



Comparing lateral bias in dogs and humans using the Kong™ ball test



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ARTICLE INFO

Article history:

Received 21 October 2015

Received in revised form 2 December 2015

Accepted 6 January 2016

Available online 18 January 2016

Keywords:

Dogs

Handedness

Kong™ ball

Laterality

Paw preferences

ABSTRACT

The Kong™ ball test has been used extensively to assess lateral bias in the domestic dog. Implicit in this challenge is the assumption that dogs use their dominant paw to stabilise the ball. This study examined whether or not this is the case. A comparative approach was adopted, exploring limb use in dogs and humans. In Experiment 1, the paw preference of 48 dogs was assessed on the Kong™ ball test. Analysis revealed an equal distribution of paw use, although significantly more dogs were paw-preferent than ambilateral. Significantly more male dogs were classified as right-pawed, while more females were ambilateral. There was no significant effect of canine sex or castration status on the dogs' paw preferences. In Experiment 2, 94 adult humans were assessed on their ability to remove a piece of paper from a Kong™ ball with their mouth, using their left, right or both hands to stabilise the ball. 76% of the right-handed people used their left hand, and 82% of the left-handed participants used their right hand, to hold the Kong™ steady. It is concluded that dogs, like humans, are most likely using their non-dominant limb to stabilise the Kong™ ball and their dominant side for postural support. This has potential applied implications from an animal welfare perspective.

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1. Introduction

Lateralised motor behaviour has been studied as an observable measure of cerebral functional asymmetry for numerous years (e.g. Harris, 1983; Springer and Deutsch, 1989). The most prominent manifestation of lateralised behaviour in humans is that of handedness (i.e., the predominant use of one hand), with roughly 90% of people using their right hand for most activities (Annett, 1985; Porac and Coren, 1981).

Studies of lateralised behaviour patterns in other species (e.g., amphibians, rodents, cats, primates, marsupials, whales) now suggest that cerebral functional asymmetry is not unique to humans, but, rather, may be a fundamental feature of all vertebrate, and even some invertebrate, brains (for reviews see Frasnelli et al., 2012; MacNeilage et al., 2009; Rogers, 2002; Rogers et al., 2013; Vallortigara et al., 2010; Vallortigara and Rogers, 2005). What is less clear is whether non-human species exhibit lateralisation in their limb use in a manner that approximates human handedness or whether the preferred use of a specific hand, paw or similar appendage is related to other aspects of brain asymmetry (see reviews by Corballis, 2009; Rogers, 2009; Versace and Vallortigara, 2015). Whilst there is a general consensus that individual

animals may show consistent hand/paw preferences, the question of whether motor lateralisation exists at the level of the population remains controversial (see MacNeilage et al., 1987). Population-level asymmetries have been found in a number of non-human species, including primates (e.g. Diamond and McGrew, 1994; Laska, 1996) and humpback whales (Clapham et al., 1995), but studies on other species, such as, for example, sheep (e.g., Anderson and Murray, 2013; Morgante et al., 2010; Versace et al., 2007), horses (Austin and Rogers, 2012, 2014; Lucidi et al., 2013) and cats (Pike and Maitland, 1997; Wells and Millsopp, 2009, 2012) point more towards motor asymmetries at the level of the individual.

The domestic dog, *Canis familiaris*, has been shown to display lateral bias in the form of paw preference at the level of the individual, with several, although not all (e.g., Branson and Rogers, 2006; Poyser et al., 2006; Tan and Caliskan, 1987) studies, hinting at a population-level bias centering around the animal's sex, with males being more likely to use their left paw and females veering more towards using their right paw (McGreevy et al., 2010; Quaranta et al., 2004; Wells, 2003). The motor preferences of dogs have been tested using a variety of methods, including reaching for food (Wells, 2003), removing something (e.g. adhesive tape, blanket) from the body (Tan, 1987; Quaranta et al., 2004; Wells, 2003) and 'giving' a paw upon request (Wells, 2003). However, the most commonly used challenge is the 'Kong™ ball test' (Batt et al., 2007, 2008; Branson and Rogers, 2006; Marshall-Pescini et al., 2013; Schneider et al., 2013; Tomkins et al., 2010a,b). Here, the

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animal is provided with a hollow conical-shaped rubber ball stuffed with food. The paw used by the dog to stabilise the toy in order to eat the food within is recorded, usually while the animal is lying down. Implicit with this challenge is the assumption that the paw used to stabilise the ball is the 'dominant' one (i.e., the one controlled by the activated hemisphere); this may or may not, however, be the case. In fact many animal studies point to a reliance on the non-dominant limb for manipulation and the dominant limb for gain of control, at least in bipeds. Numerous species of monkeys and apes, for example, use the non-dominant arm for frequently used actions, such as reaching for food, while the dominant limb is more likely to be used for postural support (e.g., Chapelain et al., 2006; Hook and Rogers, 2008; Hopkins, 1993; Laska, 1996; Westergaard et al., 1997). Tommasi and Vallortigara (1999) similarly found that, in domesticated chicks, the activated hemisphere (contralateral to the eye in use) is the one that takes control of posture, leaving reflex-like responses associated with ground scratching or body wiping under the control of the other hemisphere. The link between postural demand and motor asymmetry is poorly understood in quadrupedal species, but, as in bipeds it seems plausible that it plays a role, although to what extent is unknown (see Konerding et al., 2012).

It is important to establish whether or not the dominant paw is used by dogs on the commonly utilised Kong™ test, so that the correct inferences on cerebral functioning can be drawn. Motor bias has the potential to be used as an applied tool for assessing vulnerability to stress and welfare risk in animals (see MacNeilage et al., 2009; Rogers, 2010). Left-limbed animals, which tend to be right-hemisphere dominant, show stronger fear responses than right-limbed animals, which tend to be left-hemisphere dominant (e.g., Braccini and Caine, 2009; Cameron and Rogers, 1999). Left-sided biases of aggression, reactivity to fear-inducing stimuli and vigilance behaviour have also been noted in numerous species (e.g., Austin and Rogers, 2012; Denenberg, 1984; Koberoff et al., 2008; Lippolis et al., 2002, 2005; Zappia and Rogers, 1983). Thus, motor asymmetry has the potential to be used as a predictor of welfare risk. Recording accurate direction of motor bias is therefore important if the correct implications for animal welfare assessment are to be made. Categorising an animal as 'left-pawed', for example, on the basis of it using its left paw to consistently stabilise something like the Kong™ ball, could provide misleading information on the emotional vulnerability of that individual if the animal is actually employing its non-dominant limb to hold the object.

The following study explores, for the first time, the issue of whether or not dogs use their dominant paw on the Kong™ ball test. In light of the literature reviewed above, it is hypothesised that dogs, like other species, use their non-dominant limb to stabilise the Kong™ ball, with the activated hemisphere at that time controlling postural demand. A comparative approach is adopted in this study, exploring paw use in dogs and hand use in humans on a similar challenge. The study aims to explore which limb each species uses to stabilise an unstable object (the Kong™ ball) and shed light on whether dogs are using their dominant or non-dominant paw in what has become a widely employed measure of lateral bias for this species.

2. Methods

Two experiments were carried out. Experiment 1 was designed to assess paw preference in dogs using the Kong™ ball test, in line with previous studies of this kind (Batt et al., 2007, 2008; Branson and Rogers, 2006; Marshall-Pescini et al., 2013; Schneider et al., 2013; Tomkins et al., 2010a,b). Experiment 2 was developed to record hand use in humans using a similar challenge to the Kong™ ball test.

2.1. Experiment 1. Paw preferences in dogs

2.1.1. Subjects

Forty-eight dogs (25 males [18 neutered], 23 females [17 spayed]), of varied breeds, aged between 1 and 12 years (mean age = 3.79 ± 0.44 years), participated in the study. All of the dogs were family pets whose owners had consented to let the animals participate in the experiment. None of the dogs had received any behavioural training before or during the study.

2.1.2. Apparatus

Dogs' paw preferences were tested using a medium-sized Kong™ ball (KONG Company, Golden, CO, USA), a hollow 10.5 cm long conical-shaped rubber toy that moves in an erratic manner. The ball has a 2.9 cm diameter hole at one end, and a smaller 1 cm diameter hole at the opposite end. Before testing, the toy was filled through the larger hole with moist dog food (Pedigree, original flavour, Waltham, UK) and frozen. Balls were washed thoroughly in between tests.

2.1.3. Procedure

Each dog was tested individually in its own home environment, having been food deprived for at least 4 h. At the start of testing, the dog was shown, and allowed to sniff, the food-loaded Kong™ ball. The toy was then placed directly in front of the animal. The paw used to stabilise the Kong™ by the dog was recorded by the experimenter. A paw use was classified as the animal having one or both paws on the Kong™ ball, regardless of duration (see Fig. 1). A separate paw use was considered to have been made when the animal removed its paw from the Kong™ and replaced one or both of its paws on the object. On occasion, dogs used both paws to stabilise the ball; these occurrences were recorded, but testing was not considered complete until one hundred paw uses (left plus right combined) had been made by the animal, regardless of the number of times dogs employed both paws.

2.1.4. Analysis

Binomial z-scores were calculated to determine whether the frequency of right- or left-paw use exceeded that expected by chance. An alpha value of 0.05 was adopted for all analyses. A z-score greater than +1.96 (two-tailed) reflected a significant left paw preference, whilst a z-score less than -1.96 indicated a significant right paw preference. Dogs with z-scores between +1.96 and -1.96 were classified as ambilateral.

A one-way chi-squared analysis was carried out to investigate whether there was a significant difference in the distribution of the dogs' paw preferences. Binomial tests were also conducted to determine whether there was a significant difference in the number of animals that were: (1) paw-preferent (either to the left or right) vs. ambilateral, and; (2) right- vs. left-paw preferent. Chi-squared tests were carried out to establish whether the distribution of the dogs' paw use was associated with canine sex (male, female) or castration status (neutered, intact).

A directional handedness index (HI) was calculated to quantify each dog's paw preference on a continuum from strongly left-paw preferent (+1) to strongly right paw-preferent (-1). The HI was calculated by dividing the difference between the total number of left and right paw reaches by their sum $(L-R)/(L+R)$ [see Wells, 2003]. The strength of the dogs' paw preferences was calculated by taking the absolute value of each HI score (ABS-HI).

Two way ANOVAs were subsequently carried out to examine the effect of canine sex (male, female) and castration status (neutered, intact) on both the direction (HI) and strength (ABS-HI) of the dogs' paw preferences

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