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Tolerance to delayed reward tasks in social and non-social contexts

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ABSTRACT

Domestic dogs have demonstrated striking social skills towards humans, however, there are few studies investigating impulsivity with delay-choice tasks in communicative contexts. In Study 1 we introduced a novel social delay-choice task in which subjects had to choose between one human cueing an immediate, low quality reward and another human signaling a delayed, high quality reward. In Study 2 we evaluated the tolerance to increasing delays using social and non-social cues. We also explored if more self-controlled dogs show any distinct behaviours during delays. Finally, we correlated all results with the Dog Impulsivity Assessment Scale (Wright et al., 2011). In Study 1 dogs reached an average maximum delay of 11.55 s. In Study 2 that average was 52.14 s with social cues and 40.2 s with non-social, but differences were not significant. Tolerance to delays showed high interindividual variation. Dogs remained mostly standing and near the delayed experimenter in the social tasks although we could not to find any distinct coping strategies. No significant correlations were found between the delay reached and behaviours, neither with the scale. These results show the relevance of the parameters and methods used to investigate tolerance to delay of reinforcements. More investigations are required, especially an assessment of the same subjects performing the same tasks using different contexts.

1. Introduction

Humans and other animals frequently make decisions that promise a benefit on the short run, but turn out to be detrimental on the long run. At the same time, they have developed more or less efficient ways to manage the temptation of instant gratification whenever the immediate outcomes of a choice are less convenient than the future prospects. One characteristic that governs decisions about future consequences is called *impulsivity* (Kalenscher et al., 2006). Although impulsivity can be broadly defined as behavioural actions without adequate forethought and poor consideration of consequences prior to action (Broos et al., 2012; Rayment et al., 2015), there is little scientific consensus on the exact nature or definition of impulsivity (Evenden, 1999; Rayment et al., 2015).

The most commonly used paradigm to study impulsivity in animals is delay-choice task which generally require a single decision at the start of the trial, either to choose a smaller amount or to wait longer to gain larger rewards (Mazur, 1987; Shifferman, 2009). This paradigm was utilized in a great number of species such as humans (e.g. Lawyer et al., 2010), non-human primates (e.g. Tobin et al., 1996; Warneken and Rosati 2015), birds (e.g. Green et al., 2004; Mazur, 2007), rodents (e.g. Green et al., 2004; Renda et al., 2014), insects (e.g. Cheng et al., 2002), and domestic dogs (e.g. Wright et al., 2012). According to this paradigm, the more choices for the delayed rewards and tolerance to delays, the more self-control an animal should have (e.g. Logue, 1988; Mazur, 1987).

Although domestic dogs (*Canis familiaris*) have been evaluated in some inhibitory tasks, like A-not-B and cylinder (e.g. Bray et al., 2014; MacLean et al., 2014; Marshall-Pescini et al., 2015; Miller et al., 2010, 2012, 2015; Sümegi et al., 2013; Topál et al., 2009a), little consideration has been addressed to delay-choice tasks. To our knowledge, Wright et al. (2012), assessed dogs for the first time in a delay-choice task and Leonardi et al. (2012) evaluated five dogs in a similar paradigm called delay-exchange task.

In the case of Wright et al. (2012), subjects had to choose between two non-social cues represented by two wood panels of different colours that dogs could push with the paw or the nose. One panel would deliver a food pellet immediately, while the other delivered three pellets with a 3 s delay. Every time the delayed reinforcement was selected, the delay was increased by 1 s in the

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next trial. The dogs of this study tolerated a delay ranged from 7 to 27 s, showing considerable individual variation. Finally, an interesting approach was to correlate some behavioural and physiological measures with the *Dog Impulsivity Assessment Scale* (*DIAS*, Wright et al., 2011), a questionnaire for the owners. Higher impulsivity DIAS scores regulation as assessed by DIAS correlated with reduced tolerance to delayed rewards in the choice test, and with lower levels of urinary serotonin and dopamine metabolites (Wright et al., 2012).

Taking into account that delay-choice tasks constituted a valid paradigm for researchers to study impulsivity in a variety of species, we consider that dogs would be a particularly important specie for study because: (1) they live in intimate contact with people and therefore require self-control of unfitting impulses for a proper relationship with them; (2) they are utilized in multiple tasks such as search, rescue, assistance to the disabled, which require a high self-control demand; (3) they became adapted to living in human society, through a complex evolutionary process (Miklósi et al., 2004), and it has been claimed that some dogs' specific features and social abilities show signs of convergent evolution with humans (e.g. Hare and Tomasello, 2005; Topál et al., 2009b); and (4) given the above factors and the fact that they are a social specie, dogs are suitable candidates to study the differences of self-control in social and non-social contexts.

The mechanisms controlling the social dimension of life often present different challenges for the animal than do physical aspects of the environment (e.g. de Waal, 1982; Tomasello and Call, 1997). The social brain hypothesis predicts that species that live in a complex group should have a high tolerance to delay of rewards because these individuals need to more often employ impulse control strategies in order to observe and engage in social events (Dunbar, 2009). Given that dogs are a social species that lives in intimate contact with and depend on people throughout their lives (for a review see Udell and Wynne, 2010), we could expect that they were subjected in their daily lives to a large number of situations that require inhibitory strategies. For instance, reinforcement is not always immediate and dogs have to wait to get food or a reward (e.g. Dennis-Bryan, 2014); other times, dogs reject certain types of food if there is a chance of getting something more appetizing (e.g. Leonardi et al., 2012). Therefore, when reinforcement comes from humans, dogs are constantly exposed to opportunities to gradually develop their inhibitory capacity. All these factors make them excellent candidates for the study of impulsivity. However, we strikingly failed to find studies with the classic impulsivity delayed-choice task incorporating human social cues. From this perspective, dogs should have a better performance in a tolerance to delay task when using social stimulus compared to non-social.

Nevertheless, it is also possible that human social stimulus may interfere in dog's performance. For instance, it has been revealed that, similarly to young infants, adult dogs commit the errors in the A-not-B task in the communicative condition but do not show this response bias in a non-communicative context (Topál et al., 2009a). Several studies claim that dogsí impulse control might be subject to contextual interferences related to specific task requirements that would facilitate or hamper such self-control (Bray et al., 2014, 2015).

Another significant aspect in connection with tolerance to delay of reinforcement relates to the possible strategies developed by individuals to tolerate longer delays. For instance, humans evidence capability to develop and use several cognitive or emotional strategies to cope with longer delays (e.g. Logue, 1988). Likewise, chimpanzees are able to display a series of self-distracting behaviours (e.g. Evans and Beran, 2007; Osvath and Osvath, 2008). Leonardi et al. (2012) showed that dogs exchanged with a human experimenter lower-value for higher-value rewards, showing considerable individual variation in tolerance prior to the exchange (between 10 s and 10 min). It was observed that dogs displayed different behaviours during delays (from remaining motionless to spinning around in circles). These results suggest that some dogs tolerate fairly long delays, albeit the factors that may predict which subjects would exercise more self-control are yet unknown. Even though the small sample size, this study gives valuable information and examines dogs in a social setting. Except for this study, to date there is no evidence that dogs are capable of using spatial, temporal or self-distracting strategies to overcome impulsive tendencies.

The present paper is a descriptive study and has the following four aims. First, given the increasing interest in dogs' social cognition and the fact that dogs might learn to tolerate delays during ontogeny in their interactions with humans, together with lack of dogsí studies using social delayed reward tasks, we wanted to introduce two novel self-control tasks using delayed rewards for measuring impulsivity in a social setting. For that purpose, in Study 1 we designed a delayed object-choice test in which the subjects had to choose between one human cue associated with an immediate, low quality reward and another human signal associated with a delayed, high quality reward. In Study 2a we designed another social task in which we evaluated the ability to tolerate increasing delays to obtain a reinforcement which location was signaled by a person. In this case the dog should make a growing effort waiting longer in each trial to receive the same reinforcement. In this protocol the choice was between going to the place where the reinforcement is delayed, going at an alternative location or stop performing the choice response. The greater tolerance the animal has, the more time it is willing to wait for the reinforcement. According Beran (2015a) these kind of protocols are considered a good measure of self-control given that require an increased activity rather than inhibition to obtain the better outcome (choosing to work longer for more pay rather than leaving work early).

Second, we wanted to assess the stability of tolerance to increasing delays measured in Study 2a by comparing that function in different contexts. For this purpose, in Study 2b we designed a similar protocol using non-social cues (like location and food odor).

Third, considering that there is some evidence of human and non-human animals using strategies that might improve self-control during delays, we wanted to investigate if dogs show any behavioural strategy during delays. Especially if more self-controlled subjects displayed any distinctive behavior compared to the more impulsive ones. For this purpose we measured some dogsí behaviours during delay periods along the three studies.

Finally, we aimed to correlate tests results obtained in each study with the DIAS (Wright et al., 2011), which was translated to Spanish.

2. Study 1

2.1. Subjects

We evaluated 40 healthy adult dogs between 1 and 10 years old, of different breeds and mixed-breeds. We excluded a total of 18 dogs. We had to exclude 3 dogs due to side bias (when they chose the same side more than 80% of the trials the test was ended) because it could affect their choices during the test considering that they have to choose according to the quality and delay of the reward instead to its location. Also, 5 dogs refused to eat during the training with low quality reward (dry dog food), probably due to a contrast effect between reinforcements, so they had to be discarded. Three dogs showed separation-related behaviours, 5 dogs did not meet the criteria in the free discriminative training stage, 1 showed fatigue over the tenth test trial, and in the case of 1 dog there were experimental errors during the protocol. Possibly this is a complex task that includes an initial discriminative learning and the simultaneous acceptance of two reward qualities leading to a high exclusion rate of subjects. The definitive sample included 22 subjects, 9 males (40.9%) and 13 females (59.1%), of different breeds (2 Golden retrievers, 3 Border collies, 1 Pitbull, 1 German Shepherd, 1 French Bulldog, 1 Samoyed, 1 Beagle, 1 Labrador, 1 Yorkshire, 1 Shiba inu, 1 Greater Swiss Mountain Dog, 1 Shih tzu, 1 Toy Poodle, 1 Dalmatian and 5 mixed breeds). Also, 3 of the owners did not complete the questionnaire so we performed the correlation analysis with the DIAS scale with only 19 subjects.

All animals were domestic pets living, for at least 1 year, with their owners. None of them had training in any commands or were familiar with test procedure or the experimenters. Also, they did not present aggressive behavior and/or excessive fearfulness to strangers.

2.2. Materials and experimental setting

Trials were all conducted at the location where the dogs lived, in a room at the owners' houses. The owners were not present during the testing, and they were requested not to feed their pet for 8–12 h before the experiment so as to keep the animal highly motivated to perform the task. The dogs had access to water ad libitum. Sessions were filmed with a Sony DCR SX-85 camera using a wide angle lens so as to measure behaviours and assess inter-observer reliability. A complementary JVC GZ-MG335HU camera was used to assess interactions with the bowls.

The reinforcements used were cooked liver and dry dog food of a brand generally consumed by the dog. We based on Bentosela et al. (2009), who showed in a preference test that cooked liver is a reinforcement highly preferred by dogs, while dry dog food of the usually consumed brand is the least preferred. Four identical opaque plastic bowls were used (two per experimenter, base diameter 9 cm, diameter of the opening 23 cm, depth 10 cm), one per type of reinforcement. In order to control smelling cues, five pieces of the respective reinforcement were covered by a second bowl −in each of the four recipients- with holes which allowed smell passage, creating a double bottom (see Udell et al., 2008).

For the pre-training and discriminative learning tasks two chairs were placed at 1 m from each other facing the dog that stood with the handler 2 m from the chairs. The choice area for each chair was delimited by a 1 m^2 square with the chair placed in the center. During the test, the distance between the chairs was increased 2 m. The bowls were placed on the chairs for the dog to retrieve the reward which was previously deposited into the bowls by the experimenter once the dog made its choice. For smaller dogs, identical boxes that match their height were used, not chairs, so that the bowls remain accessible. Whatever the size of dog was, it could never watch the food in the bowl because the reward was always held by the experimenter until the choice was made.

Three persons were needed to perform the protocol. Two Experimenters (Es−E1 and E2) who gave the social cues and a handler (H) who manipulated the dog and held a chronometer to control delays and intervals. The Es were always women, all of them unknown to the animals. Before testing began, Es ignored the dog but H was able to interact with the animal. Es placed themselves right in the middle of the two chairs before giving the respective cue, while holding the food in their hands out of the dog's sight. H had the dog on a leash at the starting point that was 2 m from the chairs (see Fig. 1).

2.3. Procedure

2.3.1. Behavioural test

We tested dogs in a delayed-choice task, in which they had to choose between two social cues. One cue was given by E1 followed by an immediate low-quality reinforcement (dry dog food) and the other was given by E2 followed by a delayed high-quality reinforcement (cooked liver).

Fig. 1. Experimental setting of the Study 1: delayed choice task with pointing and body position as two different human social cues, associated with different rewards and delays.

In the delayed-choice task, two bowls were presented to the subjects who obtained the food by choosing the bowl which was signaled by an E. Each E signaled the bowls using a different cue: static proximal pointing and body position. *Static proximal pointing* is morphologically defined by the extension of the arm and the index finger towards a target, with the tip of the finger less than 50 cm away from the target. In the *body position*, the person stands behind the food bowl holding her hands behind her back. Both cues are successfully used by dogs (Miklósi and Soproni, 2006). In both cues, the person continues to give the signal until the subject makes its choice and maintains eye contact with the subject. Maintaining the cues until the choice is made (instead of having momentary cues) helps discard memory problems related to reinforcement location. For half of the subjects one of the cues (i.e. static proximal pointing) indicated an immediate but low-quality reinforcement (dry dog food) and the other (i.e. body position) indicated a delayed but high-quality reinforcement (cooked liver).

The overall procedure consisted of three stages: pre-training, discriminative learning, and delayed reward choice test. Along the procedure, E1 always was held the immediate reward an E2 always held the delayed reward, the type and order of the cues was counterbalanced between subjects (type: in half of the subjects pointing was delayed and in the other half body position was delayed; order: in half of the subjects E1 always started the trials and in the other half E2 always started the trials), and the side (left-right) cued was semi-randomized within subjects (with a maximum of two consecutive times on the same side). In the pre-training none of the two above mentioned cues were displayed. In the discriminative learning stage only one cue and type of reinforcement per trial was present, and the delay, when existing, was always 5 s. Also, only one E was present in the set giving the cue. But then, in the delayed choice test both Es with their cues and reinforcement were present at the same time, and the delay started in 5 s but increased by 1 s every other time the dog chose the delayed reward.

2.3.2. Pre-training

dogs completed four pre-training trials (two per type of reinforcement and no inter-trial intervals, ITI; the side where the dog was taken first was counterbalanced between subjects) to make sure they understood that the bowls contained food. E1 entered the room holding the two bowls containing food inside, placed one on each chair at the same time, and left the scene in the same way. Subsequently, H moved the dog closer to the right bowl, showed the food, the animal took the food from the bowl, and then H showed the left bowl for the dog to eat again. Then E2 repeated E1′s steps but with the other type of reinforcement. After 20 s the following stage began. If a dog did not consume any of the reinforcements, it was excluded.

2.3.3. Discriminative learning

dogs completed 28 trials of discriminative learning. A previous discriminative learning phase is needed to achieve a delayed-choice task to make sure the subjects understood the outcomes of the two choices. The first 16 trials of the stage were forced (two sessions per cue comprising four trials each, 1 min interval between sessions and 20 s ITI), in which an instigation of the correct response was made to facilitate the association of each cue with each reinforcement. During these trials the dog did not choose the bowl. Instead, the H took it with the leash to the correct signaled bowl, according to previous evidence showing that the instigation is used to facilitate learning (e.g. Beran et al., 2014; De Petrillo et al., 2015b). E1 placed each empty bowl on a chair at the same time, placed herself next to one of the chairs while holding the food in her hands out of the dog's sight, called the dog by its name and, after that, extended her arm and the index finger towards the bowl (pointing). Soon after, H gently led the dog on a leash keeping it on the side of the correct bowl (i.e. the cued one) and when the dog entered the choice area he/she said "now" immediately or after 5 s depending on the condition (immediate or delayed). At that point the E1 placed the food in the bowl so that the dog could eat. Then E2 repeated E1′s steps but, after placing herself in the middle of the two chairs and calling the dog, she moved towards the signaled bowl and stood behind it keeping her hands at her back (body position).

The last 12 trials of the discriminative learning stage (one session per cue comprising six trials each, 1 min interval between sessions and 20 s ITI) began one min later. The only difference between these trials and the first 16 was that they were not instigated, i.e. the subject had to choose freely without the H taking it on a leash. H waited until the cue was given by E1 and then untie the leash so as the animal could freely walk forward to one of the bowls, and H approach the bowls together with the dog. The correct choices (i.e. the dog went without instigation to the bowl indicated by E1) were verbally reinforced by the H saying "very good" and letting the subject eat. If the choice was incorrect (i.e. the dog went to the bowl that was not indicated by E1), E1 did not give the reinforcement and the H said "no", taking the dog to the starting point. If after 8 s the dog did not choose, it was called once again. If it did not choose in 8 s, it was recorded as a no choice response. In the incorrect responses and no choices, the side where food was placed was repeated in the following trial. If the subject made two consecutive mistakes and/or no choices, two recovery trials with forced choice were performed. The learning criterion was set at four out of six correct choices, and the dog was excluded if it could not meet this criterion. After 1 min interval began the next session where E2 repeated E1′s steps, but with the other type of reinforcement. In sum, these 12 trials of the free discriminative learning phase had two conditions: immediate and delayed, with 6 trials each.

2.3.4. Delayed reward choice test

dogs completed 15 trials (20 s ITI) in the delayed reward choice test, 1 min after completing the discriminative learning. The goal of this stage was to assess the dogís choice between the immediate and delayed reinforcements. Two bowls were cleaned and the food placed in the double bottom was removed, as E1 and E2 were holding both types of reinforcements each in one hand out of the dog's sight so as to control smelling cues. E1 and E2 called the dog at the same time, providing both cues together so that the subject could choose one. E1 stood on the right and displayed the pointing gesture and E2 moved to the left and displayed the body position cue (cue type counterbalanced between dogs, side semi-randomized within dog). Immediately after the Es called the dog and the cues were given, H untie the leash so as the animal could freely walk forward to one of the bowls, and H approach the bowls together with the dog. If the subject chose the immediate reinforcement, the H said "now" and the E immediately placed the reinforcement in the bowl; if it chose the delayed reinforcement, after the dog got near the bowl, the H timed the delay and said "now" when appropriate. After "now" command the dog could eat, and both Es kept their cue until the dog consumed the food reward. For the delayed reinforcement, the interval became increasingly longer: first, there was a 5 s interval, and 1 more second was added with each choice of the delayed reinforcement. In the case of a delayed choice, if the dog got closer to the immediate E1 as a second option, it did not receive any dry dog food and once the delay had elapsed, the subject was reinforced with the cooked liver that had been its first choice. Whatever choice the dog made, H always gave verbal reinforcement when the choice was accomplished.

For a general procedural overview of the behavioural test utilized to evaluate tolerance to delay of reinforcement see Table 1.

2.3.5. Dog Impulsivity Assessment Scale

The DIAS was used as a psychometric measure of the dog's behaviours according to the owner's opinion. It provides an overall score and three factors: (1) behavioural regulation (2) aggression and response to novelty, and (3) responsiveness. These three factors measure impulsivity at two levels: while the first factor measures a limited and specific type of impulsivity, the second and third factors measure a broader type. The DIAS comprises 18 statements answered with a Likert type 5-point scoring scale which have proved to be reliable and valid in the UK (Riemer et al., 2013; Wright et al., 2011).

The score interpretation presented by the authors is that a higher score in the Overall Questionnaire Score (OQS) represents higher impulsivity; higher score in factor 1 means lower behavioural regulation (i.e. higher impulsivity); higher score in factor 2 means higher aggression/negative responses to novelty; and higher score in factor 3 means higher responsiveness. Dogs with high scores in the first factor are described as less prone to control their responses to stimuli, more prone to show extreme physiological signs, or repetitive behaviours when excited (higher level of arousal), needing more time to calm down after getting excited, and show spontaneous excitement in the absence of evident stimuli. Dogs with high scores in the second factor are described as less prone to tolerate close contact and be interested in new situations, and more prone to show aggression (Wright et al., 2011). In this case, novel stimuli might be regarded as sources of fear and would therefore trigger aggression (Archer, 1976). Dogs with high scores in the third factor, which measures the general response to stimuli, are described as easily trainable, more interested in novel stimuli and with quick reactions (Wright et al., 2011).

The authors did not report any cut-points for these scores, instead they presented a distribution of DIAS scores in a sample of 560 subjects (Wright et al., 2011) that we used as a referent parameter: OQS: 0.5169 ± 0.1001 (mean ± standard deviation), Factor 1: 0.4713 ± 0.1550, Factor 2: 0.3662 ± 0.1468, and Factor 3: 0.6990 ± 0.1302.

DIAS has shown good test-retest reliability at both 6 weeks (Wright et al., 2011) and 6 years (Riemer et al., 2013). However, to our knowledge, no validation of this scale has taken place in any language other than English and it has only been used in the UK (e.g. Riemer et al., 2013; Wright et al., 2011, 2012). Considering that, our results should be taken with caution. Even when the scores we obtained (see Section 2.6.3 Correlations with DIAS Scale) were similar to those obtained by Wright et al. (2011), which supports somewhat our use of the scale, we are aware that there could be cultural differences in the interpretation of items.

Table 1
General procedural overview of the behavioural test utilized in Study 1 to evaluate tolerance to delay of reinforcement.

Stages	Objectives	Activities, rewards and cues	Trials[a]	ITI[b]
Pre-training	To learn that the bowls contain food.	Rewards: dry dog food (E_1) and cooked liver (E_2). E_1 and E_2 present in 2 trials each. H always present.	4	0 s
Forced discriminative learning	To learn the consequences of the two cues by an instigation of the correct response.	Rewards: dry dog food (E_1) and cooked liver (E_2). E1 present during the first quarter of trials, E_2 in the second quarter, again E_1 in the third quarter and E_2 in the last quarter. H always present.	16	20 s
Free discriminative learning				
Immediate condition	To learn the consequences of the immediate cue.	Choose freely between the bowl indicated by the immediate cue and the other non-indicated bowl. E_1 and H present during the session. Reward: dry dog food.	6	20 s
Delayed condition	To learn the consequences of the delayed cue.	Choose freely between the bowl indicated by the 5 s delayed cue and the other non-indicated bowl. E_2 and H present during the session. Reward: cooked liver.	6	20 s
Choice test	To assess the dogís choice between the immediate and delayed cues.	Choose between the delayed and the immediate cue. Both cues were provided at the same time so that the subject could choose one. Progressive increase of delay: addition of 1 s with each choice of delayed reward. E_1, E_2 and H present during the session. Rewards: dry dog food (E_1) and cooked liver (E_2).	15	20 s

[a] Total number of trials: 43.
[b] ITI: inter-trial intervals. E: experimenter; H: handler.

2.4. Measures

In the *free discriminative learning phase* we measured the mean number of correct responses both in the immediate and in the delayed training conditions, which were defined by entering (with paws and/or nose) the choice area where was the bowl indicated by the person displaying the respective cue.

In the *choice test* we considered the *Maximum Delay reached in seconds* ($MaxD_s$) as the main measure of impulsive choice, which was taken per dog at the end of the 15 test trials (a higher $MaxD_s$ is considered less impulsive or more self-controlled, and a lower $MaxD_s$ is considered more impulsive). As the delay started in 5 s but increased by 1 s every other time the dog chose the delayed reward, the possible time interval ranged from 0 to 19 s (0 s implied a minimum of 0 delayed choices, in case a dog never chose the delayed option; 19 s implied a maximum of 15 delayed choices, in case a dog chose the delayed option in the whole 15 trials). We measured the number of choices of the immediate and the delayed reinforcements, which were defined by approaching (entering the choice area) to one of the two bowls indicated by one of the two Es present.

In the choice test we also recorded dog' behaviours while waiting for the reinforcement in the last trial in which the subject choose the delayed reward and calculated the ratios of the cumulative durations in seconds for all behaviours measured. First we measure (1) the *time spent near the delayed E*: the ratio of the cumulative duration (s) the dog remained with its paws at a distance of up to 50 cm from the delayed E, except when the animal interacted with the delayed bowl; (2) the *time spent near the immediate E*: the ratio of the cumulative duration (s) the dog remained with its paws at a distance of up to 50 cm from the immediate E, except when the animal interacted with the immediate bowl; and (3) the *alternation between options*: the ratio of the cumulative duration (s) the dog spent going across one choice area to another. Second, we measure (1) the *interaction with the delayed bowl*: the ratio of the cumulative duration (s) the dog remained touching with the paws or nose, licking or sniffing the delayed bowl; and (2) the *interaction with the immediate bowl*: the ratio of the cumulative duration (s) the dog remained touching with the paws or nose, licking or sniffing the immediate bowl. Finally we measure the *standing position*: the ratio of the cumulative duration (s) the dog spent standing.

Considering that the frequency of behaviours aimed at the person (including barks or other vocalizations, and physical contact with the nose or the head) was low, these variables were not included in the analysis. Frame-by-frame recording was performed at a rate of 3 frames per second (0.33 s) using GOM Media Player Software© V 2.2.72.

Finally, the OQS and the three factors of DIAS (Wright et al., 2011) were calculated for each dog.

2.5. Data analyses

Regarding the behavioural task, two independent observers analyzed all the measures in 40% of the video-taped material. To test inter-observer reliability we calculated Spearman's coefficients of correlation for all the measures and they showed good reliability ($r_s > 0.98$, $Ps < 0.0001$, $n = 9$). Since all the variables (except the $MaxD_s$, and the OQS, factors 1 and 3 of the DIAS scale) did not showed a normal distribution (*Shapiro-Wilk test*, $ps < 0.005$) we calculated mostly non parametric statistics. We conducted *Bonferroni* *corrections* for all post-hoc pairwise comparisons and *Rosenthal r* for effect sizes when necessary.

We used *Wilcoxon matched pair test* to compare the correct responses of each dog, both in the immediate and in the delayed free discriminative training conditions, and also to compare the first and last blocks of trials of the choice test to evaluate the potential effect of learning or fatigue.

In the choice test we analyzed whether dogs learned the contingencies of the task. Given that we found that each subject chose the same reinforcement during the two first trials, we made two preference groups: preference for immediate reward (IR) group ($n = 12$) and preference for delayed reward (DR) group ($n = 10$).We compared the choices of both groups in order to find if the initial preferences were sustained by group considering the total test trials, using *Mann-Whitney U test for two independent samples*.

Given that the length of the last trail in which each dog chose the delayed reward varies between subjects we calculated the proportions of time (ratios of the cumulative durations in seconds) that the dog spent performing each behavior by dividing those measures by the total amount of time that last the trial.

We analyzed the correlations between the behaviours and the MaxDs using a *Path Analysis of correlations*, which allowed us to evaluate the influence of multiple correlated variables on a dependent measure.

Finally, we considered possible effects of sex and age in all dependent variables (*Chi-square* tests and *Spearmanís* correlations), and we found no significant influence in any of them (all *p*-values >0.05), so we did not include them in the remaining analyses.

To control for possible effects of the cue used and the experimenter identity in the choices between the delayed and the immediate reward both during the free discriminative learning stage and the choice test we compared the number of choices to the immediate and delayed reward as a function of the cue given and experimenter (*Mann Whitney U*). We also run the same comparison with the behaviours measured. No effects of cue or experimenter was found in any of the variables evaluated ($p_s > 0.5$), so are not reported in the text.

All the analyses were performed with SPSS Statistics 17.0. All tests were two-tailed, α 0.05.

Table 2
Individual performances ($MaxD_s$: maximum delay reached in seconds) of dogs in the behavioural tests in Study 1 (N = 22), Study 2a (N = 14) and Study 2b (N = 15).

Study 1		Study 2a		Study 2b	
Subjects	MaxDs	Subjects	MaxDs	Subjects	MaxDs
Peper	15	Laica	53	Canela	20
India	10	Cuba	53	Auki	62
Chori	17	Coca	44	Tano	20
Kelly	10	Sofi	44	Coca bull	80
Vainilla	9	Pachi	56	Salsa	11
Cira	11	Jack	29	Penny	62
Morita	9	Purpu	71	Santa	50
Colita	12	Rintin	17	Coquita	29
Teo	11	Chilo	41	Homero	71
Kale	15	Odín	77	Negro	29
Astor	11	Ashton	62	Greta	17
Pepa	10	Gala	47	Rutila	38
Juana	16	Doan	65	Timoteo	71
Aiglos	8	Aragon	71	Juan carlos	20
Killa	9			India	23
Bobi	12				
Greta	11				
Manuel	10				
Cratos	10				
India S	12				
Goku	10				
Muna	16				

2.6. Results

2.6.1. Free discriminative learning stage

Twenty-two out of 29 dogs reached the learning criterion in the free discriminative learning stage. During the free discriminative learning stage we found no significant differences comparing the mean number of correct responses of each dog in immediate vs. delayed conditions ($Z = -0.660$, $p = 0.509$).

2.6.2. Choice test

We found significant differences in the total number of immediate and delayed choices made by each preference group ($Z = -2.043$, $p = 0.041$, $r_{effectsize} = -0.43$). Dogs of the IR group made on average more immediate choices than dogs of the DR group (IR: 8.75 ± 1.055; DR: 5.90 ± 3.071) and vice versa, dogs of the DR group made on average more delayed choices than dogs of the IR group (IR: 6.25 ± 1.055; DR: 9.10 ± 3.071). These results give demonstration that dogs understood the consequences of their choices, that is, they discriminated between cues with its associated reinforcements.

In order to evaluate the potential effect of learning or fatigue we compared the first and last block of 5 trials of the whole sample ($N = 22$) and we found no significant differences in the number of delayed choices ($Z = -1.268$, $p > 0.20$).

The whole sample reached a MaxDs average of 11.55 ± 2.59 s, ranging between 8 and 17 s (for individual performances see Table 2). The *Path Analysis* did not show any significant correlation with the $MaxD_s$ ($r_s < 0.3$, $p > 0.1$).

In the last delayed trial, dogs spent the mayor proportion of time standing and near the delayed E. Regarding the locations, dogs spent more amount of time near the delayed E than near the immediate E or alternating between options ($X^2 = 27.89$, $p < 0.001$). Finally, they preferred to interact more with the delayed than with the immediate bowl. For the rest of the data and analyses see Table 3.

2.6.3. Correlations with DIAS scale

We found a high consistency with results of the English original version developed by Wright et al. (2011) with 560 subjects. As a group ($n = 19$) dogs obtained on average an OQS of 0.56 ± 0.07. We found significant differences in the scores of the 3 subscales ($X^2{}_2 = 19.71$, $p < 0.001$): on average dogs scored higher on responsiveness subscale (0.75 ± 0.15), second on behavioural regulation (0.52 ± 0.12) and last on aggression and response to novelty (0.37 ± 0.16), same order of factors obtained by Wright et al. (2011).

We did not find significant correlations between any of the questionnaireís scores and the MaxDs by the dogs of this study (OQS: $r < 0.121$, $ps > 0.621$; F1: $r < -0.099$, $ps > 0.69$; F2: $r_s < 0.92$, $ps > 0.28$; F3: $r < 0.162$, $ps > 0.51$). Furthermore, no correlations were found between the scale and the behavioural observations ($r_s < 0.92$, $ps > 0.56$).

2.7. Discussion

The present study shows that the delay average is slightly lower than the observed by Wright et al. (2012) using non-social stimuli, though it is not possible to make a direct comparison. These results could suggest that social cues interfere with the performance of the dogs during the task. However, it is also possible that by varying some parameters of our procedure, dogs would reach a higher delay. For instance, it is likely that by incrementing the delay more than only 1 s every time the dog chose the delayed reinforcement (i.e. increasing the delay to 2 or 3 s in each delayed choice), dogs could likely attain greater tolerance. Another alternative for this lower average could be a possible fatigue effect. This explanation is unlikely as no differences were found in the frequency of choices of

Table 3
Behaviors of dogs of Study 1 while waiting for the reinforcement in the last test trial in which the subject choose the delayed reward. All behaviours are calculated in ratios of the cumulative durations in seconds. Cells in the grey diagonal indicate the mean and the standard deviation of the time ratio that dogs spent doing each activity. Cells above the diagonal show the correlation (*Spearman*) between variables and cells below the diagonal show comparisons between means (*Wilcoxon*). Statistically significant results are shown in bold.

Behaviour	Near delayed E	Near immediate E	Alternation between options	Interaction with delayed bowl	Interaction with immediate bowl	Standing
Near delayed E	0.66 ± 0.35	**r_s=-0.497, p=0.019**	**r_s=-0.34, p=0.044**	**r_s=-0.930, p<0.001**	**r_s=-0.507, p=0.016**	r_s = -0.107, p=0.635
Near immediate E	**Z=-3.72, p<0.001**	0.05 ± 0.12	**r_s=0.56, p=0.006**	r_s=0.196, p=0.382	**r_s=0.977, p<0.001**	r_s =0.219, p=0.326
Alternation between options	**Z=-4.021, p<0.001**	Z=0.000, p= 1	0.04 ± 0.07	r_s=0.304, p=0.168	**r_s=0.597, p=0.003**	r_s =0.034, p=0.882
Interaction with delayed bowl	**Z=-2.603, p=0.009**	**Z=-2.959, p=0.003**	**Z=-3.408, p=0.001**	0.24 ± 0.29	r_s=0.212, p=0.343	r_s =-0.13, p=0.955
Interaction with immediate bowl	**Z=-3.881, p<0.001**	Z=-0.730, p=0.465	Z=-0.341, p=0.733	**Z=-3.220, p=0.001**	0.03 ± 0.08	r_s =0.22, p=0.326
Standing	**Z=-2.983, p=0.003**	**Z=-4.236, p<0.001**	**Z=-4.188, p<0.001**	**Z=-4.018, p<0.001**	**Z=-4.236, p<0.001**	0.94 ± 0.17

(E: experimenter).

the delayed reinforcement between the start and the end of the test trials. Another aspect of our procedure is that it would be relevant to assess responses to quantity discrepancies of the reinforcements, not only quality. Previous evidence shows that this variable affects tolerance to the delay (De Petrillo et al., 2015a). Finally, in the present protocol the dogs not only received food but also social reinforcement by the handler in each of the choices (including the immediate ones), which might have diminished the discrepancy in the hedonic value of the rewards.

Nevertheless, we consider that Wright et al. non-social protocol differs in a lot of aspects from our social protocol (e.g. difference in quantity vs. quality of the reinforcements, mass trials vs. distributed, etc.), which could explain the results found. For this reason, in future studies it would be interesting to compare the responses to social and non-social cues using the same protocol. It may be possible that the MaxDs of dogs varies according not only to individuals (e.g. Leonardi et al., 2012) but also to protocols, as evidence with other species (e.g. Bramlett et al., 2012; Paglieri et al., 2013) shows lack of alignment in results both in the same task and in different tasks that were seemingly designed to measure impulsivity. Also, there are doubts as to whether animals really manage to understand the role of delay in tasks of this kind (Bramlett et al., 2012).

In the next Study 2a we assessed tolerance to delay of reinforcement adding again human communicative cues, but with a different procedure.

3. Study 2a: social cues

3.1. Subjects

We evaluated 17 adult dogs between 1 and 10 years old (3.75 ± 2.09 years), of different breeds and mixed-breeds. Three dogs did not complete the test due to separation anxiety related problems. The definitive sample included 14 subjects, 8 males and 6 females, of different breeds (9 mongrels, 2 Poddles, 1 Rottweiler, 1 Golden retriever and 1 Dogue de Bordeaux). They were domestic pets living, for at least 1 year, with their owners. We did not evaluate dogs whose owners reported aggressive behavior and/or excessive fearfulness to strangers. None of them had any previous training or experience in inhibitory control tasks.

3.2. Materials and experimental setting

Trials were all conducted at the location where the dogs lived, in a room at the owners' houses. The owners were not present during the testing to avoid any distractions, and they were requested not to feed their pet for 4–6 h before the experiment so as to keep the animal highly motivated to perform the task. The dogs had access to water ad libitum. Sessions were filmed with a Sony DCR SX-85 camera using a wide angle lens so as to measure behaviours and assess inter-observer reliability. A complementary JVC GZ-MG335HU camera was used to assess interactions with the apparatus. The reinforcement used was cooked liver.

3.3. Procedure

The procedure consisted on an object choice task similar to Study 1. An E pointed the correct bowl and the dog could get the food if he followed the human cue (see Fig. 2a). The aim was to assess the tolerance to increasing delays in the delivery of a reinforcement. As in Study 1, the overall procedure consisted of three stages: pre-training, forced trials and delayed reward trials.

3.3.1. Pre-training

The aim was that dogs learned that bowls contained food. It consisted on 4 trials in which the E called the dog by its name, showed him the piece of food and placed it in the bowl while the dog was seeing. Then H took it with the leash to the bowls so the dog could eat from these recipients. This procedure was repeated in four trials, twice on each side.

3.3.2. Forced trials

the aim was that the dogs learned that by choosing the pointed bowl they receive a reward after a 5 s delay. It consisted on 8 forced trials that were performed placing the reward to the right or left in

Fig. 2. Experimental setting of the Study 2: (**a**) delayed choice task with pointing as a human social cue, (**b**) delay choice task with side/odor as a non-social cues.

order semi-randomized within subjects (with a maximum of two consecutive times on the same side). E called the dog by its name and pointed to one of the bowls. Immediately after that, H took the dog to the signaled bowl and held the animal in the choice area until 5 s delay period elapsed so as it could eat the reward.

3.3.3. Delayed reward trials

it consisted on 3 sessions of 10 trials each. The E emitted the cue in the same way as in forced trials except that in this case the dog could choose how to respond. Every time the dog chose the signaled bowl the delay was increased. As the delay started in 5 s but increased by 3 s every other time the dog chose the signaled bowl, the possible time interval ranged from 0 to 92 s. Incorrect responses were coded in three categories: (1) switches, if the dog chose the correct bowl but during the delay approached the incorrect, the delay was interrupted, no reward was delivered and the dog was taken by H to the starting line, considering the trial ended, (2) incorrect choice, if the dog approached the not signaled bowl, no reward was delivered and the dog was taken to the starting line, (3) no choice, if after 15 s of the E pointing signal the dog did not choose any bowl, and the trial ended.

During the forced and delayed reward stages ITIs lasted 20 s and intervals between test sessions lasted 2 min.

DIAS was administered in the same way as in Study 1.

3.4. Measures and data analysis

Two independent observers analyzed all the measures in 40% of the video-taped material and we calculated Spearman's coefficients of correlation. Results showed good inter-observer reliability for all the measures ($r_s > 0.941$, $ps < 0.006$, $n = 6$). Since all the variables (except the $MaxD_s$ and the DIAS scores) did not showed a normal distribution (*Shapiro-Wilk test*, $ps < 0.005$) we calculated mostly non parametric statistics.

We measured the $MaxD_s$ considering the 30 test trials. We also measured the number of correct and incorrect responses. Incorrect responses were separated in three categories: (1) incorrect choice (the dog approach the non-signaled bowl), (2) no choice (after 15 s from the beginning of the pointing gesture the dog do not approach any bowl), and (3) switch (after choosing the correct bowl, the dog approaches to the incorrect bowl during the waiting period). A *Chi-Square test* was used to compare the proportions of this choices, and we run a *Regression Analysis* with the $MaxD_s$ as the independent variable and the mean number of correct and incorrect choices per trial as the dependent variable.

With respect to the behaviours, measures and analysis were similar as in Study 1, but we considered: (1) the *time spent near the E*, (2) the *interaction with the signaled bowl*, (3) the *time far from the E or signaled bowl* (when the dog was outside the choice area, which signified approximately more than 50 cm far from the E or the signaled bowl), and 4) the *time spent standing*. We conducted *Bonferroni corrections* for all post-hoc pairwise comparisons. Regarding the DIAS scores, measures and analysis were the same as in Study 1.

Finally, we found no significant influence of sex and age in all dependent variables ($p_s > 0.8$), so we did not include them in the remaining analyses.

3.5. Results

3.5.1. $MaxD_s$

Dogs reached on average a $MaxD_s$ of 52.14 ± 16.78 s, ranging from 17 to 77 s (for individual performances see Table 2). Dogs made an average of 28.79 ± 3.04 tests trials in which in 57% of cases they chose the correct bowl and successfully resisted the delay. As a group they did not made more correct responses than expected by chance ($t_{13} = 1.6$; $p = 0.13$).

Taking the 168 total incorrect responses, 45.8% were due to switches, 40.4% due to no choices, and 13.6% due to incorrect choices. The distribution of responses is different than expected by chance ($X^2{}_2 = 29.89$, $p < 0.001$), however there was no difference between the number of switches and no choices ($X^2{}_1 = 0.56$, $p = 0.45$).

The number of correct choices decreased significantly as the delay increased ($F_{(1,28)} = 25.1$, $p < 0.001$; $R^2 = 0.47$, $\beta = -0.06$), while the number of no choices increased significantly as the delay increased ($F_{(1,28)} = 34.97$, $p < 0.001$; $R^2 = 0.55$, $\beta = 0.056$). While the incorrect choices itself (approach to the non-signaled bowl) remained relatively constant throughout the trials ($F_{(1,28)} = 0.034$, $p = 0.85$; $R^2 = 0.001$, $\beta = -0.001$) and switches decreased as the delay increased ($F_{(1,28)} = 6.75$, $p < 0.014$; $R^2 = 0.16$, $\beta = -0.023$). Note however that the last two estimates are not very reliable, so these data will not be discussed then.

3.5.2. Behaviours during the last delayed trial

Regarding to the body postures, dogs spent significantly ($X^2{}_2 = 11.55$, $p < 0.003$) more time standing (0.66 ± 0.36), then sitting (0.15 ± 0.27), and the less proportion of time laying (0.19 ± 0.29).

Regarding the location, dogs spent significantly ($X^2{}_2 = 6.58$, $p < 0.03$) most of the time near the E (0.53 ± 0.36), then more than 50 cm far from the E or the signaled bowl (0.4 ± 0.38), and a small percentage of the time interacting with the signaled bowl (0.07 ± 0.09). But no significant differences were found in far from E or the bowl vs. near ($Z = -1.09$, $p = 0.27$) and vs. interacting with the signaled bowl ($Z = -1.97$, $p = 0.048$).

The *Path Analysis* did not show any significant correlation with the $MaxD_s$ ($ps > 0.3$).

3.5.3. Correlations with DIAS scale

The same as in Study 1, we found a high consistency with results of Wright et al. (2011). As a group ($N = 14$) dogs obtained on average an OQS of 0.60 ± 0.09. We found significant differences in the scores of the 3 subscales (*GLM*: $F_2 = 21.88$, $p < 0.001$): on average dogs scored higher on responsiveness subscale (0.77 ± 0.09), second on behavioural regulation (0.59 ± 0.15) and last on aggression and response to novelty (0.43 ± 0.13), same order of factors obtained by Wright et al. (2011), but there was no significant difference between factor 1 and 3 ($Z = -2.29$, $p = 0.022$).

We did not find significant correlations between any of the questionnaireís scores and the MaxDs by the dogs of this study (all Pearsonís $r < 0.43$, $ps > 0.13$). However, we found a positive correlation between the OQS and time spent standing ($r_s = 0.53$, $p = 0.048$). More specifically, the behavioural regulation factor was positively correlated with standing ($r_s = 0.53$, $p = 0.048$). The other correlations showed no significant relationships ($r_s < 0.5$, $p > 0.1$).

3.6. Discussion

The $MaxD_s$ was markedly higher than the reported in Study 1. This would indicate that the ability to tolerate a delay of a reinforcement is dependent on the particular task used and especially its level of difficulty. In Study 1, the animals should first learn a complex discrimination while in Study 2a they should make an increased tolerance effort.

Both tasks include social communicative cues that the person gives the dog to find hidden food. This provides two protocols for the study of tolerance to delays of reinforcements in social contexts.

Regarding the DIAS, the same as in Study 1, we found a good consistency with Wright et al. (2011) previous results, but we did not find significant correlations with the MaxDs and with most behavioural measures (except standing posture).

The aim of next Study 2b is to replicate the procedure of Study 2a but using non-social cues in order to see if the performance of the dogs is stable or context dependent.

4. Study 2b: non-social cues

4.1. Subjects

We evaluated 18 adult dogs between 1 and 10 years old (4.97 ± 3.29 years), of different breeds and mixed-breeds. One dog refused to eat and two dogs did not complete the test due to anxiety separation related problems. The definitive sample included 15 subjects, 6 males and 9 females, of different breeds (5 mongrels, 3 French Bulldogs, 1 Poddle, 1 Cocker spaniel, 1 Labrador, 1 Doberman, 1 Yorkshire, 1 Galgo and 1 Dogo Canario). Characteristics and requisites of the sample were the same as in Study 2a.

4.2. Materials, experimental setting and procedure

It was similar to Study 2a with the exception that we used non-social cues. The main difference with Study 2a was that the pointer experimenter was replaced by a remote controlled kibble-dispensing apparatus, the Treat & Train® Dog Training System (called the MannersMinder®). The devise measures $25.4 \times 40.6 \times 25.4$ cm, it weighs 2.8 kg, and runs on batteries. Cooked liver was dispensed by remote control, which operates up to 100 feet away. The dispenser was covered by boxes put on the floor, and food was dispensed into the same bowls used in Study 2a (see Fig. 2b).

In the room were present two persons. The H lead the dog in the same way as in Study 2a, and E had the chronometer and the remote control. E and H did not make eye contact with the dog, and the only interaction with the animal allowed for H was calling the dog by its name, especially in order to lead the animal to the starting point in the case it did not approach. The dog did not received any verbal reinforcement or petting, except during the intervals.

The non-social cue that we used was a compound stimulus: spatial location (right or left sides) plus odor. The purpose was that the cue was easy for the dogs as pointing is. The side was counterbalanced between subjects: for half of the dogs the reward was in the right side dispenser and for the other half it was in the left side dispenser.

4.3. Measures and data analysis

Two independent observers analyzed all the measures in 40% of the video-taped material and we calculated Spearman's coefficients of correlation. Results showed good inter-observer reliability for all the measures ($r_s > 0.943$, $ps < 0.005$, $n = 6$). Since all the variables (except the three factors of the DIAS) did not showed a normal distribution (*Shapiro-Wilk test*, $ps < 0.005$) we calculated mostly non parametric statistics.

We measured the $MaxD_s$ considering the 30 test trials. We also measured the number of correct and incorrect responses. Incorrect responses were separated in the same way as in Study 2a, and we run the same analysis. We compared the $MaxD_s$ of dogs in Study 2a and 2b using *Mann-Whitney U test for two independent samples*.

With respect to the behaviours, measures and analysis were the same as in Study 2a, but since it was a non-social task we considered: (1) the *time spent near the cued dispenser* (we considered it as comprising two elements: the bowl and boxes), (2) the *interaction with the cued dispenser* (touching with the paws or nose, licking or sniffing the delayed bowl/box), (3) the *time far from the cued dispenser* (when the dog was outside the choice area, which signified approximately more than 50 cm far from the delayed bowl/box), and (4) the *time spent standing*. Analysis were the same as in Study 1 and 2a.

We found no significant influence of sex and age in all dependent variables ($p_s > 0.4$), so we did not include them in the remaining analyses.

4.4. Results

4.4.1. $MaxD_s$

Dogs reached on average a $MaxD_s$ of 40.2 ± 23.44 s, ranging from 11 to 80 s (for individual performances see Table 2). Dogs made an average of 26.13 ± 6.08 tests trials in which in 48% of cases they chose the correct dispenser and successfully resisted the delay. As a group they did not made more correct responses than expected by chance ($t_{14} = -1.12$; $p = 0.28$).

We found no significant differences between the $MaxD_s$ of dogs in Study 2a and 2b ($Z = -1.423$, $p = 0.155$, $r_{effectsize} = -0.26$).

Taking the 201 total incorrect responses, 34.3% were due to switches, 32.8% due to no choices, and 32.8% due to incorrect choices and the distribution of responses is not different than expected by chance ($X^2{}_2 = 0.09$, $p = 0.95$). Different from the social task of the Study 2a, the percentage of incorrect choices was quite higher.

The number of correct (approaching the cued dispenser) and incorrect (approaching the opposite dispenser) choices decreased significantly as the delay increased (Correct choices: $F_{(1,28)} = 19.68$, $p < 0.001$; $R^2 = 0.41$, $\beta = -0.062$; Incorrect choices: $F_{(1,28)} = 32.64$, $p < 0.001$; $R^2 = 0.73$, $\beta = -0.042$), while the number of no choices increased significantly as the delay increased ($F_{(1,28)} = 11.32$, $p < 0.002$; $R^2 = 0.53$, $\beta = 0.033$). The switches remained relatively constant throughout the trials ($F_{(1,28)} = 0.95$, $p < 0.76$; $R^2 = 0.003$, $\beta = -0.003$). Different from the social task we observed a decreased in the number of incorrect choices as the delay increased.

4.4.2. Behaviours during the last delayed trial

Regarding to the body postures, dogs spent significantly ($X^2{}_2 = 20.32$, $p < 0.001$) more time standing (0.84 ± 0.26) than sitting (0.09 ± 0.21) or laying (0.06 ± 0.18).

Regarding the location, dogs spent most of the time far (more than 50 cm) from the cued dispenser (0.49 ± 0.39), a less amount of time near the cued dispenser (0.39 ± 0.37), and a small percentage of the time interacting with the cued dispenser (0.12 ± 0.11), but there were no significant differences between these three measures ($X^2{}_2 = 3.33$, $p = 0.19$). No other significant differences were found.

The *Path Analysis* did not show any significant correlation with the $MaxD_s$ ($ps > 0.05$).

4.4.3. Correlations with DIAS scale

The same as in Study 1, we found a high consistency with results of Wright et al. (2011). As a group ($N = 15$) dogs obtained on average an OQS of 0.60 ± 0.09. We found significant differences in the scores of the 3 subscales ($X^2{}_2 = 17.32$, $p < 0.001$): on average dogs scored higher on responsiveness subscale (0.77 ± 0.10), second on behavioural regulation (0.63 ± 0.19) and last on aggression and response to novelty (0.37 ± 0.15), same order of factors obtained by Wright et al. (2011), but there was no significant difference between factor 1 and 3 ($Z = -1.90$, $p = 0.057$).

We did not find significant correlations between any of the questionnaireís scores and the MaxDs by the dogs of this study (all Pearsonís $r < 0.3$, $ps > 0.2$). Furthermore, no correlations were found between the scale and the behavioural observations ($r_s < 0.45$, $ps > 0.05$).

4.5. Discussion

No significant differences were found in MaxDs or the behavioural pattern displayed during the delays. This would suggest that, at least in this protocol, the self-control responses are stable over contexts and does not depend on the (social-non-social) nature of the cues used.

Regarding the DIAS, the same as in Study 1 and 2a, we found a good consistency with Wright et al. (2011) previous results, and the same as in 2a there was no significant difference between factor 1 and 3. Also we did not find significant correlations of the scale with the MaxDs neither with all behavioural measures.

5. General discussion

There are several regulatory or executive processes involved in cognitive control, such as attention, data manipulation, evaluation of available information (including seeking additional information when necessary), planning for future behaviours, and dealing with distraction and impulsivity when they are threats to goal reaching (Beran, 2015b). In this context, inhibition of unfitting impulses and self-control abilities play a central role.

The main contribution of this work was to introduce two novel methods for measuring self-control (or impulsivity) in dogs in a social setting, and also to lay some foundation for future work using social cues in delay-choice tasks. The maximum delay reached by dogs of the first protocol (Study 1) was 11.55 s on average. However, in Study 2a the delay reached was 52.14 s. This discrepancy probably relates to the difference in the methods used. We made several changes in the parameters of the first study. For example, in the second study each choice of the delayed reinforcement increased the delay 3 s instead of 1 s. This means that in a few trials the delay was increased significantly more. On the other hand, in the second protocol the discrimination that animals must learn is simpler, as the choice is between the reward and nothing, unlike between high and low quality rewards. This learning requires less cognitive effort, so it could facilitate the tolerance to delay. Furthermore, the second task turns more predictable and less confusing as it utilize only one human cue. Therefore, changing procedures made dogs largely increase their waiting performances. This finding shows the relevance of the parameters and methods used to investigate tolerance to delay of reinforcements. It is remarkable that the waiting duration sustained by animals depends on the task and the experimental procedure, making it necessary to test subjects in different experimental situations to appreciate their abilities better (Pelé et al., 2011). However we cannot discharged the influence of personality and temperament differences in the subjects (Stevens et al., 2011). For example, one interesting finding is that the maximum delay reached by dogs of the three studies showed a large individual variation (8–17 s, 17–77 s and 11–80 s respectively), which is in line with other studies (e.g. Leonardi et al., 2012; Wright et al., 2012). This variability might well be a function of fundamental interindividual differences in the ability to implement various self-control strategies (Rozensky and Bellack, 1974). In fact, the inherent interindividual variability present in dogs as a specie makes them excellent candidates to study individual differences in behavior (Jakovcevic and Bentosela, 2009).

Furthermore, beyond differences in methods and individuals, it is proposed that self-control could be influenced by contexts (e.g. Bray et al., 2014). Our second goal was to assess the stability of tolerance to increasing delays measured in Study 2a by comparing that function in different contexts. The average delay reached by the dogs of the Study 2b using non-social stimuli was lower, however this difference was not significant. This may reflect the stability in the ability to tolerate increasing delays of reinforcements, regardless of the cues used, which is in line with evidence that some species show generalized inhibitory control abilities (e.g. Baumeister et al., 1998; Duckworth and Seligman, 2005). Also it is possible that the task was too easy for dogs and therefore no differences depending on the context could be observed. Therefore, more studies are needed to reach more solid conclusions about the potential contextual factors affecting performance (MacLean et al., 2014).

The advantage of these methods is that it makes it possible to study impulsivity in a context where social interactions with people are present, in which dogsí skills are particularly relevant. In their daily lives, dogs are permanently subjected to situations in which they must tolerate different delays to have access to valuable stimuli such as food and rides. This demand is increased in the case of working dogs where performance requires awaiting the arrival of reinforcements for longer intervals.

In both protocols of Study 2, dogs decreased the number of correct choices and increased the number of no choices as the delay increased. The unwillingness to respond in the case of no choices is considered as an extinction of that response. One possible explanation is that subjects must assess the value of rewards in relation to incurred delays (e.g. Dufour et al., 2007; Pelé et al., 2010), and our results could show that as the delay was increased individuals decided more to give up than to wait. Temporal discounting −whereby the subjective value of benefits declines with time- could affect choices (Mazur, 1987).

The third purpose was to investigate if dogs that are successful in tolerating longer delays show any distinct behaviours during the waiting period. Results of the two social protocols (Study 1 and 2a) showed that dogs spent significantly more time standing and near the experimenter. The response to remain close to the person and motionless is likely related to their everyday life experience, where the dog usually obtains food if it remains close to its owner when he/she has hidden some kind of food. In our study the food was not present during the delay period. Although we cannot compare it directly with other studies in which the food was present throughout the waiting period, they observed that the animals use distraction strategies such as moving away from the source of food or perform certain activities (e.g. Evans and Beran, 2007; Leonardi et al., 2012). Anyway, it is difficult to say whether these behaviours are coping strategies or something else generated by delays. Finally, it should be noted that the delay average in Study 1 was brief (11 s), which might limit the development of other behavioural strategies. This explanation is unlikely as in the second study, where the delay was higher, animals also remained near the person and the food source.

These results were similar to those found in Study 2b with non-social cues. However, it was noted that while with social cues with dogs spent most of the time near the experimenter, with non-social cues they spent more time far from the cued dispenser, nevertheless there were no significant differences between location measures in Study 2b. This could indicate that people were more reinforcing objects, although they were both associated with reinforcements.

We could not find any correlations of these behaviours with the $MaxD_s$ in any of the three studies, which may suggest that more self-controlled subjects did not display any distinctive behavior compared to the more impulsive ones. Issues related to the variabilities of responses should be studied as a future stage. Meanwhile, factors which are more likely to be associated to that variability remain unknown.

Finally, we aimed to correlate the results obtained in in each study with the DIAS scores, and for that purpose we translated it to Spanish. We did not find significant correlations between any of the questionnaireís scores and the MaxDs by the dogs of the three studies. Furthermore, no correlations were found between the scale and the displayed behaviours of dogs during the delays, except in Study 2a where overall score (OQS) and behavioural regulation (factor 1) were positively correlated with time spent standing. Factor 1 is a more general impulsivity measure, and dogs that score higher are described as less controlled, impatient, and with a higher level of arousal. Although we may say that standing is a more active behavior than sitting or laying, and that this might explain the correlation, the dogs did not show ambulation or distancing, so that their level of activity might be considered low. It should be noted that this scale is relatively new and has not yet been used to correlate with behavioural tasks different from that operant non-social task used to validate it (e.g. Riemer et al., 2013; Wright et al., 2012). On the other hand, as it was mentioned above, this scale is not validated to Spanish language, so there could be cultural differences in the interpretation of items and results should be taken with caution. Therefore, one necessary purpose is to validate this questionnaire to Spanish and our region.

5.1. Conclusion

This study is a useable contribution to an area that is insufficiently studied and highly relevant for interactions between dogs and people. Studies on impulsivity in social situations similar to those experienced by dogs in their everyday life are extremely relevant for the development of techniques that may improve the inhibition of undesirable behaviours as well as the training of complex self-controlled behaviours. In addition, the comparison of the same task using social and non-social stimuli provides valuable information about the stability of this skill. Notwithstanding this, more investigations are required in order to achieve more valid conclusions.

Ethical statement

The three protocols were approved by the Comisión Institucional para el Cuidado y Uso de Animales de Laboratorio (CICUAL – Institutional Committee for the Care and Use of Laboratory Animals) from the Instituto de Investigaciones Médicas (Medical Research Institute) (Res.N°023-15). All owners expressed their consent for the participation of their dogs in this study.

Conflict of interest

The authors declare no conflict of interest associated with this study.

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