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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