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The effect of frequency and duration of training sessions on acquisition and long-term memory in dogs

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ABSTRACT

Most domestic dogs are subjected to some kind of obedience training, often on a frequent basis, but the question of how often and for how long a dog should be trained has not been fully investigated. Optimizing the training as much as possible is not only an advantage in the training of working dogs such as guide dogs and police dogs, also the training of family dogs can benefit from this knowledge. We studied the effect of frequency and duration of training sessions on acquisition and on long-term memory. Forty-four laboratory Beagles were divided into 4 groups and trained by means of operant conditioning and shaping to perform a traditional obedience task, each dog having a total of 18 training sessions. The training schedules of the 4 groups differentiated in frequency (1–2 times per week vs. daily) and duration (1 training session vs. 3 training sessions in a row). Acquisition was measured as achieved training level at a certain time. The dogs' retention of the task was tested four weeks post-acquisition. Results demonstrated that dogs trained 1–2 times per week had significantly better acquisition than daily trained dogs, and that dogs trained only 1 session a day had significantly better acquisition than dogs trained 3 sessions in a row. The interaction between frequency and duration of training sessions was also significant, suggesting that the two affect acquisition differently depending on the combination of these. The combination of weekly training and one session resulted in the highest level of acquisition, whereas the combination of daily training and three sessions in a row resulted in the lowest level of acquisition. Daily training in one session produced similar results as weekly training combined with three sessions in a row. Training schedule did not affect retention of the learned task; all groups had a high level of retention after 4 weeks. The results of the study can be used to optimize training in dogs, which is important since the number of training sessions often is a limiting factor in practical dog training. The results also suggest that, once a task is learned, it is likely to be remembered for a period of at least four weeks after last practice, regardless of frequency and duration of the training sessions.

1. Introduction

Despite the popularity of the domestic dog (*Canis lupus familiaris*) as a pet and its need for training, the scientific papers within this field are rather limited when it comes to guidelines as to how often and for how long a dog should be trained. This lack of systematic studies probably has to do with the problem of finding sufficiently large number of dogs comparable in breed, temperament, early experiences and training level, because most dogs are kept as family dogs and therefore handled differently. Laboratory dogs on the other hand are very suitable for systematic studies as they are kept under relatively standardized conditions.

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Effects of different training schedules are often investigated as differences between a compressed training schedule (massed training) vs. a training schedule with long intervals between the training sessions (spaced training). Earlier studies suggest that spaced training cause better acquisition and retention than massed training. For instance, Meyer and Ladewig (2007) tested the effect of two training schedules on the number of training sessions required to reach a certain training level in dogs. Eighteen laboratory Beagles were trained either once a week or daily to perform a target response. Dogs trained weekly learned the task in significantly fewer training sessions than dogs trained daily and the weekly trained dogs tended to have a higher success rate at the different steps of the exercise. Experiments with ponies have produced similar results; Rubin et al. (1980) trained 15 ponies to perform specific maneuvers, such as to clear a small hurdle and to move backwards, following a visual cue in order to avoid a mild electric shock, and found that the animals trained once a week achieved the learning criteria in significant fewer training sessions than those trained seven times a week.

Commins et al. (2003) examined the effects of different training schedules on spatial learning and long-term memory in rats in an object displacement test and water maze seven days post-acquisition and obtained similar results: massed trained animals (16 consecutive trials, all in one day) had an impaired ability to retain a spatial memory of the environment in both the water maze and the object displacement test, compared to spaced trained animals (4 trials per day in 4 days), and were slower to acquire the task. Morris and Doyle (1985) found that spaced trained rats in a water maze (1 trial per day in 8 days) learned the task slower than massed trained rats (8 trials in one day), but only spaced trained rats were able to consolidate the learned escape route in long-term memory.

Not all studies suggest that spaced practice compared to massed practice is beneficial for acquisition. Kusunose and Yamanobe (2002) trained twelve yearling horses either daily or under distributed practice, each session lasting 30 min and daily training was found to be the most effective training schedule. The effect of duration of training sessions has not been investigated to the same extent as frequency and often refers to exposure time of a stimulus object in studies with humans. In the experiment of Hintzman (1970), duration was measured as exposure time of words and the results demonstrated that memory in humans was affected by both frequency and duration of the repetitions.

The purpose of the present study was to investigate the effect of frequency and duration of training sessions on acquisition and retention in dogs. Training sessions were either offered daily or 1–2 times a week. The duration of training sessions refers to either three continuous training sessions or one training session only. Acquisition was measured as achieved training level at a certain time. Four weeks post-acquisition the dogs' retention of the task was tested to detect if the different training schedules had resulted in different levels of retention.

2. Materials and methods

2.1. Subjects

Forty-four laboratory Beagles participated in the experiment, 19 females and 25 males. The age of the dogs varied from 5 months to 6 years. All dogs were bred at the same breeding site specializing in puppies for laboratory use, and brought to the medical firm at a young age. All dogs had the same daily routines with regards to feeding and living conditions. They were all kept in indoor facilities with about 6 dogs in each pen. All dogs spend three hours a day in an outdoor enclosure; half of the dogs were out in the morning and trained in the afternoon, the rest were trained in the morning and were out in the afternoon. The dogs were fed an average of 200–400 g of dog food (Arovit petfood A/S) depending on their size, and water was available ad libitum. The feeding was postponed till after the training as much as possible. Irregularities in feeding relative to training were random with respect to dog and training session and could not have introduced any consistent bias.

2.1.1 Distribution into the groups

The forty-four dogs were distributed into 4 comparable groups with regard to age, sex, personality and pen. Dogs from the same pen were distributed among the groups as much as possible. All groups had an equal allocation of dogs (50 percent), with regard to whether the dogs were in the outdoor enclosure before or after the training, because this could otherwise give rise to a different activity level and perhaps a different degree of concentration. In addition, the dogs were divided into three personality types according to their behavior around people: 1) very contact seeking, 2) moderately contact seeking, and 3) slightly nervous (see Table 1). Their personalities were estimated prior to the experiment by the personnel at the medical firm. Group W1 (training 1–2 times per week/1 session) and group W3 (training 1–2 times per week/3 sessions) both had five females and seven males, whereas group D1 (daily training/1 session) had five females and four males, and group D3 (daily training/3 sessions) had four females and seven males.

The experiment originally consisted of fifty dogs, but six dogs were excluded due to various reasons (three dogs from group D1 and one dog from each of group W1, W3 and D3). Two dogs showed no interests in the treats and were excluded after the first session, because it could not be assumed that they had the same motivation as the other dogs to perform the task. One dog became ill and three dogs were too nervous to be used in the experiment and were therefore excluded. A dog was considered too nervous to participate in the experiment if it had not taken the treat in the basket within 10 min.

2.2. Training

2.2.1. Initial training

The dogs were trained by means of operant conditioning using positive reinforcement and shaping to perform a traditional obedience task, i.e. to go to the basket and stay (see

Table 1
Distribution of age and personality type in the four groups. Personality type refers to the dog's behavior around people: type (1) very contact seeking, type (2) moderately contact seeking, and type (3) slightly nervous.

Group	Age (at the beginning of the study)							Personality type		
	5 months	1 year	2 years	3 years	4 years	5 years	6 years	Type 1	Type 2	Type 3
W1	3	3	5	0	0	1	0	5	4	3
W3	2	1	6	0	0	1	2	5	4	3
D1	2	1	2	0	1	3	0	3	6	0
D3	2	4	2	1	1	1	0	5	4	2

Table 2). The dogs were rewarded with treats (Frolic) and all dogs showed interest in the treats. The task was divided into 12 levels, starting with level 1 (Table 2). After each session the dog's level was noted. Acquisition was measured as achieved training level at a certain time. The training of a next level would start when the lower level tasks had been learned using the criterion of at least 5 correct trials out of 6. All dogs received a total of 18 training sessions each consisting of 6 trials. A trial was equal to a single repetition of the level task described in Table 2, meaning that for example the command jump was given only once in every trial. A session was counted in trials and not in minutes, because it is more precise to count the number of times a task has been repeated rather than training for a certain amount of minutes. One dog can repeat a task several times at the same time it would take another dog to perform the task once and it would result in an unequal amount of repetitions of the task. Dogs trained three successive training sessions had 18 trials in a row; dogs trained one session had 6 trials in a row. A dog moved on to the next level when it had at least 80% correct performance in a session, i.e. a minimum of 5 out of 6 trials had to be correct.

Table 2
Training program of the forty-four laboratory Beagles in the experiment. When a dog had more than 80% correct performance in a session, it was allowed to move to the next level in the following training session; i.e. minimum 5 out of 6 trials in a session had to be correct. A total of 18 training sessions was given to each dog.

Description	
Level 1	The dog approaches the trainer when called at (habituation to the trainer).
Level 2	The dog takes the treat from the basket, with the trainer standing next to it. It is enough that the dog takes the treat without having all 4 paws inside the basket at the same time (habituation to the basket).
Level 3	The dog goes into the basket to take the treat while the trainer stands 2 m away. The treat in the basket is visible to the dog. It is enough that the dog takes the treat without having all 4 paws inside the basket at the same time.
Level 4	The dog goes into the basket while the trainer stands 2 m away; the treat is not visible to the dog. The dog has to have all 4 paws inside the basket at once but is allowed to jump out immediately after taking the treat.
Level 5	The dog goes into the basket on command with all 4 paws inside the basket. There is no treat in the basket; the dog is only rewarded by the trainer when it is in the basket.
Level 6	The dog jumps into the basket on command and stands still for 4 s, while the trainer is 2 m away.
Level 7	The dog jumps into the basket and stands still for 4 s, after which it sits down as the trainer approaches it with a command to sit down.
Level 8	The dog jumps into the basket and sits down, as the trainer approaches it with a command to sit down.
Level 9	As in level 8 but the trainer moves 5 m away and immediately back again, while the dog is still sitting down.
Level 10	As in level 8 but the dog has to stay seated for 5 s after the trainer has moved 5 m away, and also stay put as the trainer moves back to the dog, without the dog changing position.
Level 11	As in level 8, but the dog now has to remain seated as the trainer walks 5 m away with the back towards the dog and back again.
Level 12	As in level 8, but the dog has to remain seated for 20 s while the trainer has its back on it 5 m away and stay seated also while the trainer goes back to the dog.

All dogs were trained by the same person (H.D., experienced female dog trainer) and all training took place in the same building as the housing facilities. The training took place in a room that initially was unfamiliar to the dogs. The room contained a small table in the height of 35 cm and a desk with a computer. The room was closed (app. 5.5×2.5 m) and only the trainer was present. The dogs were led on a leash to the training room and returned to their pen one at a time. The dogs were not familiar with the trainer or any of the commands before the experiment.

2.2.2. *Training schedule*

The forty-four dogs were divided into 4 groups; group W1 received one training session 1–2 times per week, group W3 received three training sessions in a row 1–2 times per week, group D1 had one daily training session, and group D3 was trained daily for three sessions in a row. Dogs trained three sessions in a row had a short intersession interval of 15 s. The training took place on weekdays, and for daily trained groups (groups D1 and D3), this meant training 5 days in a row followed by 2 days off. Weekly trained groups (groups W1 and W3) had alternately an interval of a whole week or 3–4 days.

To ensure the same starting point for all subjects, the dogs stood on a small table (of 35 cm height) at the onset of each trial. All dogs were trained separately. Before onset of the first training session, the dogs were given 1 min. to habituate to the room; the subsequent times the dogs were only given 10 s. The command "jump" was accompanied by a hand movement pointing towards the basket.

To counteract any unwanted effect of the trainer on any of the dogs, the training exercise and the circumstances involved in the training were standardized in every detail. The same trainer carried out all the training and acted the same towards every dog, and the dogs were always brought from the kennels in random order.

2.3. Test of long-term memory after four weeks

Four weeks after the last training session, the dogs' long-term memory of the previously learned obedience task was tested in a retention test. Regardless of the length of the training period, all dogs had a retention period of exactly four weeks. Each dog was given ten trials, with only a few seconds between the trials. After each trial it was registered which level the dog had attained. The ten trials are referred to as trial number in the results. Levels 1 and 2 were left out in the retention test because they functioned as habituation to the trainer and the basket, respectively, and all dogs were habituated to both at that point. In the retention test two dogs were reported sick and excluded from the test.

2.4. Statistics

The outcome of each trial was judged as one of 12 discrete acquisition levels, data hence followed a multinomial distribution. The data set for testing the acquisition curve consisted of the outcome of each of the 18 training sessions for the 44 dogs (792 observations in total). We used a repeated measures generalized linear model to test how duration of training sessions, frequency of training sessions, sex, session-number and interactions affected the acquisition level. In the model session-number was a continuous variable, whereas all other variables were treated as categorical. The model we tested included main factors, all second order interactions and the third order interactions between frequency, duration and session-number. Sex and age were only included in the model as main factors to account for the variation they may contribute, but their effects were not central to test our current hypothesis.

The data on retention of acquisition consisted of 10 trials for each of the 42 dogs (420 observations). This data set was also tested with a repeated measures generalized linear model assuming a multinomial distribution, which tested how duration of training sessions, frequency of training sessions, training level (level after the 18 training sessions), and trial number influenced the retention level. Trial number refers to the ten repetitions of the task in the retention test. Trial number was treated as a continuous variable and the other variables were categorical. The model included main factors, second order interactions and third order interactions between duration, frequency and trial number. Training level partly reflect duration and frequency during the acquisition tests, therefore interactions with training level were omitted from the model. Interactions between training level and trial number were included in the model to test if training level affected the retention. The repeated measures accounted for the multiple observations on the same individual in both tests. All tests were calculated using Proc Genmod, in SAS version 9.1 (Cary, NC).

3. Results

3.1. The effect on acquisition

The statistical analysis of the dogs' acquisition, measured as achieved training level at a certain time, revealed a significant effect of session number on performance ($\chi^2 = 40.78$, DF = 1, $P < 0.0001$), confirming a positive acquisition curve for all groups (see Fig. 1). The acquisition curves for the two frequencies differed as the interaction frequency of training session by session number was significant ($\chi^2 = 26.12$, DF = 1, $P < 0.0001$), indicating that training 1–2 times per week resulted in steeper acquisition curves than daily training (Fig. 1). Also the interaction duration of training session by session number was significant ($\chi^2 = 18.44$, DF = 1, $P < 0.0001$), indicating that one training session resulted in steeper learning curves than three training sessions. The third order interaction frequency of training session by duration of training session by session number proved to be significant ($\chi^2 = 7.64$, DF = 1, $P = 0.006$), suggesting that frequency and duration affect acquisition differently during the sessions, depending on the combination of these. The main factors sex, age, frequency and duration did not differ significantly ($\chi^2 < 9.33$ DF = 6, $P > 0.156$), nor did the interaction frequency of training session by duration of training session ($\chi^2 = 0.63$, DF = 1, $P = 0.426$).

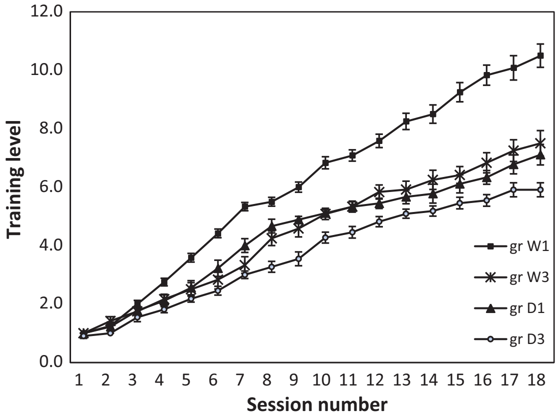

Fig. 1. Effect of the differential training schedules on acquisition (mean ± SE). Training 1–2 times per week in one training session (group W1) produced the steepest acquisition curve, whereas daily training in three training sessions (group D3) produced the lowest acquisition curve. Training for 1–2 sessions per week in three training sessions (group W3) produced an overlapping acquisition curve with group D1 (daily training in one training session).

3.2. Retention test four weeks post-acquisition

As shown in Fig. 2, all four groups appeared to have an unimpaired long-term memory of the learned task after 4 weeks corresponding to the training level achieved during acquisition. The dogs had received no further training prior to the test. The statistical analysis verified a significant effect on retention of training level ($\chi^2 = 14.69$, DF = 1, $P < 0.0001$) indicating a strong influence of the acquisition level after the 18 training sessions on the results of the retention test. There was no significant effect of either frequency ($\chi^2 = 1.03$, DF = 1, $P = 0.311$) or duration ($\chi^2 = 1.07$, DF = 1, $P = 0.301$) of training sessions, trial number ($\chi^2 = 3.00$, DF = 1, $P = 0.965$) or any interactions ($\chi^2 < 9.20$, DF = 1, $P > 0.231$) on performance after four weeks, strongly indicating that the only factor influenc-

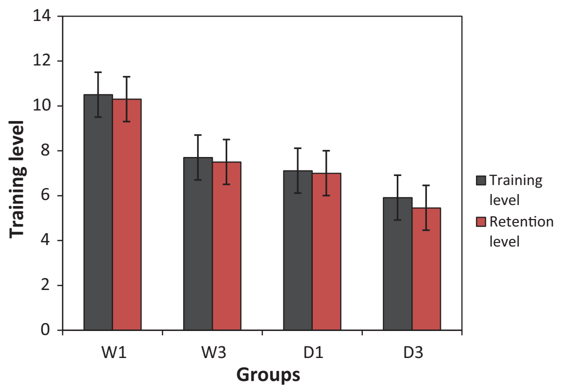

Fig. 2. Mean training level (level after the 18 training sessions) and mean retention level (results of the retention test after 4 weeks) with standard deviations. Training schedule did not affect retention; all groups had an unimpaired retention of the learned task after 4 weeks.

ing retention level is the level the dogs achieved during training.

4. Discussion

The results of the present study confirm that frequency and duration of the training sessions affect acquisition in dogs. As shown in Fig. 1, dogs trained 1–2 times a week had significantly steeper acquisition curves than daily trained dogs, when acquisition was measured as achieved training level at a given time. A short duration of the training session (1 session) resulted in significantly steeper acquisition curves than three successive training sessions. No effect of the differential training schedule was detected on the dogs' long-term memory; all dogs showed good retention of the learned task after 4 weeks.

4.1. The effect of a differential training schedule on acquisition

The results are consistent with those of Meyer and Ladewig (2007), who found that dogs trained once a week required fewer training sessions to obtain a given training level than dogs trained daily. Rubin et al. (1980) similarly found that spaced trained ponies completed the training program in significantly fewer training sessions than massed trained ponies. Rubin et al. (1980) also found that ponies trained at an intermediate rate produced intermediate results, which is consistent with the findings of the present study as groups W3 and D1 produced intermediate results. Fernström et al. (2009) found training in Rhesus Macaques once a day and three times a week to be more efficient than training twice a day, which is similar to our results. In the experiment of Fernström et al. (2009) animals trained twice a day actually learned the behaviors more slowly than animals trained only once a day.

The third order interaction frequency of training session by duration of training session by session number proved to be significant, suggesting that frequency and duration affect acquisition differently during the sessions, depending on the combination of these. The positive effects of a short duration and training 1–2 times per week appeared to be most prominent when combined (Fig. 1), whereas the combination of a long duration and daily training resulted in the lowest levels of acquisition. The overlapping performances of groups W3 and D1 indicate that it makes no difference if a dog was trained weekly/3 sessions or daily/1 session.

The results of the study can be used to optimize training in dogs, which is important since the number of training sessions often is a limiting factor in practical dog training. The aim of the study was not to provide the optimum training schedule for training in dogs, because acquisition might depend on multiple factors such as the type of task being learned and on how the intertrial interval is spend. In the review of Donovan and Radosevich (1999) short rest periods in humans appeared to produce the strongest results for simple tasks, whereas for more complex tasks longer rest periods appeared to benefit acquisition the most, and this observation might very well be relevant for animals as well. Results of Maslovat et al. (2004) suggest that interference of an extra task might be as beneficial to acquisition in humans as extra practice on the initial task, which suggests an important effect of the intervening interval.

4.1.2 Long-term memory

A high level of retention after 4 weeks was found in all groups, regardless of frequency and duration of training sessions. The high retention of the learned task after 4 weeks is not surprising when compared to long-term memory of other animals; e.g. horses (*Equus caballus*) have demonstrated the ability to remember relatively complex problem-solving strategies for a minimum of 6 years and as long as or longer than 10 years without further training (Hanggi and Ingersoll, 2009). A study by Kastak and Schusterman (2002) showed that a California sea lion (*Zalophus californianus*) can remember abstract problem-solving strategies for at least 1 and up to 10 or more years.

Even though massed training had a negative impact on acquisition as did a long duration of training sessions, this result did not affect long-term memory; once a task was learned, the dogs retained the task in memory. Our result is not consistent with earlier findings on long-term memory in rodents and honey bees (*Apis mellifera*) where spaced training has led to improved retention of the learned behavior compared to massed training (Commins et al., 2003; Menzel et al., 2001; Morris and Doyle, 1985; Spreng et al., 2002). The discrepancy of results could be due to the fact that massed training in these experiments was all conducted in one day. Spaced training for honey bees refers to training all in one day but with different intertrial intervals (Menzel et al., 2001), and for rodents it refers to training offered during 4–8 days (Commins et al., 2003; Morris and Doyle, 1985; Spreng et al., 2002). Massed training in the present experiment consisted of daily training on either six days (group D3, 18 trials per day) or eighteen days (group D1, 6 trials per day).

Lack of occasions for consolidation processes between massed training sessions has been suggested to cause the impaired performance in massed trained animals (Commins et al., 2003; Fernström et al., 2009; Spreng et al., 2002). In our study, the massed trained dogs (group D3 and D1) had a greater possibility to store the learned task on long term memory, since the training schedules were less compressed than most studies with e.g. rats. The training schedules were constructed in an attempt to simulate practical dog training and, therefore, it did not make sense to compress all the training in one day. Commins et al. (2003) attribute poor encoding of the initial environment in the object displacement task to contribute to the poor retention performance of the massed trained animals; their results suggest that spaced trained animals did not habituate to the environment but rather renewed their exploration in each session and built up a better spatial representation.

4.2. Mechanisms behind the spacing effect

The results give rise to the important question of why spaced training is better than massed training. Over time a number of suggestions have been proposed to explain the spacing effect but the suggestions are not consistent and a sole explanation to include all the findings has not been found. Jacoby (1978) found that the effort required to solve a problem enhances later retention performance, which gives rise to an explanation for the spacing effect; spaced training proves more of a challenge to the subject to retrieve the contents of the last session than massed training because of the greater interval between each session. The increased numbers of repetitions facilitate later recalls of the task, whereas successive training sessions produce an almost automatic response after a number of repetitions, where the content of the last session is effortlessly remembered. This is especially of great importance when the subjects do not have rest periods between the training sessions as in the long duration of the training session in the present study (three sessions in a row), but can also play an important part in the daily training. Spaced training also implies greater variations for the subject because of the time factor, both external (e.g. events of the day or physical environment) and internal (e.g. physiological status or mood) conditions (Rowe and Craske, 1998). This will lead to an extended memory of the task e.g. by including sub steps leading towards the solution and by increasing the number of familiar cues for later recall (Jacoby, 1978).

4.2.1 Consolidation during sleep and while awake

Sleep has been identified as a state that optimizes the consolidation of newly acquired information in memory (Born et al., 2006; Gais et al., 2006; Stickgold and Walker, 2007) and facilitates retrieval in wakefulness (Hennevin et al., 1995). When rodents are trained to follow a given trajectory, pyramidal cells (place cells) in the hippocampus will increase their firing rate when the animal crosses the corresponding places of these place cells, thereby generating a sequential activation of cells according to the animal's trajectory through the explored environment (Lee and Wilson, 2002; Wilson and McNaughton, 1994). The same sequences of action potentials, equivalent to sequences fired during spatial behavior, are re-expressed in the animal brain during slow wave sleep (Lee and Wilson, 2002) and during the wake state (Davidson et al., 2009), which are proposed to promote synaptic plasticity necessary for memory consolidation (Eschenko et al., 2008). The occurrence of replay during the wake state does not undermine the support to consolidation of memories during sleep; it merely suggests the concept of memory consolidation to include episodes of consolidation during the wake state as well. This gives rise to an explanation of the spacing effect; spaced training offers more possibilities for replay between the trials, because the intervening intervals are bigger and the training period passes over a longer time period than massed training. Thus it is not only the number of nights with sleep that plays a role in the consolidation process, also the time period in which learning takes place appears to be important in itself. Consequently, spaced repetitions of a task results in more rehearsal than do massed repetitions. The same argument can be applied to the positive effect on acquisition of a short duration of the training session compared to three sessions in a row. Group D3 and W3 had a night's sleep between every third training sessions, whereas groups D1 and W1 slept between every training session. A night's sleep between every session cannot alone explain the results, since group D1 in that case should have performed better than group W3, but they had overlapping performances. The total number of days and nights during the acquisition phase could actually provide a theoretical explanation for the effect, since group W1 were trained for 11 weeks and performed the best, group W3 and D1 were both trained in 4 weeks and produced equal intermediate results, and the training of group D3 took place during 8 days (6 days of training) and this group performed the worst. This merely suggests the spacing effect to be a time dependent one, but does not provide a satisfying explanation in itself since the underlying mechanism responsible for this effect still is unclear. In the interest of parsimony it is tempting to seek a single explanation that holds for all tasks, in which the spacing effect has been demonstrated but this might not be possible; e.g. implicit and explicit memory might require different consolidation processes.

4.2.2 The effect of duration

The results give rise to another important question, which is why a short duration of the training session is better than a long duration. Many of the same suggestions to the spacing effect might also apply to the long duration as well. When a dog trained three sessions in a row moved on to another level after the first or second training session, the dog immediately started training on a new level without having time to consolidate the last level before new learning took place. Three training sessions in a row only left the possibility to consolidate between every third session, and the content of the training sessions was retrieved fewer times than when training for one session at a time. The fewer retrievals of the task in the long duration of the session might have affected the dogs similarly to the massed trained dogs, e.g. by providing fewer familiar cues for recall. Two other obvious suggestions to the effect of duration are motivation and concentration. It is assumed in the experiment that all dogs have the same motivation to perform the task, since all the outer circumstances are the same. They are comparable by means of breed, housing, early experiences, feeding and daily routines. The training procedure and the treats used in the training are of the same quality and quantity. But an increased feeling of satiety in dogs with a compressed training schedule cannot be ruled out, since these dogs did receive a larger amount of treats per week. However, this was considered to be of minor importance as the dogs had not been fed since the day before and all showed interest in the treats. Genetic differences can affect dogs' love of food and eagerness to work, and past experiences with humans can give rise to different expectations to the training, which all can explain some of the variation within the groups, but the share of "disobedient" dogs must be assumed to be the same in each group at the beginning of the experiment. If any training schedule compared to another make the dogs less concentrated or motivated to work, this should be reflected in the results and will be an incentive to train with another training schedule.

5. Conclusion

The results demonstrate that frequency and duration of training sessions affect acquisition in dogs. In order to optimize the training sessions as much as possible training 1–2 times a week is to be preferred compared to daily training, and short durations of the training sessions are to be preferred compared to longer durations of the training sessions. In addition, our results demonstrated that dogs are highly capable of remembering a learned task for at least four weeks without further training, suggesting that breaks in the training, e.g. as a consequence of trainer vacations does not impair long-term memory of a learned task. We did not detect any effect on retention of frequency or duration of training sessions, suggesting that once a task is learned it is likely to be remembered regardless of frequency and duration of training sessions.

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