fukuzawa, 2002). The reasons why the dogs needed more training sessions to re-establish the response may include the absence of certain key non-verbal cues, such as lip movement and changes in the sound quality of the recorded command. Lip and face movements of a speaker have been found to affect vocal perception in human (Moore, 1989) and this might also apply to pet dogs; since they often spend much time in close contact with humans. There is also evidence to suggest that dogs have become selectively sensitive to human communicative signs (Topal et al., 1998; Soproni et al., 2001). However, the quality of sound is also markedly changed in this treatment. Speech sound is produced from a combination of the vocal organs, i.e. lungs, trachea, larynx, nasal cavities, and mouth. Opening and closing the vocal folds produces a time-varying acoustic signal, the glottal source signal (Moore, 1989). When speech is recorded on a tape, certain features of the glottal source signal are absent, resulting in a sound, which we may be able to clearly recognise, but which may not be immediately apparent to the dog. For example, a tape-recorded command will not have the same frequency composition, or harmonics and will lack resonance compared to a human—generated command (Howard and Angus,

Table 5
Change in error rate between the end of one trial and the start of the next

Dog	Trial transition				
	1–2	2–3	3–4[a]	4–5[b]	5–6
'Sit'					
A	+1	+2	−1	+1	−3
B	0	0	0	+7	−3
C	0	0	0	0	0
D	+3	+2	+1	+3	−1
E	+1	+9	+3	0	−1
F	0	0	+2	+2	+4
G	0	+1	+1	+1	+1
H	+1	−2	+4	+2	−2
I	−1	0	+3	+1	0
J	+5	−1	+1	+3	−1
Dog	Trial transition				
	1–2	2–3	3–4[a]	4–5	5–6
'Come'					
A	0	0	+1	−1	0
B	0	0	0	0	0
C	−1	−1	0	+1	−1
D	−1	+2	+1	+1	−1
E	−1	+4	+1	0	+1
F	−3	+1	+2	+2	−2
G	0	0	+1	−1	0
H	+1	0	+4	0	0
I	+2	−2	+3	+2	0
J	+1	0	0	0	0

[a] $p < 0.05$, Wilcoxon signed-rank test.
[b] $p < 0.01$, Wilcoxon signed-rank test.

1996). The changes in the quality of the sound is illustrated by sonographic representations of the live and recorded sound (Fig. 2). In the recorded sound, a loss in some of the lower and higher frequencies can be seen. There is more background noise and a less distinctive trace.

The use of the tape recorded command also increased the time required to demonstrate a reliable response to the commands in the dogs, i.e. it took more presentations for the dogs to learn the transcribed command in trial 3 than it did the equivalent spoken command in trial 1. It took longer than the initial training required to establish the commands de novo. Thus the information gained from earlier trials was not generalised, and it seems that within the context of this experiment, the recorded command may be harder to learn than the human one.

When the dogs progressed from trial 3 to 4, (i.e. the restriction of eye contact with the use of a transcribed command), there was a significant increase in the number of errors for both commands. By contrast, there was no significant increase in the number of errors between trials 1 and 2 which introduced the restriction of eye contact with the spoken

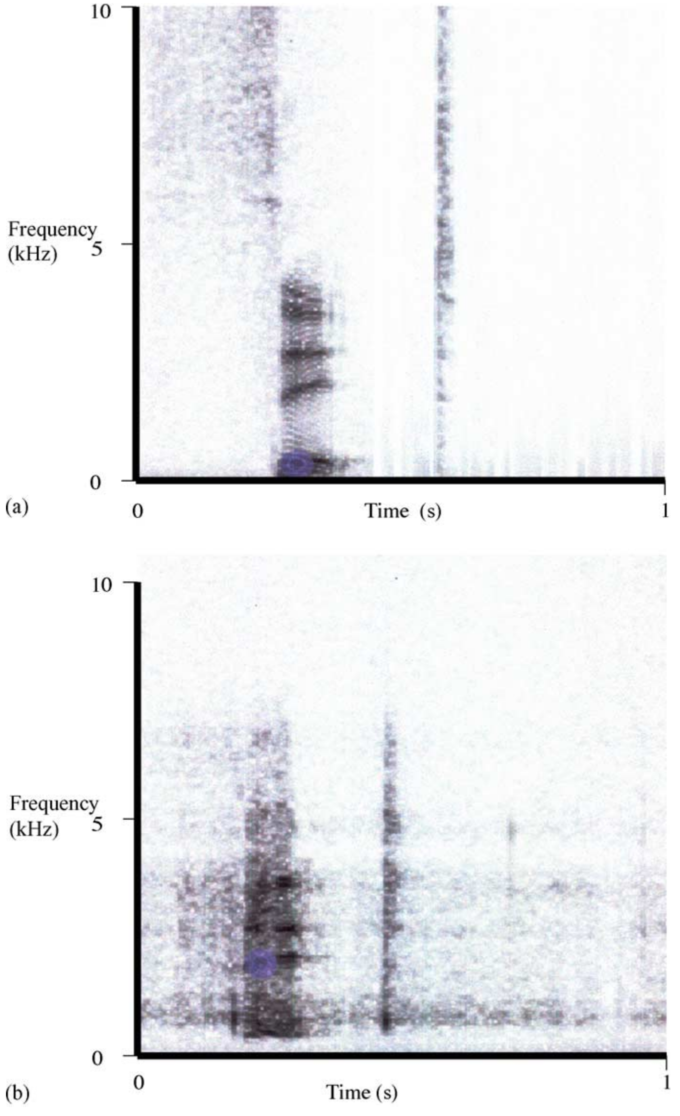
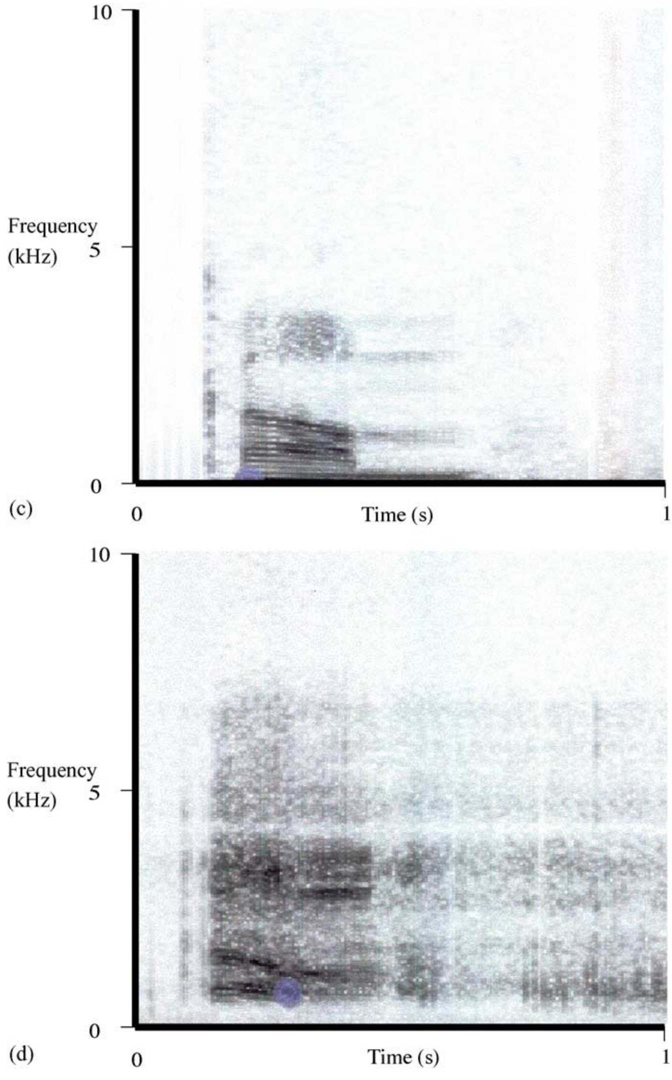


Fig. 2. One second traces of ‘sit’ and ‘come’ sonograms obtained using Visible Speech Sonogram DFKI software, version 2.2. Pitch is represented on the *Y*-axis, time on the *X*-axis and the density of shading reflects loudness. (a) Live spoken ‘sit’ command; (b) playback recording of the same ‘sit’ command from the recorder used in the study; (c) live spoken ‘come’ command; (d) playback recording of the same ‘come’ command from the recorder used in the study. Note there is a loss of some of the lower and higher frequencies on the playback recordings. The latter being most noticeable with the ‘sit’ command. Play back recordings are also less distinctive and have more background noise.



'Fig. 2. (*Continued*).

command for both commands. Thus, it seems the combination of the transcribed commands and the restriction of eye contact leads to a decline in the dogs' response, suggesting eye contact is important in some circumstances but not all. These results also suggest that dogs do not generalise their learning in response to tape recorded commands as well as it does to oral commands. This might be due to greater experience of oral commands in a variety of contexts or some other unknown factor. However, the number of sessions required to reach criterion at trial 4 did not differ significantly to that required at trial 2. During these two trials, the dogs were exposed to the same change (i.e. the restriction of eye contact and of posture), the only difference being whether it was the spoken or transcribed command that was used. This result suggests that whilst the dogs may not initially generalise their learning at the point of transition when a recorded command is used, they appear to rapidly build the appropriate association following appropriate reinforcement. This has particular relevance to the field of veterinary behavioural medicine where recordings have been advocated for the desensitisation of sound sensitive animals (Tuber et al., 1974) but their utility in practice has been questioned (Overall, 2002), since recordings to not necessarily represent accurate representations of the stimuli triggering the problem.

There was no significant increase in the error rate at the end of trial 0 and the start of trial 1. This indicates that in this context, the dog could get sufficient information to recognise commands, even if human body movements were restricted. A command is sent to a receiver with both verbal and non-verbal communicative signs. Among the non-vocal systems used by man there are the 'paralinguistic' systems of head-nods, gestures, lip and eye movements, and so on (Lyons, 1979), and these non-verbal elements influence the receiver as well as the verbal message. Dogs use body language (i.e. non-verbal communicative signs) when they communicate with other dogs and humans, and so it might be expected that these paralinguistic signals are similarly important to dogs. However, these results might suggest that human body movements have no effect on the dog's cognitive ability when the dog already recognises the verbal commands. Such gestures may however be significant in gaining and maintaining attention in a more distracting environment. This remains to be investigated empirically.

Eye contact or gazing, are known to affect an animal's behaviour, including that of dogs (Povinelli et al., 1999; Topal et al., 1997, 1998; Soproni et al., 2001). By contrast the restriction of eye contact did not affect the dog's behaviour in this study. Thus the dogs maintained a comparable level of recognition when they progressed from training trial 1 to 2.

During the first three training trials of experiment 2, the experimental trainer was wholly visible to the dog and there was no significant increase in the number of errors between training trials. However, when the experimental trainer was partially obscured though still facing the dog, there was a significant increase in the number of errors for both commands. Whilst this might be due to the obstruction of the line of vision, it might also relate to the absolute distance between the experimental trainer and the dog at this time. In either case, this finding indicates that the dogs differentiated a change at this point since their response to both commands were affected. This may be of practical value in training classes and so is worthy of further investigation. There was also a significant increase in the number of errors between trial 4 and trial 5, in which the experimental trainer stood in the same location as trial 4 but turned away from the dog, for the 'sit' command. This would suggest that at this distance, orientation is of some significance. The lack of an effect on the 'come' command in this context is not so surprising since this command is frequently used when the animal is out of sight and so prior experience is likely to have had an effect. This hypothesis is reinforced by the lack of a significant increase in the number of errors for either command between trials 5 and 6, in which the experimental trainer hid behind the screen, since at this point the dog has learned to respond to both commands in the absence of other experimental trainer cues. The response therefore appears to rapidly generalise to novel contexts.

5. Conclusion

There is evidence for both non-verbal cues and sound quality characteristics being important in auditory cognition in dogs, and that the dogs pay attention to both the distance of the experimental trainer and/or their position relative to visual barriers. Learning relative to these latter variables appears to generalise efficiently.

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