Clicker Bridging Stimulus Efficacy

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Abstract

Acquisition of a multiple component task, such as approaching and touching a target apparatus on cue, plays an important role in animal training and husbandry. Experimental training of two groups of 10 naïve dogs *(Canis familiaris)* to perform the target task differed only by the assigned bridging stimulus: a clicker or spoken word "good." Although both types of bridging stimuli are used in the training field to indicate the precise instance of correct behavior, this study represents the first systematic comparison of the efficacy of these two types of bridging stimuli. There was a decrease of over 1/3 in training time and number of required reinforcements for the clicker as compared to the verbal condition group. The clicker trained dogs achieved behavior acquisition in significantly ($p < .05$) fewer minutes and required significantly fewer primary reinforcements than verbal condition dogs. The difference in effectiveness of the two bridging stimuli was most apparent at the onset of each new task component. It appears that use of the clicker, by providing a more precise marker than a verbal bridging stimulus, is responsible for superior acquisition of complex behaviors such as that studied here. The facilitation of learning provided by the clicker bridging stimulus has important implications for animal training, especially when professionals are confronted with time constraints. The potential of the clicker stimulus to improve animal learning throughout the entire process of a behavior may not only increase the rate of behavior acquisition, but also reduce animal frustration and further enhance the relationship between trainer and animal.

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An Analysis of the Efficacy of Bridging Stimuli

In the field of animal training, learning is improved by the continual modification and refinement of training techniques. As this discipline has its roots in psychology, the application of learning theory to animal behavior forms the foundation for the training process (Breland & Breland, 1951, 1966; Skinner, 1951; Skinner, 1938/1999). The training procedure relies entirely on multimodal communication between trainer and animal. This transactional system is based upon a multiplicity of signals including both verbal and nonverbal means of communication (Berko, Wolvin, & Wolvin, 1995). As behavior in response to transactional communication consists of "an ongoing stream of activities" (Domjan, 2003) it becomes increasingly important for a trainer to indicate which of the animal's responses is correct in the training scenario.

In the training procedure, animal learning is limited largely by how well professional trainers can facilitate the learning process. Behavior training is a step-by-step progression of teaching an animal to offer a particular behavior in response to a specific cue. In the initial stages of this process, the animal learns to emit behaviors based on the consequences that follow, a type of learning known as operant conditioning (Skinner, 1938/1999). For example, if a dolphin dives and immediately receives fish reinforcement from the trainer, the behavior of diving is strengthened and its probability of recurrence increases.

Once the desired behavior is readily offered, the trainer teaches the animal to demonstrate the behavior only in response to a specific cue such as a spoken word or hand signal. Such a cue is known as a discriminative stimulus or S^D (Skinner, 1969). The discriminative stimulus is introduced just prior to each performance of the behavior; only correct responses in the presence of the specific cue are reinforced. In this way, the animal learns that

reinforcement is contingent upon correct performance of the behavior only after presentation of the discriminative stimulus (Pryor, 1984).

To train a novel behavior, trainers often use food rewards to reinforce existing behaviors that approximate the final desired behavior. The technique of reinforcing successive approximations of the desired behavior is known as shaping (Skinner, 1951). To pinpoint a response that approximates the desired behavior, a trainer may sound an auditory stimulus such as a whistle, clicker, or specific spoken word at the exact moment the correct response is offered (Pryor, 1984; Skinner, 1951). After sounding the auditory stimulus, the trainer will deliver food or other potent primary reinforcer to the animal. In the learning and training literature (Domjan, 2003; Miltenberger, 2001; Skinner, 1951) The previously neutral auditory stimulus is known as a conditioned stimulus (CS) and the primary reinforcement with which it is paired is known as an unconditioned stimulus (US). Demonstrated by Russian scientist Ivan Pavlov in 1927, this process of learning by association is termed classical conditioning. Classical conditioning establishes the auditory stimulus as a reliable predictor of food and conditions the animal to recognize the stimulus as a reinforcer in and of itself.

Once associated with primary reinforcement, the auditory stimulus is used by animal trainers to provide immediate reinforcement for a correct response (Domjan, 2003; Skinner, 1951). Training professionals refer to a stimulus used in this manner as a secondary or conditioned reinforcer (Domjan, 2003; Miltenberger, 2001; Skinner, 1951). The use of a conditioned reinforcer provides identification of a specific correct behavioral response even if the primary reinforcement cannot be delivered at that precise moment in time (Breland & Breland, 1966; Pryor, 1984, 2006). As “conditioned reinforcers can serve to bridge a delay between the instrumental response and the delivery of the primary reinforcer,”(Domjan, 2003),

animal training professionals often employ the term “bridging stimulus” or “bridge”(Breland & Breland, 1966; Pryor, 1984; Ramirez, 1999). Professional dog trainers also refer to a conditioned reinforcer as a “reward marker” as it specifies the behavior that will receive reinforcement (Donaldson, 1996). Because it identifies the animal’s movement, the auditory stimulus may also be termed an “event marker” (Pryor, 1984, 2005b; Ramirez, 1999). Throughout this paper, I will use the term “bridging stimulus” consistently to refer to auditory stimuli used to provide immediate reinforcement for a correct response.

It is highly possible that the type of bridging stimulus used in a training scenario may play a critical role in animal learning. To determine if one method facilitates learning over the other, it is necessary to evaluate by scientific comparison the most common bridging stimuli used for animal training. Evidence for a faster rate of behavior acquisition by the use of a specific type of bridging stimulus may provide canine, zoo, and aquarium professionals with science based answers regarding the training technique most favorable for animal learning. Improvements in technique may expedite the training process by minimizing animal confusion, reducing frustration, and ensuring that interactions between trainer and animal are entirely positive. Results such as these may increase animal health and overall welfare by facilitating acquisition of important husbandry behaviors and fostering an environment in which training provides positive mental stimulation for animals.

A very common bridging stimulus used for the training of domestic dogs as well as pinnipeds in human care (seals, sea lions, and walruses) is a verbal stimulus, such as the spoken word “good.” However, there has been a recent movement in the dog training field toward the utilization of a clicker bridging stimulus, a tin “cricket” that produces a short, distinct sound when pressed (Alexander, 2003; Jones, 2002; Pryor, 1999, 2005a; Reid, 1996). Clicker training

professionals have reported faster novel behavior acquisition in dogs trained with a clicker in comparison to those trained with a verbal bridging stimulus (Jones, 2002; Pryor, 1999; Ryan & Mortensen, 2004).

Although originally discussed by Skinner (1951), clicker use did not become popular until the early 1990s (Pryor, 1999). Clicker popularity is now widespread and the method is frequently applied to the training of many types of animals including birds, cats, and horses (Pryor, 1999, 2001a, 2001b). The pioneer of canine clicker training, Karen Pryor has been instrumental in the implementation of clicker use to facilitate human learning in athletics, performing arts, special education and physical, occupational, and speech therapy (Pryor, 1999, "TAGTeach International," 2003-2004).

With the rising popularity of the clicker bridging stimulus, the selection of this stimulus is a growing consideration for professionals responsible for training animals in zoos, aquaria, and the companion animal industry. There are critical features of bridging stimuli that must be considered in this selection process. It is essential that a bridging stimulus deliver precise information in a manner free of ambiguity, thereby improving trainer ability to indicate appropriate behavioral responses (Ramirez, 1999; Reid, 1996). Providing accurate information may increase rate of learning and minimize confusion on the part of the animal as to what is required during the training process (Miller, 2001; Pryor, 1999; Ramirez, 1999).

Additionally, it is important that all of the trainers of a facility deliver a consistent sounding bridging stimulus to ensure that the animals come to know its value well (Ramirez, 1999). As transactional communication involves an awareness and interpretation of a multiplicity of overlapping signals (Berko et al., 1995), an animal may be able to cue into paralinguistic differences in the verbal messages of the trainer. In any communication process, the delivery of

verbal messages is accompanied by paralinguistic vocal variables such as rate, tone, volume, and rhythm (Devito, 1994). Therefore, intra-trainer and inter-trainer variability is present in the acoustical characteristics of a verbal bridging stimulus. Although the word itself may be the same, vocal variations may convey different information (Devito, 1994). Due to these variations in sound production, a verbal stimulus may span several moments of ongoing behavior, providing ambiguous information to the animal as to which response earns reinforcement.

As the trainer must be able to specify with "pinpoint accuracy" which response in a series is correct, a bridging stimulus that produces a quick, discrete sound provides the most accurate information to the animal in training (Belting, 1997 as cited in Ramirez, 1999). An auditory cue of standardized sound and fixed length of sound production, the clicker bridging stimulus may offer greater precision and accuracy than a verbal stimulus in pinpointing a correct instrumental response. The sound of the clicker does not vary in length or tone; there is not an excited click or a mild click. As each production of the clicker is identical, it is easily transferred from trainer to trainer. All of these factors may significantly improve the animal learning process.

As this is a new area of scientific interest, there are few empirical studies to be found regarding clicker efficacy. McCall and Burgin (2002) as well as Williams, Friend, Nevill and Archer (2004) compared the effect of the clicker to the use of only a primary reinforcer on the acquisition and extinction of a learned behavior in horses. While Williams et al. (2004) concluded that the use of the clicker was not more effective at producing shorter training times than the use of a primary reinforcer, McCall and Burgin (2002) reported that the clicker facilitated the acquisition of a novel behavior. No comparison was made in either study between the clicker and another bridging stimulus. However, many professional training books advocate the use of the clicker as a highly effective means of delivering information (Alexander, 2003;

Dennison, 2003; Donaldson, 1996; Hetts, 1999; Jones, 2002; King, 2004; Miller, 2001; Parsons, 2005; Pryor, 1999, 2005a; Reid, 1996; Ryan & Mortensen, 2004). An empirical analysis of the efficacy of the clicker bridging stimulus would be a significant contribution to the literature as well as to the animal professionals and caregivers who devote their lives to providing the highest standard of treatment for those in their care.

The objective of the present study is to evaluate differences in novel behavior acquisition between two groups of canine subjects that differ only by assigned bridging stimulus. This study compares the effect of the clicker bridging stimulus to that of the spoken word "good" on dogs' learning to touch a freestanding target. Because the clicker specifies correct behavior in a more precise and consistent manner than the verbal bridging stimulus, the hypothesis of this study proposes a faster rate of behavior acquisition in those dogs trained with the clicker bridging stimulus.

Method

Subjects

The sample for this study was comprised of 20 domestic dogs *(Canis familiaris)*, 11 males and 9 females housed at the New Rochelle Humane Society. Subjects were selected on the basis of training naiveté, interest in food, and age, with a preference for adolescent dogs (six months to three years of age). Prior to inclusion in the study, age appropriate dogs were assessed by the experimenter for a 5 minute period to determine prior training exposure and food motivation. In order to minimize different reinforcement histories among individuals, the experimenter selected only those canines that demonstrated an absence of correct responses to verbally cued behaviors such as sit, lie down, and shake. As staff and volunteers implement basic

training once an individual is deemed ready for adoption, this necessitated that all subjects were new arrivals to the facility (less than 1 week) and not yet available for adoption. Based on lack of training and minimal length of time in the shelter facility, recruited subjects possessed no evident prior conditioning history to the clicker or verbal bridging stimulus. All dogs were provided with a physical exam and deemed to be in good physiological health by New Rochelle Humane Society staff.

In an effort to reduce variability among individuals across conditions in terms of propensity for learning, subjects were matched as closely as possible along breed, age, and gender characteristics. As mixed breeds are often more common in shelters than purebreds, the final selected sample was representative of common household breed mixes. The breed, age, gender and assigned condition of all subjects are presented in Table 1**.**

Table 1

Subjects Included in the Study and Their Primary Characteristics

Subject	Breed	Gender	Approximate Age (years)
Verbal Condition			
Riley	Golden Retriever	Male	1.0
Buddha	Boxer	Male	2.0
Almond	Pit Bull Terrier mix	Female	1.0
Allen	Shepherd mix	Male	1.0
Jazz	Pit Bull Terrier mix	Female`	1.0
Fiona	Spaniel mix	Female	1.0
Blackie	Labrador Retriever	Male	2.0
Candy	Beagle	Female	3.0
Una	Golden / Shepherd mix	Female	1.0
Buster	Pit Bull Terrier mix	Male	.4 (12 weeks)

Clicker Condition			
Sasha	Sharpei mix	Female	2.0
Flip	Pit Bull Terrier mix	Male	1.0
Ron	Retriever / Setter mix	Male	1.0
Honey	Pit Bull Terrier mix	Female	3.0
Freddie	Terrier mix	Male	2.0
Brownie	German Shepherd	Male	3.0
Aphrodite	Golden Retriever	Female	6.0
Fawn	Pit Bull Terrier mix	Female	1.0
Chipper	Pit Bull Terrier mix	Male	1.0
Kitty	Spaniel mix	Male	1.0

Apparatus

The clicker employed for this study was the standard box clicker distributed by Karen Pryor Clicker Training™. All sessions were video recorded with a JVC Compact VHS Camcorder. Time intervals were measured with a Polder stopwatch. Background music was played by an Apple iPod through an Altec Lansing inMotion iPod speaker dock. Food rewards were cheese squares measuring .64cm^2. The freestanding target measured 53 cm in height and was constructed of PVC pipe topped by a 17 cm in diameter yellow, foam ball. Four concentric squares of blue adhesive tape were place on the floor around the freestanding target to delineate criteria for correct approximations. One of the blue squares bordered the legs of the freestanding target to provide its accurate placement for every session. A chair was placed on an additional tape mark 91 cm away from one side of the largest square. Figure 1 depicts room setup, target apparatus, and tape marks.

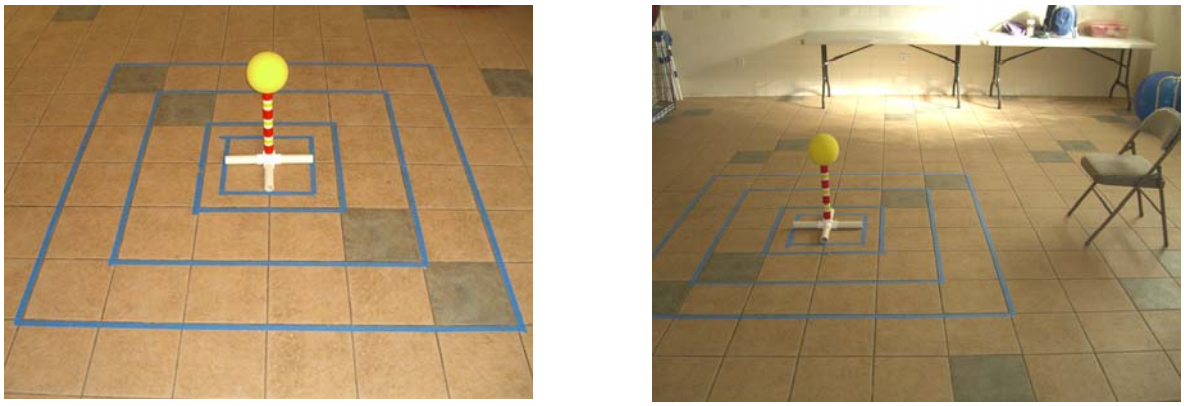

Figure 1. Photograph of target, achievement level tape marks, and room setup

Procedure

Upon selection for participation in the study, shelter dogs were randomly assigned to one of the bridging stimulus conditions. As new shelter arrivals met selection criteria, they were matched as closely as possible with current experimental subjects along age, breed, and gender characteristics to ensure that matched pairs differed only by the bridging stimulus employed for training the novel behavior.

To meet the desired sample size of 20 subjects, two dogs outside of the desired age range of six months to three years were included in the study. These two dogs were assigned to bridging stimulus condition in a manner that ran counter to the study's hypothesis. As the optimal learning period for dogs is considered to be between 8 to 12 weeks of age (Dunbar, 2004), the younger dog was expected to learn at a more rapid rate. Because the hypothesis of the study predicted clicker training would facilitate learning, the younger dog was assigned to the verbal condition and older dog to the clicker condition.

Based on ease of training and potential for facilitating adoption, the nose touch to object behavior ("target") was selected as the novel behavior to be trained for this study. Target touch is

a foundation level behavior that is usually absent from shelter dogs' behavioral repertoires, but can be highly useful for potential adopters as a method for teaching additional behaviors.

The target behavior consisted of 14 standardized achievement levels to ensure that all dogs met an identical criterion before progressing to the next training step. By comparison to the predetermined standard for a correct response, each response was objectively determined as correct or incorrect, eliminating researcher subjectivity in training decisions. Each dog was required to meet a minimum number of correct responses before commencing the next step. Table 2 depicts the standardized achievement levels.

The first four achievement levels represented successive movements toward the target apparatus and constituted one task within the overall behavior. The second task component was comprised of achievement levels 5 through 11 which represented successive approximations of nose touch to target apparatus. As part of this second component, in achievement level 9, the word "target" was introduced as the discriminative stimulus. Level 11 represented the final stage of behavior acquisition and the end of the second task. Levels 12 through 14 were repetitions of the previous level and included in the training plan only to strengthen the acquired behavior. While this procedure of training two separate tasks within the goal behavior was not deliberate, it provided the opportunity to further evaluate the effect of the clicker on the process of animal learning.

In order to mitigate any effect of social cueing, the emitted behaviors of each dog were shaped by bridging and reinforcing successive approximations to the desired behavior of nose touch to the target ball. No vocal or physical prompts such as target taps or vocal cues were used to encourage movement toward the target. Furthermore, no use of food to lure the dog to walk in the direction of the target was applied.

Table 2

Achievement Levels and Description of criteria for each

Achievement Level	Description of Criteria
1	Both feet cross 1st tape mark; head and body orientation to target
2	Both feet cross 2nd tape mark; head and body orientation to target
3	Nose cross line of 3rd tape; head and body orientation to target
4	Nose cross line of 4th tape; head and body orientation to target
5	Nose touch target leg
6	Nose touch target base
7	Nose touch target post
8	Nose touch target ball
9	Nose touch target ball within 5 seconds of introduced verbal cue, “target”
10	Nose touch target ball; within 3 seconds of verbal cue
11	Nose touch target ball immediately upon verbal cue
12	For a 2nd time block, nose touch target ball immediately upon verbal cue
13	For a 3rd time block, nose touch target ball immediately upon verbal cue
14	For a 4th block, nose touch target ball immediately upon verbal cue

Training

Each dog followed the same daily procedure throughout the study. After removal from its kennel, the dog received an outdoor walk with the researcher for approximately 10 minutes before entering the experimental room. Upon entering the room, the trainer unleashed the dog

and placed the free-standing target inside the designated tape mark in the center of the room. Toys and a water bowl were made available to the dog in the training room. To mask external environmental noise, one of five selected quiet music albums was played throughout the session on a randomized basis. After a five minute acclimation period to the room, presence of the trainer, freestanding target, and background music, all toys in the room were removed from dog access and the experimenter sat in the designated chair.

Preceding the initial training session, each dog received 20 trials of conditioned stimulus (CS) – unconditioned stimulus (US) pairings. The assigned bridging stimulus served as the CS and the delivery of one single food treat served as the US. One trial was defined as one CS-US pairing; an intertrial interval between 15 to 20 seconds was used to ensure comparable intervals for all subjects while minimizing temporal conditioning. If a dog showed signs of obvious distress or lack of interest in food, it was removed from the study. Of the 30 dogs that participated in bridging stimulus conditioning, 25 were deemed appropriate for experimental inclusion.

Upon completion of bridging stimulus conditioning, each dog was given access to toys for a two minute resting period before initiation of the training session. After the two minute resting period, the experimenter sat in the chair and set the stopwatch for the first two minute interval of the training session. Each training session consisted of a maximum of 20 minutes, divided into 10 blocks of 2 minute intervals. During each two minute interval, the trainer followed the steps described in Table 2 to shape the dog to move toward the target apparatus and touch the yellow ball with its nose. If a dog achieved behavior acquisition in less than 20 minutes, the timer was stopped at the end of the current two minute interval.

The response criteria for achievement levels are shown in Table 3. Each dog was required to make at least five correct behavioral approximations in the two minute interval to proceed to the next achievement level. All additional correct approximations within the two minute interval were also marked with the appropriate bridging stimulus and reinforced. This prevented extinction of correct offered responses during the standardized time interval for each achievement level. If a subject demonstrated at least five correct approximations of an achievement level more advanced than the current one, the intermediate achievement levels were skipped and the next two minute time interval began with the demonstrated achievement level.

If the subject made three to four correct approximations during the two minute time interval, the current achievement level was repeated until the minimum number of five correct approximations was attained. If the subject made only one or two correct approximations, the achievement level was lowered to the previous step. If a subject emitted no correct approximations in the two minute interval, the achievement level was lowered to the initial level (see Table 3). Preliminary pilot work indicated that these procedures would maintain a sufficiently high rate of reinforcement to prevent frustration and maintain enthusiasm for the training process.

Every correct approximation was marked with the assigned bridging stimulus (a single depression of the clicker or the spoken word “good”) and rewarded with one cheese square. To ensure the dog noticed the cheese reward, it was tossed on the floor outside of the blue tape marks in the direction of the dog’s face. In this manner, delivery of the treat required the dog to move off of the tape marks. This set the dog up to offer another correct response by moving onto the tape marks. Incorrect approximations had no consequence other than failure to receive the bridging stimulus and food reward.

Once an individual reached the ninth achievement level, the experimenter introduced the discriminative stimulus, the verbal word “target.” At this stage, food rewards were tossed on the floor near the experimenter’s chair outside of the blue tape marks or delivered directly to the dog by the experimenter’s hand. This encouraged the dog to attend to the experimenter for introduction of the verbal cue. Training continued in this manner until each dog acquired the novel behavior. Acquisition was demonstrated when the dog completed achievement level 11 and would touch the target apparatus immediately upon verbal cue; achievement levels 12, 13, and 14 were used to strengthen this final behavior. After completion of each training session, the dog received an additional outdoor walk before returning to its kennel.

Of the 25 dogs included, 20 completed the training phase and contributed data to this study. Two dogs were removed from the study on their initial day of training; one dog was adopted and one exhibited stress behaviors of whining and pacing at the door. Additionally, two dogs contracted a mild case of kennel cough early in their training which caused a lack of interest in food and their removal from the study. After three days of training, one dog was removed from the sample due to a lack of general attention abilities. As she was assigned to the verbal bridging stimulus group, her continued participation in the study would have exaggerated the hypothesized effect of slower rate of learning for dogs of the verbal bridging condition.

Table 3

Response Criteria for Achievement Level Decisions

Correct Responses	Level Decision
5+ of advanced level	Raise to the advanced level
5+ in current level	Raise to next level

3-4 in current level	Repeat current level
1-2 in current level	Lower to previous level
0 in current level	Restart with initial level

Data Collection and Analysis

Each correct approximation in a two minute period was noted by the experimenter on each dog's daily data sheet. The number of completed criteria levels, reinforcements, and required minutes of training time was calculated at the end of each session. All sessions were reviewed by video playback to confirm the scores noted during the training procedure.

Total Training Time - The speed of behavior acquisition for each dog was assessed by summing total minutes to acquisition. To provide an additional measure of the efficacy of the two procedures, the number of total required reinforcements to reach achievement level 11 was calculated for each dog as well. As achievement levels 12 through 14 served as repetitions of achievement level 11 to strengthen the learned behavior, they were not included in this measure of the data analysis.

Initial Day of Training - To further evaluate the efficacy of clicker use on the learning process, measures from the first day of training were analyzed. The average number of successfully completed criteria stages during the initial training day was compared for the two conditions.

As the dogs were reinforced for every correct approximation in the two minute time interval (even those in excess of the required number), the average number of earned reinforcements was also compared between the clicker and verbal bridging stimulus conditions.

Analysis by Achievement Level - To further investigate the effect of bridging stimulus condition, individual achievement levels were analyzed for significant differences in the number of required reinforcements. The comparisons of required reinforcements between bridging stimulus conditions for achievement level 1 as well as for achievement level 5 were predicted to be significant as these levels served as either the initial stage of the target behavior (achievement level 1) or as a new task within the target behavior (achievement level 5).

Results

Total Training Time - Consistent with the hypothesis of a faster rate of behavior acquisition in clicker trained dogs, behavior acquisition in the clicker bridging stimulus group required fewer minutes of total training time that of the verbal group. The difference in the number of minutes to behavior acquisition for clicker group, (M=36.40, SD=8.58) and the verbal group (M=59.20, SD=15.67), was statistically significant, $t(18) = 4.036$, $p = .001$.

As training time to behavior acquisition was significantly decreased in the clicker condition, these dogs were predicted to require a smaller total number of reinforcements to reach acquisition criteria. Consistent with the significant difference in required training time, the clicker group required fewer numbers of total reinforcements to meet acquisition criteria (M = 82.80, SD = 15.99) than did the verbal group (M=125.70, SD = 25.17), $t(18) = 4.55$, $p = .0002$.

Initial Day of Training - Those subjects assigned to the clicker condition averaged a greater number of successful completions in the initial training session (M = 7.40 SD = 2.22) than did those assigned to the verbal bridging stimulus condition (M = 4.20, SD = 1.48), $t(18) = 3.795$, $p = .001$. Clicker condition dogs earned significantly more reinforcements on the first day of training (M = 57.70, SD = 12.02) than the verbal group (M = 44.60, SD=6.35), $t(18) = 3.048$, $p = .007$.

Analysis by Achievement Level - The mean number of reinforcements required for each achievement level as a function of bridging stimulus condition is displayed in figure 3. Reference lines indicate initial level of task components within the overall behavior. In 13 out of 14 achievement levels, the means for the clicker condition demonstrated fewer required reinforcements to meet criteria than the means from the verbal bridging stimulus condition.

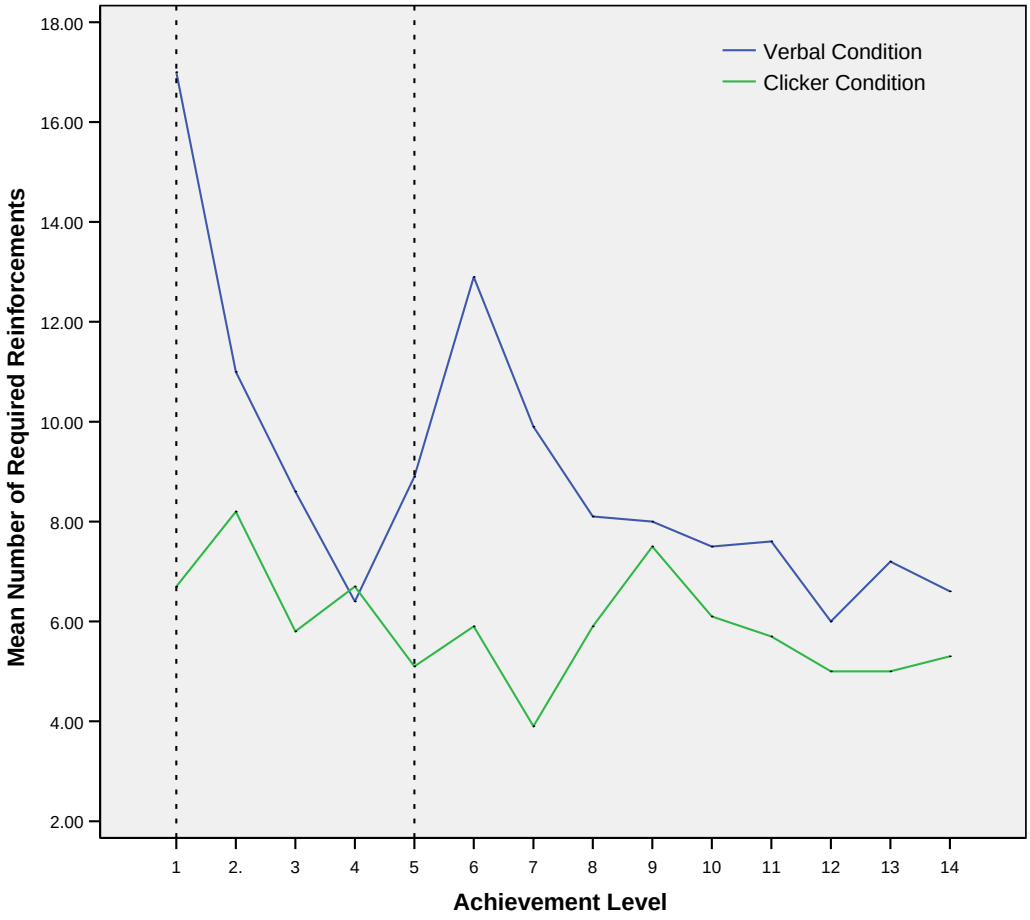

Figure 3. Mean required reinforcements for each achievement level by condition

A two-way mixed ANOVA was conducted to evaluate the effect of bridging stimulus condition on the number of required reinforcements for each achievement level. The within-subjects factor was achievement level with 11 levels and the between-subjects factor was bridging stimulus condition with 2 levels: clicker or verbal condition. The dependent variable

was the mean number of required reinforcements per level. The Achievement Level main effect and Achievement Level × Condition interaction effect were tested using the Huynh-Feldt correction for sphericity. The Achievement Level main effect was significant, $F(10, 180) = 2.45$, $p=.031$. The Bridging Stimulus Condition main effect was also significant, $F(1,18) = 16.95$, $p=.001$. The Achievement Level × Condition interaction was marginally significant, $F(10, 180) = 2.10$, $p=.061$.

Post hoc t-tests were used to determine which differences contributed to the significant effect of bridging stimulus condition. As predicted, differences in mean required reinforcements between the two bridging stimulus conditions were significantly different for achievement level 1, $t(18) = 3.10$, $p=.006$) and achievement level 5, $t(18) = 2.14$, $p=.021$. These achievement levels were those at which the dogs were required to initiate a new task within the overall behavior; achievement level 1 required dogs to approach the target and achievement level 5 required the dog to touch the target apparatus.

Discussion

The results of this study are consistent with qualitative reports of clicker use as a powerful training method to facilitate animal learning (Alexander, 2003; Dennison, 2003; Donaldson, 1996; Jones, 2002; King, 2004; Miller, 2001; Parsons, 2005; Pryor, 1999, 2005a; Reid, 1996; Ryan & Mortensen, 2004). As revealed by comparison of the average number of training minutes to behavior acquisition for the clicker and verbal bridging stimulus conditions, clicker use significantly increased the rate of novel behavior acquisition. Dogs in the clicker condition successfully completed the target behavior in an average time of 36 minutes, whereas verbal condition dogs required an average of 59 minutes of training. In the field of animal training, an average reduction of over 20 minutes of training time per individual animal may

have considerable implications for professionals faced with immediate training deadlines for unexpected medical purposes or necessary behavior modification strategies.

Training with a clicker bridging stimulus not only reduced the required amount of training time, but also the amount of food reinforcement needed to successfully teach the novel target behavior. Clicker trained dogs required an average of 83 primary reinforcements to reach the end of training, whereas verbal condition dogs required an average of 126 primary reinforcements. This significant reduction in the required number of primary reinforcements may alleviate concerns regarding animal weight gain and can also contribute to a reduction in the financial cost of food for animals in human care environments.

Analysis of the initial training session revealed a significant effect of the clicker on behavior acquisition within the first day of training. In the first 20 minute training session, clicker condition dogs averaged successful completion of approximately 7 out of a possible 14 achievement levels, whereas verbal condition dogs successfully completed an average of only 4 out of 14 achievement levels. The facilitative effect of the clicker on the early stages of learning may be due to a more precise indication of correct behavior than that of the verbal bridging stimulus “good.” Accurate, clear communication of information from trainer to animal results in faster learning at the very onset of training.

The completion of significantly more achievement levels in the initial 20 minute training session produced a significant increase in the rate of reinforcement for clicker conditions dogs. Clicker condition dogs earned an average of 58 primary reinforcements in the initial training session; verbal dogs earned an average of 45 primary reinforcements. As more reinforcements in an interval of time lead to more progress (Donaldson, 1996), the increased rate of reinforcement in the clicker condition suggests a more efficient and clear training process.

Analysis of the initial stage within first task component of moving toward the target apparatus (achievement level 1) demonstrated that verbal dogs required over twice as many reinforcements as clicker dogs; verbal condition dogs required an average of 17 reinforcements, whereas clicker dogs required approximately 7 reinforcements. As training of the first task continued through achievement level 4, both clicker and verbal dogs exhibited a progression in the acquisition of the task. The difference in required reinforcements for each condition decreased in statistical significance until the number of reinforcements approached a similar total for both clicker and verbal condition dogs. By completion of achievement level 4, the final stage of the first task, both clicker and verbal dogs required approximately 6 to 7 reinforcements to achieve criteria. Interpretation of this finding suggests the clicker not only facilitates learning of a novel behavior as a whole, but also of each new task component within that novel behavior.

Providing additional support for this interpretation, analysis of the second task (achievement levels 5 through 11) also demonstrated the facilitative effect of the clicker on the early stages of new task learning and revealed a progression in task acquisition. In achievement level 5, the initial stage of the second task of touching the target apparatus, the difference in required reinforcements between verbal and clicker condition dogs again attained significance; verbal dogs required an average of 9 reinforcements, while clicker dogs required approximately 5 reinforcements. By achievement level 11, the final stage in the second task, both clicker and verbal condition dogs required approximately 6 to 8 reinforcements to achieve criteria.

It appears that the effect of the clicker on learning is considerable at the initiation of each new training component. In the initial stage of training, as well as in the introduction of the second task within the current training process, verbal dogs were significantly slower to attain achievement level criteria than clicker dogs. As the early stages of novel behavior learning may

be the most difficult for an animal, it appears that use of the clicker as the bridging stimulus significantly improves the learning process. This suggests that the clicker is not only beneficial to the animal's progress when learning an entirely novel behavior, but also when achieving the different steps of any one behavior. The potential of clicker bridging stimulus to facilitate and improve learning throughout the entire process of a single behavior may increase rate of learning, reduce animal frustration, and further enhance the relationship between trainer and animal.

Conclusions

The results of this study hold practical implications for the facilitation of animal learning in a variety of training contexts including zoo, aquarium, and companion animal settings. These findings indicate the potential for improved animal learning by employment of the clicker over the verbal bridging stimulus. The unexpected results regarding the effect of the clicker on task component within a single novel behavior may be highly beneficial to animal professionals for the training of naïve animals as well as the training of complex multiple task behaviors such as husbandry practices, visitor interaction programs, and behavior modification strategies.

In every study there exists the ever-present possibility that experimenter effects may impact results (Orne, 1981; Rosenthal & Rosenthal, 1966); therefore, researchers seek to minimize these effects as best as possible. To mitigate potential researcher subjectivity or bias in the training decisions of this study, the achievement levels were standardized between both bridging stimulus conditions. This standardized approach to training allowed each behavioral response to be objectively deemed correct or incorrect, ensuring every dog met an identical criterion before progressing to the next achievement level. It is also possible that any potential bias of the experimenter may impact experimenter interaction with subjects, thereby impacting

the results of a study (Orne, 1981). For future studies, it would be optimal to further minimize any experimenter effects by replicating this study with two trainers, each led to believe in the efficacy of different bridging stimuli. Alternatively, one experimenter could replicate this study by following the shaping procedure while observing through one-way glass in a separate room. In this situation, food reinforcements could be delivered remotely by a dispenser in the experimental room.

In consideration of these results, it is worthwhile to restate that animal training is a process of transactional communication between trainer and animal (Berko et al., 1995). Such multimodal communication includes paralinguistic signals that are attended to and interpreted by both trainer and animal (Devito, 1994). As domesticated dogs are capable of utilizing human communicative signals to solve object choice tasks (Hare, Brown, Willamson, & Tomasello, 2002), it remains possible that they may read human social cues to solve other tasks. Although attention to this multiplicity of signals may facilitate animal learning through inadvertent social cueing by the trainer, these signals are present in both the clicker and verbal bridging stimulus conditions. The purpose of this study was to assess bridging stimulus efficacy in the normal animal learning process; the intention was not to isolate training from the normal social context.

In spite of the variability in dog breed, age, and gender, the differences in learning due to the type of bridging stimulus were significant. Effects due to subject variability were controlled by matching along these characteristics as closely as possible. The external validity of this experiment is addressed by the representative nature of this sample. Those breeds most commonly found in shelters and well represented in homes form the experimental sample.

In consideration of the ethics involved in training shelter animals, the results of this study indicate important practical implications for training in the shelter environment. Practical

considerations indicate that clicker training may be a highly effective teaching method for shelter dogs. The results of this study suggest that the clicker provides more accurate information than the verbal bridging stimulus, thereby increasing rate of reinforcement and decreasing the amount of required training time. The higher rate of reinforcement demonstrates that clicker training promotes learning in a positive manner that is free of frustration. Analysis of the reduction in required training time indicates that clicker use facilitates learning in the initial stages of novel behavior training as well as in each new task component within a single behavior. Such improvements in learning promote positive interactions between dogs and human caregivers. Positive training interactions may facilitate the dog's future learning process, improve adoptability, and assist the smooth transition to a permanent home. For shelter care of dogs, the effects of clicker training may very well reach far beyond improvements in animal learning.

While the goal of this study was an experimental analysis of bridging stimuli, it also aimed to meet and address specific ethical implications for research in the shelter environment. There is an ethical responsibility that must be upheld when conducting experimental training investigations on shelter dogs. The primary obligation of the experimenter must be to the dogs, not the research at hand. Shelter dogs require interactions with humans that are entirely positive, including training sessions that provide mental stimulation in a manner free of frustration. While this is necessary for all dogs in the shelter environment, it is crucial for under-socialized dogs and those with fear based behavior problems. Successful behavior modification and subsequent adoption will require a dog to develop positive associations with humans. For an experimental study to be of benefit to shelter dogs, it is essential that an experimenter not employ training methods that induce frustration or undermine the positive nature of the interaction between human and animal.

Data from the present study provide strong evidence that the rate of novel behavior acquisition is significantly faster for dogs trained with the clicker bridging stimulus in comparison to dogs trained with the verbal word “good.” Clicker dogs learned the target behavior on average of 20 minutes faster than verbal dogs and required an average of 38 fewer primary reinforcements. Furthermore, this study is the first demonstration of the significant effect of the clicker in facilitating learning of each task within a single behavior. As behaviors are often composed of multiple tasks, the clicker’s impact is considerable not only at the initiation of training, but also in the ease with which animals learn the new tasks that comprise a single, final behavior.

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