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A Positive Affirmation Marker to Improve Response Rate and Reduce Non-target Behaviours During Reinforcement Thinning in Dogs

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Abstract

Most dog training protocols use food as an unconditioned reinforcer. To maintain a learned behaviour with reduced reinforcement it is necessary to transition from continuous reinforcement to a leaner schedule, during which it is desirable to minimise problematic behaviour by the dog who is receiving fewer rewards. Experimental evidence for the most ethical and effective way to manage this transition is lacking. This paper describes a proof-of- concept study of using a conditioned verbal "positive affirmation marker" (PAM) to support the transition from a continuous to a variable ratio schedule of reinforcement. Four dogs were trained to perform a new task before introducing PAM by higher order conditioning. The reward schedule was then thinned using PAM, and behaviours were compared on a variable ratio schedule of reinforcement under two conditions; with PAM or without, in a within- subject study design. We observed an increased response rate and a reduction of non-target behaviours, particularly those indicative of frustration, in the PAM condition compared to without PAM for three of the dogs but not the fourth. The reasons behind the variability observed, as well as limitations and possible implications and uses of this conditioned reinforcer, are discussed. We propose PAM as a useful addition to the dog training toolkit.

Keywords: variable ratios of reinforcement, secondary reinforcer, discriminative stimulus, keep going signal

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Introduction

Animal training, whether of domestic pets, zoo or working animals, commonly relies on a combination of associative learning and operant techniques first publicised by Skinner (1938). Operant learning depends on the direct relationship between the consequence of a behaviour and the future likelihood of that behaviour. Specifically, appetitive consequences will reinforce and increase a wanted behaviour, while unpleasant consequences will make a behaviour less likely. In the 1980's, Karen Pryor began to bridge the gap between science and practice in dog training with the publication of her bestselling book *"Don't Shoot the Dog"* (Pryor, 1985). This led to science-based learning becoming embedded within the daily practice of dog trainers and of dog training accreditation organisations such as the Institute of Modern Dog Trainers (IMDT), who advocate the use of positive reinforcement techniques to build wanted behaviours (IMDT, 2018). Pryor's book also introduced the clicker, which is a small auditory device which is commonly deployed immediately prior to the reward, thus acting as a conditioned or secondary reinforcer because of its learned association with the primary reinforcer, which is commonly food, in dog training. Physical touch is a potential alternative primary reinforcer, but studies confirm that, where a preference has been observed, most dogs prefer food to petting (Feuerbacher & Wynne, 2014; Bremhorst et al, 2018; Isernia et al, 2022). Interestingly, larger food rewards provide increased incentives and are recommended for more effortful behaviours such as behaviour chains (sequential behaviours without reinforcement in between) which are often required for working situations (Bentosela et al., 2009; Feuerbacher et al., 2022).

Most dog training protocols begin by providing a food reward after each instance of a correct behaviour, and this is termed continuous reinforcement (CR). In most practical applications of learning by positive reinforcement it is essential at some point to thin the reinforcement schedule, which means reducing the frequency of rewards (Agrachov, 2019). In dog training there are three clear incentives to reduce food rewards: welfare, convenience and efficiency. Large amounts of fatty food (sausage often being a preferred high value reward) (Bremhorst et al., 1999) are a major cause of pancreatitis, the most common pancreatic disorder in dogs, with treats frequently being consumed prior to an incident (Cridge et al., 2022). Maintaining all learned behaviours indefinitely with CR is, therefore, a potential welfare issue. Secondly, it is inconvenient for owners or handlers to always and indefinitely have food rewards available. Thirdly, experimental animal behavioural studies (with species other than dogs) have shown that reinforcement inconsistency can induce behavioural persistence (Zimmerman, 1971; Cuenya et al., 2012). Variable reinforcement schedules (VR) provide rewards for some instances of a wanted behaviour in a pattern that is unpredictable to the learner and are experimentally demonstrated to be most effective at maintaining behaviours (Soreth & Hineline, 2009; Schlinger et al., 2008). This can be thought of as analogous to continuing to play a slot machine when the pay-out rate is very low. In dog training, some behaviours, such as recall, have a cost to the dog, yet are required with 100% efficiency such that CR is always advised. However, for the reasons stated above, many behaviour training plans will begin with CR and trainers are then advised to reduce reinforcement (a process known as thinning) to maintain the behaviour on a VR schedule (Burch & Bailey, 1999).

Reduced reinforcement, however, means less rewards for the learner making the CR to VR transition potentially aversive and liable to cause frustration. Frustration is an emotional response which can be defined in terms of behaviours arising in response to loss or reduction of access to desired or expected rewards (Jakovcevic et al., 2013). In a laboratory study with rats, for example, a sudden reduction in the rate of reinforcement significantly impaired running speed (latency to reach their food goal by running down an alley) (Cuenya et al., 2012). This behaviour change was interpreted to indicate frustration, and was only evident when there was a shift from continuous to partial reinforcement, and not for rats trained at the partial reinforcement rate, suggesting that the difficulty lies in the transition itself. Interestingly, the behaviour change was also dependent on genetic background, as it was only observed in the rat strain with a predisposition to fear-related behaviours (Cuenya et al., 2012).

Frustration behaviours are ethically and practically problematic in dog training and arise as a function of behaviour extinction, which occurs when reinforcement is no longer available (Bentosela et al., 2008; Jakovcevic et al., 2013). Dogs who were intentionally exposed to an extinction protocol were found to increase their distance from the experimenter, to increase sniffing behaviour, to orient away from the experimenter, to lie down and to vocalise (Jakovcevic et al., 2013). None of these frustration behaviours were observed previously when reinforcement was available. When thinning from CR to VR during training protocols, it is desirable to avoid such frustration. Dog training experts advise to do this gradually and to replace food with a secondary reinforcer (Burch & Bailey, 1999), but there is no research evidence that instructs dog trainers on how to avoid frustration and how to thin in the most effective and ethical way.

Behavioural research on lab animals (but not with dogs) has long since established that learned behaviours can be effectively maintained at very low reinforcement ratios using conditioned (secondary) reinforcers such as light signals (Findley & Brady, 1965). A recent meta-analysis of the scientific literature on animal training studies using conditioned reinforcement in an applied setting confirmed the clicker as the most common secondary reinforcer for dogs (Pfaller-Sadovsky et al, 2020). Although this study found that training with a secondary reinforcer was an effective approach, individual studies have not found conditioned reinforcers (clicker or verbal encouragement) to be superior to the use of a primary reinforcer alone in learning of a new behaviour (Gilchrist et al, 2021; Smith & Davis, 2008).

The role and function of the clicker is interpreted in a variety of ways by animal trainers, often being described as a bridging stimulus (to allow delayed food rewards), or as a mechanism to mark the correct behaviour more precisely (more comprehensively discussed by Fernandez, 2001 and Feng et al., 2016). Others have questioned whether the clicker, due to its learned association with a primary reinforcer, might be emotionally rewarding even in the absence of food by activating the seeking system (McConnell, 2014; Panksepp, 2011). Accordingly, Smith & Davis (2008) found the clicker to provide short-term protection against extinction in the absence of primary reinforcement. This raises the question of whether the clicker, without reward, can be used to maintain behaviours during thinning from CR to VR. The answer to this question rests on whether the clicker acts only as a secondary reinforcer or whether it also acts as a discriminative stimulus that reliably predicts food. Kalafut and colleagues (2024) conducted a study where dogs’ behaviors were rewarded once for a chain of two behaviours and compared the quality of response when the clicker was used after each behaviour or when the click was only used prior to the food reward. Using the clicker as a secondary reinforcer when it no longer predicted food led to deterioration of the trained behaviour confirming the clicker to have an important role as a discriminative stimulus or cue for collecting the reinforcement (Kalafut et al., 2024). This explanation agrees with previous findings where the use of click without treat reduced the frequency and accuracy of trained behaviours and produced behaviours indicative of mild frustration (Wennmacher, 2007; Peiris & RosalesƀRuiz, 2022). This evidence argues against the use of the clicker to mark unrewarded behaviours during thinning of reinforcement. Kalafut and colleagues conclude, however, that the role of the clicker is dependent on the method by which it has been conditioned, pointing out that the role as a discriminative stimulus results from having learned that the clicker is always paired with food which is normal practice in dog training. Is it possible then to establish a conditioned reinforcer that is not a discriminative stimulus for collecting food by pairing it with an already conditioned reinforcer but not as a reliable predictor of primary reinforcement? Shahan & Cunningham (2015) suggest that this is the case pointing out that behavioural chains illustrate this principal in practice. In behaviour chains, a series of behaviours are performed in succession with each behaviour reinforcing the previous behaviour but with only one reward at the end.

An alternative but common conditioned reinforcer is the spoken word (Pfaller- Sadovsky et al, 2020). Within dog training communities, reference is often made to a spoken “keep going’ signal to support the performance of behaviours where the reward is delayed. Most commonly this is used as encouragement during a long duration behaviour, although both the method and intended purpose of the “keep going” signal vary widely between trainers. There are no published studies exploring the effectiveness of the keep going affirmatory marker and no clarity nor agreement on its nature as a conditioned reinforcer or otherwise.

Here we investigate the use of a spoken word reinforcer, which we call a positive affirmation marker (PAM), that is conditioned by association with an already conditioned stimulus but not by pairing directly with food. Specifically, we propose that the use of PAM during thinning could provide feedback to the dog that the correct behaviour has been performed without causing the dog to orient to collect a treat, thus protecting against extinction. We first tuned our strategy with ten human learners to establish non-aversive conditions. We then trained four dogs to perform a new behaviour, conditioned the PAM and used it during thinning of the reinforcement schedule. We then used a within-subject experimental design to compare the dogs’ performance of the learned behaviour with or without the PAM, at the thinned reinforcement schedule (Figure 1).

Figure 1 *Structure of the current study*

Materials and Methods

Project Context and Ethics

The entire training protocol, including PAM conditioning and reinforcement thinning, were first finely tuned with ten humans using the desktop Portable Operant Research and Teaching Lab (PORTL) (Hunter & Rosales-Ruiz, 2023) with the purpose of minimising stress with respect to the care for animals. The project lead is an IMDT-qualified dog trainer, and the IMDT code of dog training ethics was adhered to throughout this study (IMDT, 2018). The final year undergraduate student experimenters carrying out the study had no prior experience of dog training and had never met any of the dogs in the study. An earlier unreported iteration of this study, as in Figure 1, was carried out with ten humans and eight dogs during the global pandemic, whereby all training and experiments were necessarily conducted via Zoom. Although it was possible to include more dogs than in the reported study due to the convenience of online meetings, it was not possible to accurately control the behaviour of dog handlers remotely, and the encouraging results were not published. This prior study was, however, used to inform and finesse the plan for the iteration of the study presented herein. One dog took part in both studies, which were conducted one year apart. All human subjects and dog owners signed consent forms prior to the study and were made aware of their rights to privacy and to withdraw at any point. The project received ethical approval (reference hmcqueen-0002) from the University of Edinburgh School of Biological Sciences ethics committee, which adopts the UK research integrity office code of practice for research.

Subjects and Setting

Four dogs (described in Table 1) belonging to colleagues or acquaintances of the project lead were selected for convenient location, allowing the experimenter to travel easily to sessions at their homes. The two Havanese were littermates who lived together. Prior to starting the study, the owners completed a factual questionnaire on general background, dietary requirements and training experience. Owners had no information about the purpose or nature of the study, other than that it was an investigation of a training method, and owners were not permitted to watch.

Table 1 *Dog subjects*

	Luna	Nova	Arlo	Ginny*
Age (months)	12	12	36	23
Sex	Female	Female	Male	Female
Breed	Havanese	Havanese	Working cocker spaniel	Labrador golden retriever cross
Training experience	Puppy classes	Puppy classes	Puppy classes	> 1yr attendance in classes
Clicker experience	No	No	No	Yes
Behaviour shaped	Paw touch	Paw touch	Paw touch	Paw touch
Training sessions required	6	5	5	4
Variable ratio schedule of reinforcement in experiment	VR1:3	VR1:4	VR1:3	VR1:4

* Ginny also took part in the prior unreported iteration of the study.

Dogs were trained individually in their own gardens as a familiar environment with only the experimenter and the project lead, as an observer, present in the garden. In each garden a safe paved area was chosen. Garden landmarks were noted to allow consistent placement and distance (1-2 meters) between target and food receptacle to be maintained for each dog. The experimenter also took the same position between the target and food receptacle at each session (using convenient garden landmarks), lowering her position so that she could drop the food directly into the receptacle. To signal the end of each session the dog was given an edible chew, and the experimenter then offered the option for the dog to play tug with a toy to add value to the training session.

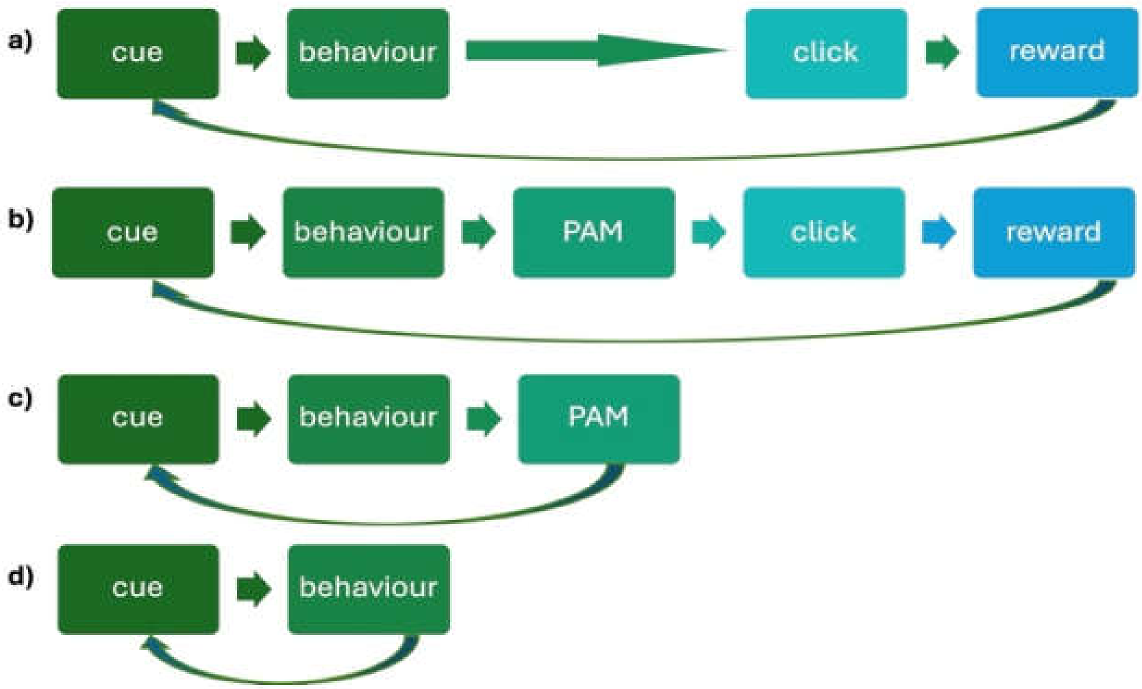
Training Materials

A balance cushion was used as a target for the paw touch behaviour, and the food rewards were collected by dogs from a tin lid. The experimenter used a clicker affixed to her wrist and wore a treat bag around her waist. A notebook showing the schedule for the current session was placed on the ground within view of the experimenter and all sessions were recorded on a phone set up on a tripod, also on the ground, to capture the entire training area. The dog treats consisted of chopped hot dogs, liver, and cooked sausage in the first two training sessions to improve learning efficiency (Bremhorst et al., 1999), reducing to liver and hotdogs for the rest of the training sessions for convenience. In the final two experimental sessions when the total number of reinforcers was low, the size of each piece of food reinforcement was increased to maintain reinforcer magnitude and protect against frustration (Feuerbacher et al., 2022). Sessions were always set at least two hours after mealtimes to avoid food satiation.

Procedures for Training the Behaviour, Conditioning PAM and Thinning Reinforcement

Each dog attended between four and six training sessions as well as two experiment sessions (Figure 1) over four to six weeks. Training sessions were broken into short trials of ten correct behaviours with breaks lasting between five and ten minutes in between. Sessions lasted no more than an hour, but were usually ended earlier on any sign that the dog was tiring, such as leaving the training area or not interacting with the experimenter with higher frequency than earlier in the session. All four dogs were taught the new behaviour of a paw touch to a target for this experiment. In all cases the clicker was classically conditioned as a secondary reinforcer by pairing with food in a mark and reinforcement sequence (M+R) (Figure 2a) and then used to shape the behaviour by operant learning (Table 2). Shaping continued until the paw touch behaviour reached the set criteria and was consistently performed as part of a fluid training loop of "cue, paw touch, M+R," returning to the target for the next repetition (Figure 2a). We then conditioned the positive affirmation marker by saying "PAM" the instant that the correct behaviour was completed and immediately prior to M+ R (Figure 2b). The word PAM was chosen as an acronym for "positive affirmation marker" that we would expect to have no prior meaning to the dog subjects. We checked that no-one called "Pam" was significant to any of our subjects. The word was always spoken in a neutral tone. A task analysis of the training procedures is shown in Table 2. Trials of ten behaviours were repeated for each training loop until fluidity was established for that stage at which point the next stage of behaviour training, PAM training or thinning was begun (Table 2). Training loops used are illustrated in Figure 2.

Figure 2 *Training loops*



Within any loop each step was performed immediately on completion of the preceding step. a) behaviour training, b) PAM conditioning, c) thinning and experiment (PAM A trials) experiment, d) experiment (without PAM B trials).

The dogs learned at different rates and the fluent loop of cue, paw touch, PAM, M+R (Figure 2b) was established for all dogs on or before the fourth session, after which each dog experienced two sessions of thinning by omitting M+ R for some correct behaviours (Figure 2c). Thinning was conducted on a pre-determined schedule as outlined in Table 3 with progression to the next step being reliant on maintaining a fluid training loop at the prior step. For variable ratio schedules of reinforcement (VR) trials the total number of treats were first counted into the training pouch and given at random for correct behaviours.

Experimental Procedures

Thinning videos were reviewed to determine the lowest reinforcement ratio for which a fluid training loop was maintained for each dog. This was considered the functioning VR ratio for that dog and was used for the final two sessions from which the experimental data were collected. Experiments consisted of A trials with PAM (Figure 2b and 2c) and adjacent B trials without PAM (Figure 2a and 2d). The two experimental sessions each consisted of two A and two B trials each of 12 correct behaviours (48 correct behaviours per session). One experimental session took the form ABAB and the second BABA, to correct for any order effects.

Measurements and Analysis

All videos were reviewed and all target and non-target behaviours were noted by the experimenter. Correct behaviours were counted only when the dog hesitated with the front paw(s) on the target and not if the dog walked over the target with all feet. Non-target behaviours were grouped either as unwanted behaviours that had a previous reinforcement history that we termed as reward-seeking behaviours or as behaviours that we interpreted to indicate frustration. Reward-seeking behaviours were sitting, lying down, offering a paw to hand or a nose target. Frustration behaviours were vocalising, sniffing, scratching or licking, wandering away from the training area and refusals. A refusal was recorded when the correct behaviour was not performed after two “target” cues. There were no continuous bouts of vocalisation and each individual vocalisation was counted as one behaviour. Vocalisations were characterised as a “bark” when the dog opened its mouth to make a clear barking sound, a “gruff” when a lower smaller bark or wuff emanated with very brief mouth opening and a “whine” when it was high-pitched and did

Table 2 *Task analysis of training and experimental procedures*

Phase	**Task**	**Details**
Behaviour Training	Food collection	Training starts with dropping treats onto the food receptacle for collection by dog.
	Condition clicker	Clicker is deployed immediately before treat drop (M+R). Start to organise as ten reward trials.
	Shaping paw touch	Place target and M+R interest. Progressively reward orientation to, approach towards, and finally contact with target. Form a continuous loop of dog approaching target and returning to food receptacle. Progress shaping to final criteria of one or two front paws on target for

Phase	**Task**	**Details**
		M+R. Target removed at completion of final behaviour in each trial of ten rewarded behaviours.
	Add Verbal Cue	Add verbal cue "target" after collecting reward as part of the training loop (Figure 2a).
PAM training	Condition PAM	Add verbal "PAM" as the dog touches the target, immediately followed by M+R to sustain continuous reinforcement (Figure 2b).
Thinning	Thinning Reinforcement	Reduction of M+R but retain "PAM" (Figure 2c). Maintain the training loop by gently removing target and replacing if dog stays there. Reinforce according to a predetermined schedule (Table 3). Gradually reduce to variable ratio schedules (VR1:3 or below).
	Determine VR Ratio	Review videos to identify the functional VR ratio (lowest ratio at which training loop maintained) for each dog.
Experiment	First experiment (ABAB)	Four trials of 12 behaviours at functional VR for each dog. Trials alternate between with "PAM" (A) (Figure 2c) or without "PAM" (B) (Figure 2d) the first being an A trial. Target removed at end of each trial.
	Second experiment (BABA)	Repeat of first experiment session but starting with a trial without "PAM" (B) and ending with a "PAM" trial (A)

Table 3 *Number of reinforced and unreinforced behaviours during training, thinning and experimental trials*

Task description (reinforcement schedule)	M+R (Fig 2a)	PAM+M+R (Fig 2b)	PAM (Fig 2c)	Without PAM (unmarked) (Fig 2d)	Number of reinforced behaviours
Behaviour Training (CR)	10	-	-	-	10
PAM Training (CR)	-	10	-	-	10
Thinning (1:2)	-	5	5	-	5
Thinning (VR1:3)	-	4	8	-	4
Thinning (VR1:4)	-	3	9	-	3
Thinning (VR1:5)	-	2	8	-	2
Thinning (VR1:10)	-	1	9	-	1
Experiment with PAM (A trials) (VR 1:3 or 1:4)*	-	4 or 3	8 or 9	-	4 or 3
Experiment without PAM (B trials) (VR 1:3 or 1:4)*	4 or 3	-	-	8 or 9	4 or 3

*Two dogs were tested at VR1:3 and two at VR1:4

not require an open mouth. There were continuous bouts of scratching or moving away which were counted as one behaviour irrespective of their duration. If the dog stopped scratching or returned to the training area before repeating the behaviour this was counted as a new behaviour. Trial durations were extracted from videos and defined as beginning with a "target" cue and ending when the experimenter started to lift the target after the last correct behaviour. The response rate was determined by dividing the number of correct behaviours by the trial duration (in minutes). For statistical analysis each A trial (with PAM) was paired with the adjacent B trial (without PAM) giving four paired values for each dog for each of response rate, reward- seeking behaviours and frustration behaviours. For each of these measured variables the 16 paired values were compared in two-tailed Wilcoxon signed-ranks tests using Minitab. Significance was set at $p<0.05$.

Results

Training and Thinning Sessions

All the dogs successfully learned a paw touch behaviour during training sessions one or two. The next one or two sessions were used to condition PAM, and a further two sessions were dedicated to thinning procedures. Ginny completed the training, PAM conditioning, and thinning procedures within four sessions, Arlo and Nova in five sessions and Luna required all six sessions. The functioning VR ratio for the final two experiment sessions was determined individually for each dog and was 1:4 for Ginny and Nova, and 1:3 for Arlo and Luna.

Experimental sessions with or without PAM

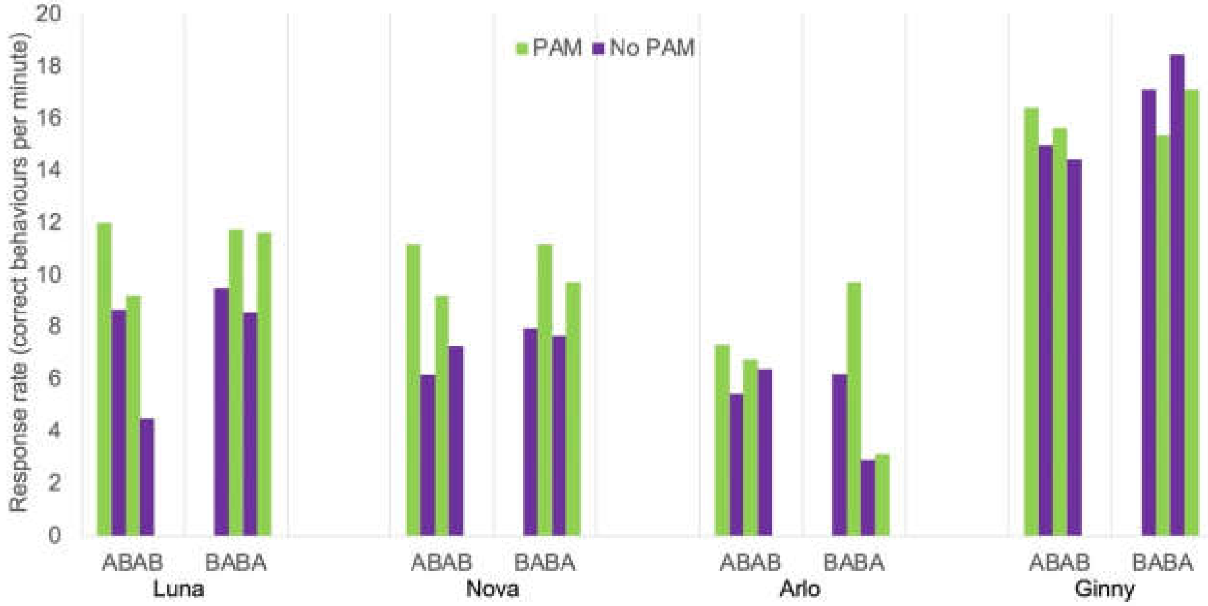
The response rate for all of Luna, Nova and Arlo's trials with PAM was higher than the adjacent non-PAM trial (more behaviours per minute) irrespective of which condition was tested first or last in the alternating ABAB or BABA pattern (Figure 4). Ginny's response rate was also higher with PAM in the first experimental session but not on the second day when the order of trials was reversed such that the trial without PAM was the first condition tested (Figure 4). The average response rate was higher with PAM than without PAM for each of Luna, Nova and Arlo, but not for Ginny and was statistically significant overall (Table 3).

Table 3 *Average response rates in each of the PAM (A) or without PAM (B) conditions*

Measurements were collected for each dog during eight A or B trials of 12 correct behaviours with variable ratio schedules of reinforcement. SEM = standard error of the mean

Average response rate (behaviours per minute)	**PAM (A) (SEM)**	**No PAM (B) (SEM)**
Luna	11.2 (0.6)	7.8 (1.1)
Nova	10.4 (0.5)	7.3 (0.4)
Arlo	6.8 (1.4)	5.3 (0.4)
Ginny	16.2 (0.4)	16.3 (0.9)
W value	126.00	
P value	0.003	

Figure 4 *Response rates for paw touch behaviour of four dogs in PAM (A) or without PAM (B) conditions*



Behaviours are shown for each of four dogs during eight A or B trials of 12 correct behaviours with variable ratio schedules of reinforcement. A =PAM (green), B= without PAM (purple). Data are presented in the order collected for each dog over two sessions (ABAB and BABA).

All non-target behaviours were noted for each dog across both experimental sessions and are presented in tables 4-7 in the order that each behaviour was observed within each trial. There were significantly more non-target behaviours in the trials without PAM than in the PAM condition, particularly frustration behaviours (p=0.007) (summarised in Table 8). Although Luna, Nova and Arlo offered the least non-target behaviours within PAM trials (Tables 4-6), and more non-target behaviours, particularly frustration, during the trials without PAM, the only two non-target behaviours that Ginny offered were within the PAM condition (Table 7). Overall, we counted 44 frustration behaviours without PAM and 13 in the PAM condition (Table 8). 87% (76/87) of the non-target behaviours recorded across all dogs and trials occurred on behaviours that were unrewarded due to the variable reward ratio (Tables 4-7).

Table 4 *Luna’s non-target behaviours in each of the PAM (A) or without PAM (B) conditions at VR 1:3*

Each trial of 12 correct behaviours is represented as a separate column and non-target behaviours are listed in the order that they were observed within each trial. Behaviours grouped as indicating frustration are shown in red and those that we termed reward-seeking behaviours are in black. The total number of non-target behaviours is shown in the bottom row. *indicates behaviours occurring alongside a correct rewarded behaviour.

	ABAB				BABA			
	PAM (A)	No PAM (B)	PAM (A)	No PAM (B)	No PAM (B)	PAM (A)	No PAM (B)	PAM (A)
	paw	wander	down	down	down		down	paw
	paw*	wander*	down*	down	bark		paw	wander
		down		refusal	down			
		down		down*	down			
				sit				
				refusal				
n	2	4	2	6	4	0	2	2

Table 5 *Nova's non-target behaviours in each of the PAM (A) or without PAM (B) conditions at VR 1:4*

Each trial of 12 correct behaviours is represented as a separate column and non-target behaviours are listed in the order that they were observed within each trial. Behaviours grouped as indicating frustration are shown in red and those that we termed reward-seeking behaviours are in black. The total number of non-target behaviours is shown in the bottom row. *indicates behaviours occurring alongside a correct rewarded behaviour.

	ABAB				BABA			
	PAM (A)	No PAM (B)	PAM (A)	No PAM (B)	No PAM (B)	PAM (A)	No PAM (B)	PAM (A)
	A	B	A	B	B	A	B	A
		wander	scratch	scratch	refusal	paw	wander	
		sniff	paw	bark	lick*	paw	refusal	
		scratch	down*	scratch	scratch	scratch	nose target*	
			paw		wander	paw*		
					paw	paw		
						nose target		
n	0	3	4	3	5	6	3	0

Table 6 *Arlo's non-target behaviours in each of the PAM (A) or without PAM (B) conditions at VR 1:3*

Each trial of 12 correct behaviours is represented as a separate column and non-target behaviours are listed in the order that they were observed within each trial. Behaviours grouped as indicating frustration are shown in red and those that we termed reward-seeking behaviours are in black. The total number of non-target behaviours is shown in the bottom row. *indicates behaviours occurring alongside a correct rewarded behaviour.

	ABAB				BABA			
	PAM (A)	No PAM (B)	PAM (A)	No PAM (B)	No PAM (B)	PAM (A)	No PAM (B)	PAM (A)
	wander	gruff	gruff	paw	sit	wander	bark	bark
	gruff*	gruff	refusal	gruff	bark		bark	bark
		gruff	wander	refusal	wander		bark	bark
		refusal	refusal	wander			bark	
		bark		refusal			bark	
		bark					bark	
		bark					bark	
		bark					scratch	
		bark						
		gruff*						
		refusal						
		whine						
		wander						
	2	13	4	5	3	1	8	3

Table 7 *Ginny's non-target behaviours in each of the PAM (A) or without PAM (B) conditions at VR 1:4*

Each trial of 12 correct behaviours is represented as a separate column and non-target behaviours are listed in the order that they were observed within each trial. Ginny displayed no behaviours grouped as indicating frustration. Those that we termed reward-seeking behaviours are in black. The total number of non-target behaviours is shown in the bottom row. *indicates behaviours occurring alongside a correct rewarded behaviour.

	ABAB				BABA			
	PAM (A)	No PAM (B)	PAM (A)	No PAM (B)	No PAM (B)	PAM (A)	No PAM (B)	PAM (A)
						paw		paw*
n	0	0	0	0	0	1	0	1

In our prior unpublished study which involved eight dogs, we observed similar variability with four dogs appearing to show improved behaviours with PAM compared to without PAM (increased response rate, and reduced frustration behaviours) (James Brown, unpublished data). Ginny was the only subject that took part in the previous study where she was one of the four dogs not showing improved behaviours with PAM. However, this prior study was carried out on Zoom and was subject to handler inconsistencies precluding precise measurements suitable for publication.

Table 8 *Sum of non-target behaviours in each of the PAM (A) or without PAM (B) conditions for all 4 dogs*

Subject	Reward-seeking behaviours		Frustration behaviours		Total non-target behaviours	
	PAM	No PAM	PAM	No PAM	**PAM**	**No PAM**
Luna	5	11	1	5	**6**	**16**
Nova	8	2	2	12	**10**	**14**
Arlo	0	2	10	27	**10**	**29**
Ginny	2	0	0	0	**2**	**0**
W value	25.50		2.00		12.00	
P value	0.878		0.007		0.021	

Discussion

We have used a conditioned spoken word as a positive affirmation marker (PAM) during reinforcement thinning from CR to VR in dogs. We found PAM to reduce the number of non-target behaviours, particularly those suggesting frustration, and to improve the response rate for three out of four dogs when compared to not marking correct behaviours. This is the first controlled study to test the concept of a spoken affirmation marker to assist in this thinning process with dogs and has implications for animal training protocols with respect to reducing frustration and thus improving welfare.

The PAM in our study can be classed as a reinforcer in so far as that the number and quality of behaviours were improved (in three of four dogs) in its presence. The PAM was not conditioned by association with a primary reinforcer but by higher-order conditioning with a secondary reinforcer (the clicker). The PAM provides feedback to the dog that the behaviour is correct but not that food is available and can, therefore, be described as a conditioned reinforcer but not a discriminative stimulus for collecting food. We suggest that the use of a higher-order conditioned reinforcer during thinning avoids damaging the effects of the clicker which are weakened when no longer paired with primary reinforcement (Rescorla and Wagner, 1972) and also reduces the frustration arising from an unrewarded discriminative stimulus (Cimarelli et al., 2021; Wennmacher, 2007; Peiris & RosalesƀRuiz, 2022; Kalafut et al., 2024).

We have demonstrated the use of PAM to avoid behaviour deterioration over two short sessions at reduced reward ratios. Although our purpose in this study was to use it only to support the transition to VR rather than in an ongoing manner, it is important to note that the effects of PAM may weaken over continued use with unreinforced behaviours due to no longer predicting the associated secondary reinforcer, exactly as the unrewarded clicker was shown to weaken in previous studies. In addition, the behaviour deterioration and increased frustration that we noted in our parallel unmarked and unrewarded experimental trials could be said to be unsurprising if these were considered to be extinction trials. However, we did use equivalent larger magnitude food reinforcers in both unmarked and PAM experimental trials to counteract this possibility. Useful follow-up studies could investigate longer-term use of PAM at VR, optimise the fading out of the PAM or repeat the experiment with simply a clicker in place of PAM.

We are curious about the relevance of our PAM conditioned reinforcer being a spoken word. We wonder whether the use of a verbal marker rather than another auditory signal might be particularly favourable here due to the sophisticated capacity that dogs have to understand human cues (reviewed in Boada & Wirobski, 2025). In our study the verbal PAM was intentionally neutral in tone, unlike the meaningful tone used in social interactions between owners and their pets. It would be interesting to know whether higher order conditioning with an emotionally-charged PAM from a trusted handler would be more effective. Over 100 years ago, before Skinner’s work reached academic audiences, Colonel Conrad Most was teaching guide dog handlers to use their voice as a conditioned reinforcer (Burch & Bailey 1999). Intuitively, people provide praise to their pet dog as encouragement for desired behaviours, usually without knowing that this praise is operating as a conditioned reinforcer (often paired with petting or food). Although the context within which the verbal praise is provided can be inconsistent, perhaps the PAM results explain why so many pets behave in ways that are socially acceptable to humans in the absence of formal training. It would be instructive to investigate the effectiveness of PAM across other animal species, particularly to unravel whether the effect with dogs relates to their strong social bond with humans.

We interpret the results of our study to indicate that the classically conditioned PAM also has a role in operant learning, encouraging the dogs to perform the behaviour again. In some ways this is akin to a step in a behaviour chain, with the PAM acting as a true “Keep going” signal. Search and detection training aims to avoid extinction or behaviour deterioration when reinforcement is not available until the search has ended. In a study with 18 scent detection dogs, neither a non-contingent reinforcement (presented irrespective of behaviour after a set time schedule), nor a Pavlovian-conditioned tone stimulus improved detection effectiveness (DeChant et al., 2023). Further study of long-term use of a higher- order conditioned spoken word reinforcer would be most instructive towards confirming or ruling out its validity as a keep going signal for behaviour chains and any potential application for long duration behaviours such as search and detection.

Clearly our sample size of four dogs is a limitation and constitutes only first proof-of-concept. We did also observe an increased response rate and reduced frustration with PAM for four of eight dogs in a previous study (James Brown, personal communication), but this study was conducted remotely with unavoidable inconsistencies and is unpublished. A second limitation is the double reporting within our study that results from recording refusals, scratching or wandering as non-target behaviours when these behaviours also extend trial duration and reduce the response rate. This means that the two changes that we have noted overlap and, while of interest independently, cannot be considered as independent measures. Thirdly, our small sample size precluded any investigation of breed, sex, age, learning history or other individual differences. Interestingly, the only dog to take part in both this and our prior unreported study was also the only dog in the present study with a strong training history. This dog gave no refusals nor frustration behaviours during the thinned schedule and no marked difference with or without PAM in either study. It is possible that training history, personality or genetics may be responsible for variable levels of resilience or susceptibility to frustration as shown for rats (Cuenya et al., 2012), resulting in a non-uniform need for PAM. Such variability demands a larger study to firstly confirm whether the benefits of PAM are widespread across dogs and across trained behaviours, as well as to further investigate its effect on individual dogs varying by genetics and life histories.

While the mechanism and long-term effectiveness of PAM remains unconfirmed and the variability in its effects dependent on genetic, learning and life-style background are unexplored, we have piloted proof of concept that PAM can improve response rate and reduce non-target behaviours during reinforcement thinning in dogs. With very little knowledge of learning theory this concept can be easily applied to pet dog training in the home by novice dog owners as well as being incorporated into more formal protocols for the thinning procedure by more experienced trainers. In both cases the reduced frustration due to a conditioned PAM could represent a potentially important welfare improvement.

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Declaration of interest statement

The authors have no competing interests to declare.

Data availability statement

Example videos and raw data are available on request.

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