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RESEARCH

Influence of delayed timing of owners' actions on the behaviors of their dogs, *Canis familiaris*

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punishment

Abstract This study examined the influence of delayed actions from the owner, including commands, reinforcement, and punishment, on already-learned behaviors in 10 dogs. The delay times were set to 2.0, 1.0, 0.5, 0.27, and 0.13 seconds (s). Responses to commands with a delay (Delayed) were compared with those that were not delayed (Nondelayed). The results indicated that appropriate responses to commands decreased in 2.0, 1.0, and 0.5 s delayed conditions. As delay time increased, response to commands decreased. The numbers of commands used by handlers to make their dogs obey was significantly increased with a 2.0 and 1.0 second delay compared to the nondelayed trials. The time required for dogs to obey the commands was significantly increased in 2.0, 1.0, and 0.5 s delayed conditions compared to those of the nondelayed trials. There were no significant differences between the 0.27 s, 0.13 s, and the nondelayed condition. These results suggest that timing is an important factor affecting a dog's behavior not only while learning new things, but also in the production of learned desirable behaviors that could occur during everyday interactions.

Introduction

A dog's response to commands is influenced not only by the relationship with its owner, but also the owner's dog-handling ability. Professional dog trainers can sometimes control dogs better than their owners, and often dogs obey the trainers' commands better even during their first interaction. This finding suggests that there is a skill to giving commands, and appropriate rewards or punishment, to elicit desired behavior from dogs.

Human behavior seems to affect a dog's behavior and response to commands. For example, some dogs may find hidden food by following human gestures and focus of attention, including pointing, head turning, nodding, and gazing toward the target (Miklósi et al., 1998; Hare and Tomasello, 1999; Agnetta et al., 2000; McKinley and Sambrook, 2000; Soproni et al., 2002; Riedel et al., 2006). Other studies indicate that dogs may read a person's attentional state and change their response to cues depending on a human's attentional focus (Call et al., 2003; Virányi et al., 2004; Schwab and Huber, 2006). These studies revealed that dogs were able to perceive the attentional state of their owners by judging observable behavioral cues, such as eye contact and eye, head, and body orientation (Call et al., 2003; Virányi et al., 2004; Schwab and Huber, 2006) and obeyed commands better when they received more attention from their owners than when they got less attention. Moreover, Fukuzawa et al. (2005) demonstrated the importance of visual cues given by humans, in addition to their verbal cues, on eliciting appropriate responses in dogs.

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Timing of rewards and punishment is an important factor that will affect dogs' training behavior, especially if handlers need to reward or punish dogs as soon as the responses are observed (Reid, 1996). In the performance of service dogs and their users, Coppinger et al. (1998) also reported that timing must be precise. Many studies on timing have indicated that delayed reinforcement and punishment will retard classical conditioning in dogs and rabbits (Ellison, 1964; Schneiderman, 1966) and operant conditioning in dogs, rats, pigeons, and humans (Solomon et al., 1968; Baron et al., 1969; Andrew and Braveman, 1975; Lattal and Gleeson, 1990; Dickinson et al., 1992; Critchfield and Lattal, 1993; Neef et al., 1994; Schlinger and Blakely, 1994). However, all these studies focused on the acquisition of new behaviors. Ohnishi et al. (2003, 2004) examined the effects of delayed reinforcement and/or punishment on verbal conditioning to audio communication and showed that a delay of as little as 0.3 seconds (s) retarded the already-conditioned response in humans, indicating that performance of already-learned behaviors can be retarded by delayed reinforcement and/or punishment.

Owners sometimes command their dogs to perform behaviors they are already performing or command their dogs to perform behaviors when the dogs are not paying attention. They also sometimes attempt to reward dogs when dogs are not paying attention or show no response to the "reward" and further punish dogs when they are not responding to the punishment. Rooney et al. (2001) found that the signals that humans used most frequently to encourage dogs to play were ineffective. It appeared as though the owners did not pay attention to the responses of their dogs when determining how to elicit specific behaviors. These mismatches between owners and their dogs could influence the dogs' reaction to commands. Although the importance of timing is emphasized in the training of dogs and dogs change their behaviors depending on the handler's behavior as mentioned above, there are few studies that examine the influence of mismatch between owners and dogs. For example, it is not known how delays in presentation of commands, rewards, or scolding would affect a dog's performance of already-learned behaviors such as "sit" and "lie down." In this study, the authors examined the overall mismatch between what owners do relative to the current behavior of their dogs, and to how dogs subsequently respond to the owner. If owners' actions, such as timing of commands reinforcement, and punishment (scolding), are delayed, there may be a decrease in the probability of the dog obeying the command or showing other preferable behavior such as focusing on the owner. The aim of this study was to examine the effect of delayed actions from the owner, including commands, reinforcement, or punishment, on dogs' already-learned behavior and the dogs' attention to their owners.

Materials and Methods

Ten dogs, *Canis familiaris*, of various breeds consisting of 8 males and 2 females, were used in this study (Table). These dogs had been trained to "sit" and "lie down" and obeyed more than 80% of 20 commands (10 "sit" and 10 "lie down," presented randomly). During the process of selecting dogs for this experiment, the owners commanded their dogs as they would normally, with face-to-face interaction. Therefore, owners were allowed to provide both verbal and visual cues in addition to their usual methods of praising and scolding their dogs. In this experiment, praise or reward included words such as "good" and treats, whereas punishment or scolding included words such as "no" or speaking to the dogs in a loud voice that is apparently aversive to the dogs. Owners presented 20 commands in the selection test, and if the dog did not obey the command within a few seconds, the behavioral response was defined as incorrect. During the experiment, owners were required to make their dogs obey 5 commands (3 "sit" and 2 "lie down") using the same cues, but in this situation the dogs and handlers were in separate rooms and the dogs were shown a life-size image of the handler projected on a screen in front of them while the handler's voice was projected via speakers located next to the screen. In the nondelayed condition, the responses to commands projected by video were almost the same as the responses elicited during the selection test. In the test, a correct "sit" was defined by the dog's rump touching the floor, and a correct "down" was defined by the dog's elbows touching the floor. All the dogs were kept as pets, and their owners acted as their handlers.

Table Subjects for all experiments

Breed	Gender	Age (mo)
Border collie	Male	48
Flat-coated retriever	Female*	47
German shepherd dog	Male*	26
Labrador retriever	Male*	53
Labrador retriever	Male*	53
Labrador retriever	Male*	53
Labrador retriever	Male	60
Miniature dachshund	Male	27
Mix	Female*	27
Standard poodle	Male	72

*Neutered.

For experiments on delay, it was important that the subjects be blind to the experimental procedure. In this study, we used delay devices (sound: Boss DD-20 Digital Delay, image: Ito Co., Kakoroku) and arranged the setup to conduct blind experiments with handlers and to control the delay periods. Two rooms were prepared for the experiments (Figure 1); the dogs and the examiner were in room 1 (12 m x 6 m) and the handlers were in room 2 (5 m x 1 m). The rooms were separated enough so that sound could not be heard from the other room. The movements of the examiner and dog were recorded by video camera in room 1 (Hitachi DZ-HS403; Tokyo, Japan), and the image was played on a TV (Sony KV-14AF1; Tokyo, Japan) in room 2. The movement and voice of the handler was

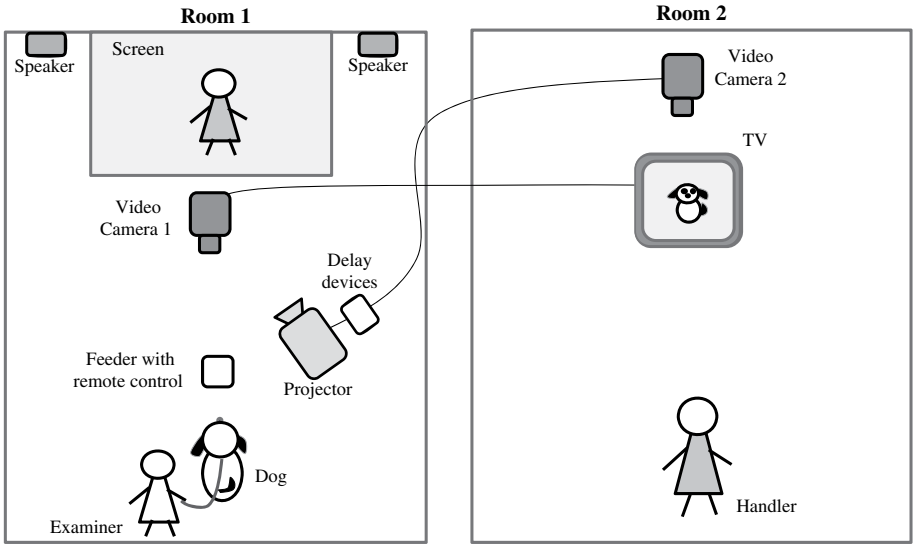


Figure 1 Experimental Rooms. The sounds and images recorded on Video 2 were delayed by the delay devices (sound: Boss DD-20 Digital Delay, image: Ito Co., Ltd Kakoroku) on the screen. Feeder was remote controlled.

recorded by video camera in room 2 (Victor GZ-MG77-S; Kanagawa, Japan) and played on the screen (243 cm x 160 cm) and speakers in room 1. The handler was projected life-size on the screen. The dogs stood 6 m from the screen, and the handlers stood 5 m from the TV. During the experiment, the handlers and the dogs could see the action in the other room on the TV or the screen. Dogs were presented with commands in both delayed and nondelayed situations. In the delayed experiments, the images and audio communication that were played on the screen and the speakers were delayed by 2.0, 1.0, 0.5, 0.27, or 0.13 s by the delay devices. With this experimental setup, the owners could see the dogs' behavior in real time, but every image and sound that was presented to the dogs was delayed throughout the delayed condition. Thus, every signal the owners presented to the dogs, including commands, rewards, and punishment, was presented to the dogs after a specific delay (2.0, 1.0, 0.5, 0.27, and 0.13 s) from when the owners responded to the dog's actions (Figure 2).

This study was divided into 3 separate experiments designed to examine the influence of delayed actions from owner, including commands, reward (praise), and punishment (scolding). Experiment 1 examined the effect of a 2.0 s delay in the owner's actions, such as presentation of commands, and the handler's response to the behavior (reward or punishment). Experiment 2 used 0.5 and 1.0 s delays, and Experiment 3 used 0.13 and 0.27 s delays (Figure 3). All commands were given by the dogs' owners via projected image and audio communication in both the delayed and nondelayed situations. "Nondelayed" means that there was no delay in the projection of handlers' images and voice to the dogs. "Delayed" means that the handlers' projected images and voice were delayed by the delaying devices; thus, the dogs received the images and voice communication after a delay of 2.0, 1.0, 0.5, 0.27, or 0.13 s. Four sessions were performed for each experiment, with 2 to 3 trials per session. Experiment 1 had 2 trials (nondelayed and 2.0 s delayed), Experiment 2 had 3 trials (nondelayed, 0.5 s delayed, and 1.0 s delayed), and Experiment 3 had 3 trials (nondelayed, 0.13 s delayed, and 0.27 s delayed). Each trial consisted of 5 commands (3 "sit" and 2 "down"). There was a 1-minute break between trials within a session and a 5-minute break between sessions. The order of trials and commands were performed randomly to minimize any order effects, but within each session owners were required to get their dogs to sit 3 times and lie down 2 times, with the order of commands predetermined by the experimenter. For example, the order of commands was "sit," "sit," "down," "down," and "sit" in one trial, and "sit," "down," "sit," "sit," and "down" in another trial. Dogs were commanded to sit and lie down from a stand position. If the dog did not respond immediately, owners were told to make them obey until the instruction was completed.

Handlers were given a few rules for the experiment. First, handlers were told to make their dogs obey the commands as they would normally. Second, they were told to press a clicker when they wanted to praise their dogs after commands were obeyed. The examiner pressed the button of a remote control at the same time as she heard the sound of the clicker, releasing a small treat to the dogs from a remote-controlled feeder. Prior to the experiment, the examiner was required to master the ability to press the button of the remote control as soon as she heard the sound of the clicker, and only 1 person worked as the examiner in all sessions. The authors used a videotape to confirm that the examiner reliably pressed the button of the remote control as soon as the clicker was pressed. Prior to the experiment, dogs were habituated to the feeder until they ate food from the feeder in the same way as they would eat

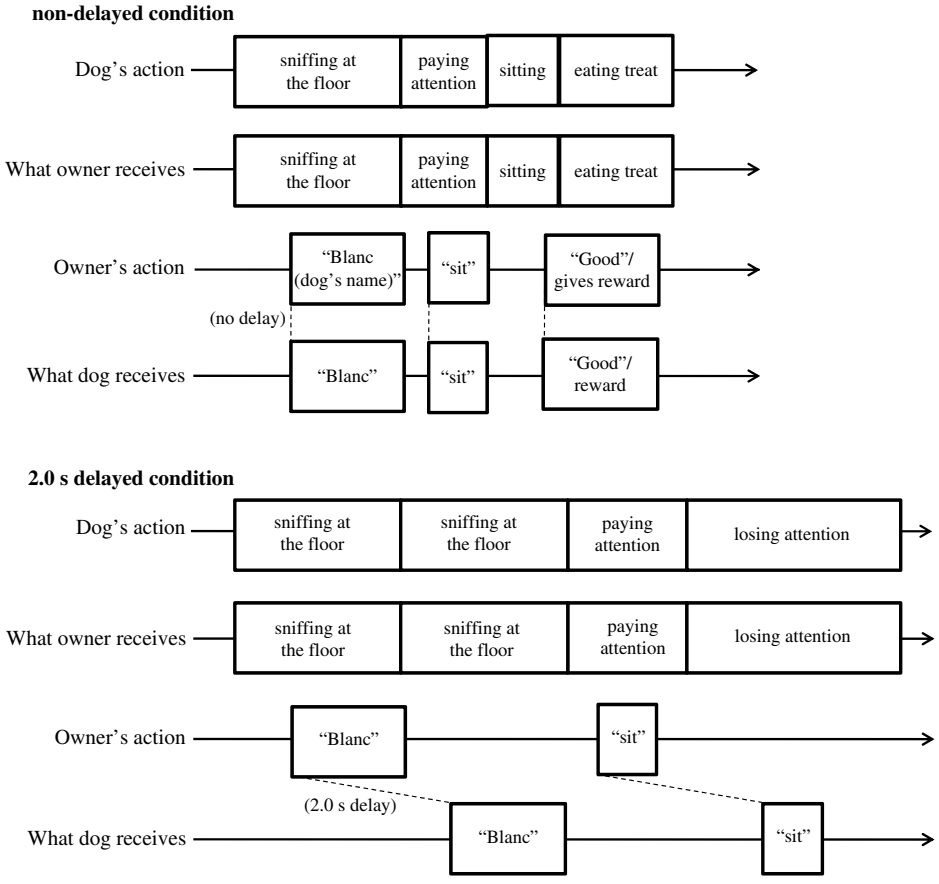


Figure 2 An example of the interplay between dog and the handler in the experiment.

from a normal bowl. Seven dogs received the pellets of dog food that they usually ate as a meal, and they ate the pellets immediately when the food was released from the feeder. Three dogs were not motivated by the pellets, and they were given small pieces of dog treats, such as jerky, which they ate immediately upon release from the feeder. During the experiments, the examiner held the leash loosely and had the dogs stand up before being commanded by their owners and after they completed the instructed position. The examiner neither watched the eyes of the dog nor moved, except to get the dog to stand up after a sit or down.

Each dog's behavior was recorded on video, and the following parameters were measured: latency to complete the behavior (reaction time); total number of commands given during each trial (number of commands); and percentage of time spent gazing at the projected image of the handler (gazing time). The "reaction time" was the time elapsed from when the handler gave his or her dog the first command to when the dog completed the behavior. A command was completed when the dog's rump touched the floor for "sit," and when the dog's elbows touched the floor for "down." The "number of commands" was how many times the handler had to repeat the commands to make the dog perform the 5 correct responses per trial. The commands that were presented when the dog was starting to perform the desired behavior were not included in the analysis. The "gazing time" was calculated as the proportion of time spent by the dog gazing at the image of the handler projected on the screen (time gazing/total time of trial [%]). Repeated-measures analysis of variance (ANOVA) was used to test if there was a learning effect throughout the session. The Wilcoxon signed-rank test was used for the statistical analysis in Experiment 1, using the statistical program OMS Statcel2 (2nd ed., 2004, Tokyo). Because there were multiple comparisons in Experiments 2 and 3, a Wilcoxon signed-rank test with Bonferroni correction was used to test for differences among nondelayed and delayed situations. All statistical analyses were done with the mean of each estimated parameter calculated for each individual over multiple trials.

Results

Figure 4 shows the differences in response to commands during the nondelayed and 2.0 s delayed trials from Experiment 1. Dogs required significantly more time to complete the commands in the delayed trials compared with the nondelayed trials ($T = 1.5$, $N = 10$, $P < 0.01$). The handlers had to use significantly more commands to complete the

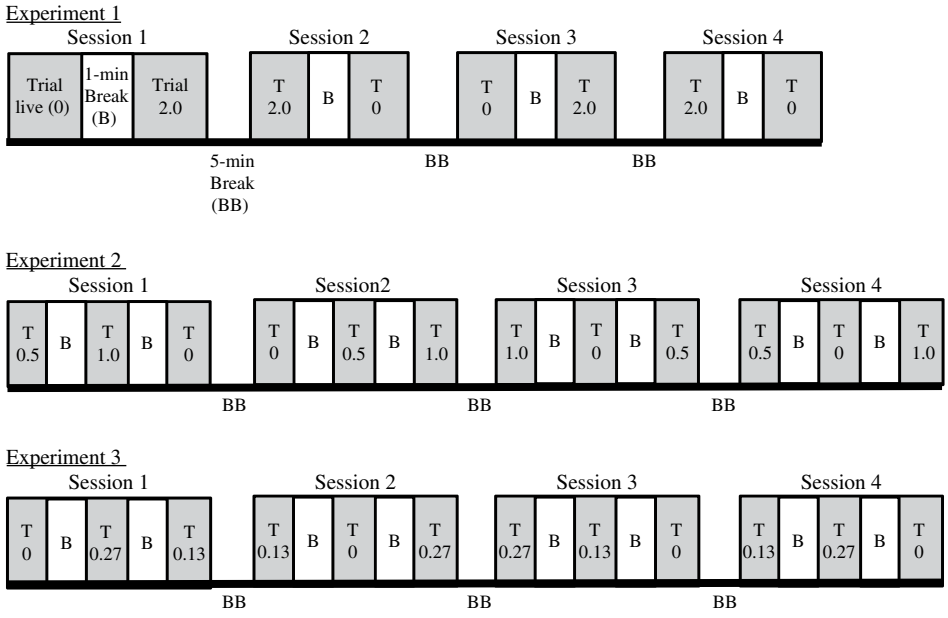


Figure 3 The experimental procedures. All the experiments consisted of 4 sessions, which were made up of 2 trials (T s) and one 1-minute break (B) in Experiment 1, and of 3 trials with two 1-minute breaks in Experiments 2 and 3. Five-minute intervals (BB) were inserted between sessions. Six types of timing were prepared for 3 experiments: T0, no delay (live); T0.13, 0.13 s delay; T0.27, 0.27 s delay; T0.5, 0.5 s delay; T1.0, 1.0 s delay; T2.0, 2.0 s delay. The order of timing was random. Handlers made their dogs obey 5 commands of 3 "sit" and 2 "down," which were randomly given to dogs.

series of behaviors in delayed conditions ($T = 5$, $N = 10$, $P < 0.025$). Moreover, dogs gazed at the projected image of their handlers for significantly less time in the delayed trials compared with the nondelayed trials ($T = 4$, $N = 10$, $P < 0.025$). When the dogs did not gaze at the projected image of their owners, they were distracted by other things such as the smell of the floor, the noise from outside, and the feeder. Because of these factors, on average, the nondelayed trial lasted 86.4 s and delayed trial lasted 131.8 s.

Figure 5 illustrates the differences in response to commands during the nondelayed and 1.0 or 0.5 s delayed trials from Experiment 2. Dogs required significantly more time to react to commands in both the 1.0 and 0.5 s delayed trials compared with the nondelayed trials (1.0 s delayed: $T = 3$, $N = 10$, $P < 0.025$: 0.5 s delayed: $T = 4.5$, $N = 10$, $P < 0.025$). The handlers required significantly more commands to complete the series of behaviors in 1.0 s delayed but not 0.5 s (1.0 s delayed: $T = 2$, $N = 10$, $P < 0.01$). However, there were no differences in the number of commands between nondelayed and 0.5 s delayed. Also, there was no difference in percentage of time gazing between nondelayed and 0.5 and 1.0 s delayed.

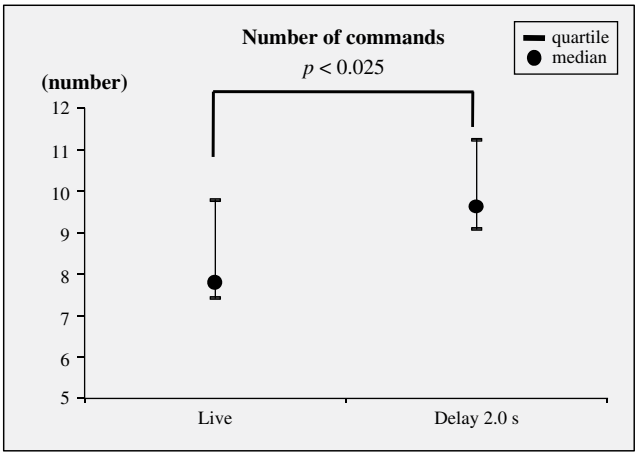
In the Experiment 3, there were no differences in reaction time to commands, number of commands, or percentage of time gazing between nondelayed and 0.27 and 0.13 s delayed.

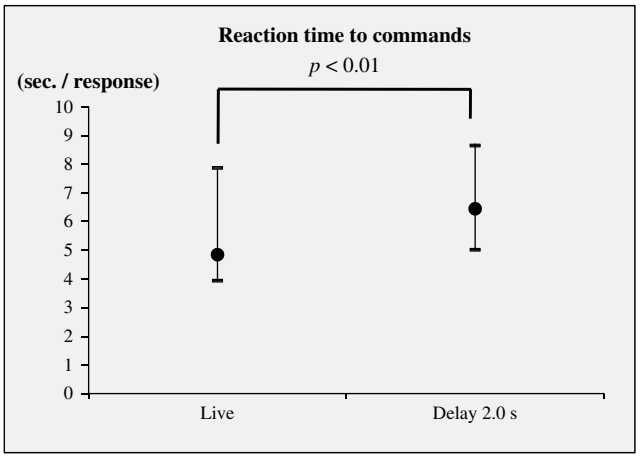
The number of dogs that showed changes in response to commands in delayed conditions is shown in Figure 6. As the delay increased, there was an increase in the number of dogs that required more commands to obey and in the time taken to respond. Repeated-measures ANOVA showed there were no differences across replicates.

Discussion

There are often mismatches between owners' actions and their dogs' simultaneous behavior and subsequent behavioral response. This study examined the effect of delayed timing of owners' actions, such as presentation of commands, reinforcement, and punishment, on already-learned behaviors in dogs. In this study, response to commands declined significantly in 2.0, 1.0, and 0.5 s delayed conditions. As the delay increased, response to commands decreased. These results indicate that the already-learned behaviors were influenced by the delays, and the authors speculate that this observation is caused by the following 3 factors.

First, the decreased performance may be a consequence of the delayed reward and/or punishment. In this experiment, punishment included only verbal scolding because dogs and owners were in different rooms. Because of the delays, handlers could not reward and/or scold their dogs as soon as their dogs responded correctly or incorrectly. Ohnishi et al. (2003, 2004) also indicated that performance of already-learned behaviors could be retarded by delayed reinforcement and/or punishment. Moreover, the delays might have caused confusion, because in the delayed conditions dogs were scolded for correct responses or were rewarded for incorrect responses. The authors observed that the dogs were praised when they were distracted by something and were not paying attention to the owners. Dogs





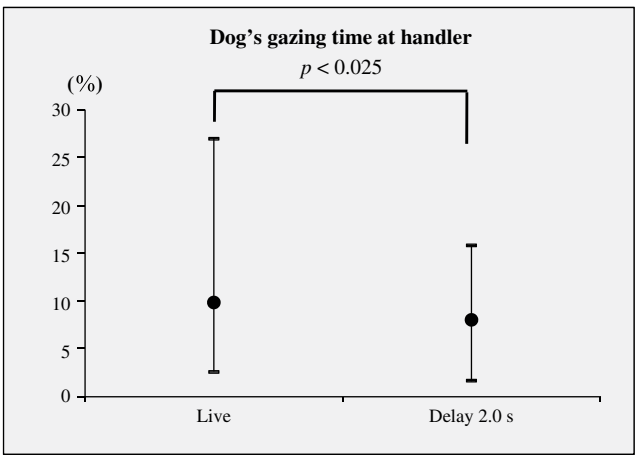
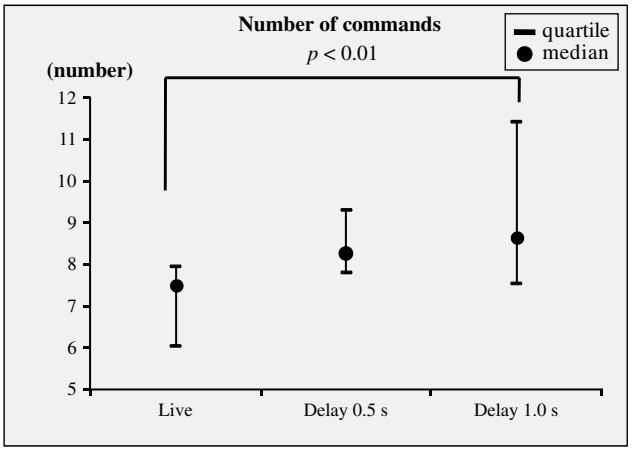


Figure 4 The influence of 2.0 s delay on a dog's reactions to commands (Wilcoxon signed-rank test).



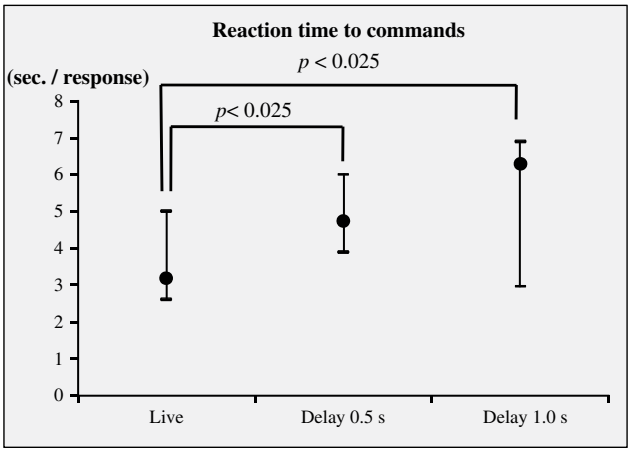


Figure 5 The influence of 1.0 s delay and 0.5 s delay on a dog's reactions to commands (Wilcoxon signed-rank test and Bonferroni correction).

were also scolded even when they were obeying commands. These mistakes were also observed in a study by Coppinger et al. (1998). Donaldson (1996) also pointed out that, frequently, the timing of owners' feedback (reinforcement/punishment) to dogs' behaviors was late.

Second, the delayed presentation of commands also might be one of the factors that affected the dogs' responses. In delayed experiments, dogs sometimes got commands while they were not focused on their handlers or while they were attracted to something else. Haverbeke et al. (2008) reported that distracted dogs showed low performance in obedience exercises. Fukuzawa et al. (2005) showed the importance of visual cues given by humans, in addition to their verbal cues, on obedience of dogs. These visual cues include lip and face movement, and they are subtle and perhaps unintentional cues. This finding indicates that owners should give commands when dogs are looking at them. So the presentation timing of commands should be precisely when the dogs are paying attention.

Last, confusion of the dogs seems to be one of the factors that caused the decline in response to the commands. Some dogs showed signs of confusion such as whining. It has been shown that in humans, transmission delays caused a negative psychological effect such as feeling awkward (Reeves and Nass, 1996; Ohnishi et al., 2003; Ohnishi et al., 2004). It is possible that dogs also experienced a negative psychological effect from the delayed communication, leading to confusion. It implies that the awkward interactions between the owners and dogs caused

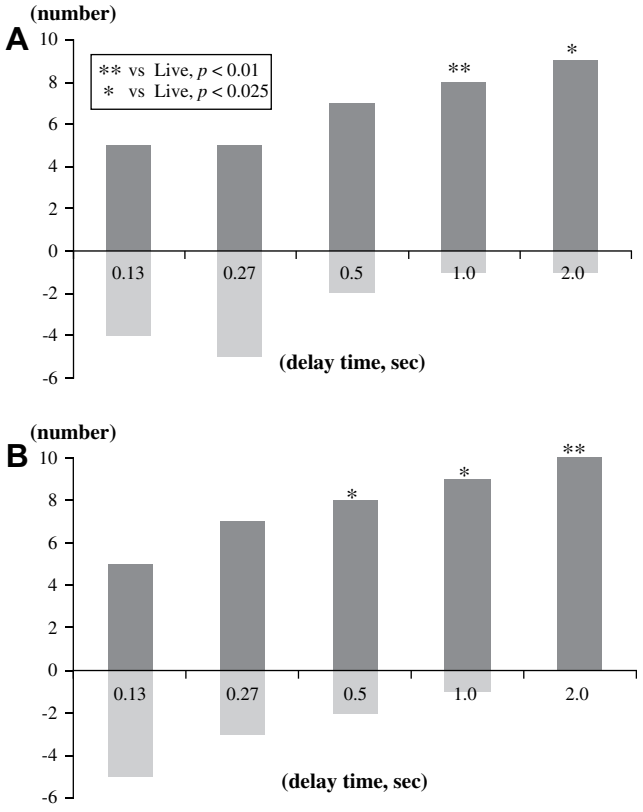


Figure 6 The numbers of dogs that showed worse reactions to commands in Delays than Live A. Dogs required more commands to obey commands. B. Dogs required more time to obey commands. (Wilcoxon signed-rank test and Bonferroni correction)

by delayed feedback may have elicited the dogs' declined response to commands.

In the experiments, Labrador retrievers showed a relatively slower decline in response to commands under delayed conditions, whereas the German shepherds, poodles, and border collies had a more rapid decline. The difference among breeds in response to delays might be significant especially for the development of working dogs such as guide dogs, although further experiments are required.

In conclusion, this study showed that even a 0.5 s delay in owners' actions such as giving commands, rewards, or scolding decreased a dog's response to well-known commands. It indicates that a mismatch between the owner, interaction and what the dogs are doing or how the dog responds influences the reaction to commands. The declines in performance observed in this experiment suggest that repeated delays in usual interactions between a dog and his or her owner could lead to miscommunication. Sometimes dogs do not pay attention to their owners and thus are unable to behave appropriately according to their owners' commands. This study has indicated that timing of presentation of commands and subsequent reward or scolding is an important factor that can affect dogs' behavior not only when learning new behaviors, but also in the production of learned desirable behaviors that could occur during everyday interaction. If there is a continuation of the mismatch between what owners do and what dogs are doing or how the dogs respond, dogs' expectations toward their owners would decline and the response to commands would get worse. Also, this mismatch could cause stress, frustration, and anxiety in dogs; thus, owners need to learn to be aware of how their actions influence their dog's behavior. However, to examine the independent influence of the timing of commands, it is important to parse out the relative importance of the timing of commands and attention state in future research.

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