Exploring the Social Behaviour of Domestic Dogs (*Canis familiaris*) in a Public Off-Leash Dog Park

By

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Abstract

The growing popularity of dog parks has created an opportunity to learn more about interactions between companion dogs. Dog-dog behaviour in a public off-leash dog park was described and analyzed using a motivationally-neutral approach. I observed focal dogs from park entry for 400 s and constructed activity time budgets (percentages of time spent with dogs, humans, etc.); rates of socially-relevant dog behaviours (e.g., snout-muzzle contact, physical contact) were also calculated. On average, focal dogs spent 50% of their time alone, nearly 40% with other dogs and 11% in other activities; time with dogs decreased and time alone increased over the first six minutes. Some behaviours were very frequent (i.e., more than 90% of focal dogs initiated and received snout-muzzle contact to the anogenital and head areas, while others were rare (i.e., 9% and 12% of focal dogs initiated and received lunge approaches, respectively). Dog density and focal dog age, sex, neuter status, and size were found to influence some behavioural variables. Future studies should continue to investigate the diverse range of canid behaviours and factors that influence social behaviours in dog park settings.

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Chapter 1 : General Introduction

1.1 Importance of Studying Dog-Dog Contexts

Although domestic dogs (*Canis familiaris*) are unique social canids because of the relationships they form with humans, it is important to also acknowledge the social life that dogs share with conspecifics. Conspecifics are prominent social partners for many modern domestic dogs. For one, free-ranging individuals such as “village dogs” (dogs that loosely associate with humans) and feral dogs (dogs that live independently from humans) are known to associate and/or to form stable social groups with one another (Cafazzo, Natoli, & Valsecchi, 2012; Daniels & Bekoff, 1989; Lord, Feinstein, Smith & Coppinger, 2013; Pal, Ghosh, & Roy, 1998; Sparkes, Körtner, Ballard, Fleming, & Brown, 2014). Despite having their activities more closely monitored and controlled, interactions between companion dogs (i.e., pet dogs cared for by particular humans) also occur often; prior to weaning, companion dogs are typically in close contact with their mother and littermates, a substantial number of companion dogs share their homes with other dogs (21% of dog owners surveyed in Canada reported owning more than one dog; Ipsos Reid, 2001), and many companion dogs frequently encounter and interact with each other in public areas (Weston et al., 2014), as well as in facilities such as “doggy daycares” or boarding kennels. Given the prevalence of dog-dog contact, and because it appears there is a societal expectation that dogs should be able to tolerate or interact amicably with each other, it is evident that intraspecific social patterns between dogs deserve broad investigation.

1.2 Dog Behaviour Research

Surprisingly, dog social behaviour has only recently captured the broad scale attention of researchers. For instance, a Web of Science^{TM} Core Collection article search using the terms "dog social behavio(u)r canis familiaris" returned no articles prior to the year 1990. However, from 1990 onward the number of available articles increased steadily, with a dramatic rise in articles occurring within the last decade (Figure 1.1). Since dogs were shaped by domestication processes, and thus by humans, part of the reason for this lack of interest may have been because dogs were viewed as an artificial species, and were thereby believed to exhibit behaviour that was unnatural (Bekoff, 2014; Miklósi, Topál & Csányi, 2004). However, recent strides in dog behaviour research suggest this idea has been abandoned; it is now recognized that the natural habitat of dogs is living among humans, and that like wild species, dogs are a product of evolution (Fugazza & Miklósi, 2014; Miklósi et al., 2004). Despite the recent surge in dog social behaviour research, there is still little work available on dog-dog social behaviour. Dog-dog social behaviour research has also noticeably lagged behind research that evaluates dog-human interactions (Smuts, 2014). More empirical investigations of behaviour in dog-dog contexts are needed to achieve a more complete understanding of companion dog social life.

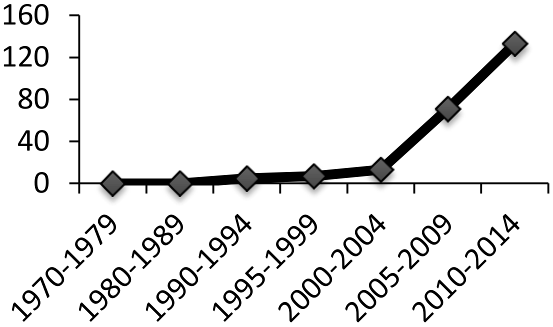

Figure 1.1 Frequency of articles available from a "Web of Science" search between 1970 and 2014 using search terms "dog social behavio(u)r canis familiaris".

1.3 Background: Dogs and Wolves

Since there is a popular belief that dog social behaviour may be equated with wolf social behaviour (e.g., as discussed by Bradshaw, Blackwell & Casey, 2009; van Kerkhove, 2004), I now turn to a discussion of how dogs and wolves are related, specific differences evident between dogs and wolves, and, briefly, comment on why interspecies differences must be considered when interpreting dog-dog social behaviour.

1.3.1 How Dogs Relate to Wolves

Dogs and grey wolves (*Canis lupus*) have remarkably similar genomes, with reportedly less than a 0.2% difference in their mitochondrial DNA sequencing (Wayne, Lehman, Allard & Honeycutt, 1992). However, dogs are considered a distinct group of animals from wolves, having diverged from an ancestor shared with modern grey wolves between an estimated 9000 and 34000 years ago (Freedman et al., 2014). It has been postulated that the strong, yet flexible, social tendencies of wolves (e.g., formation of pair bonds via monogamy, territorial defense, cooperative hunting, cooperative pup rearing) promoted an association with humans, thus setting processes in motion that led to the emergence of dogs (Marshall-Pescini & Kaminski, 2014). The actual divergence of dogs from wolves is believed to be the result of evolutionary processes through which dogs became adapted to living with humans (Miklósi et al., 2004).

At least one major process discussed in relation to dog domestication includes natural selection for the trait of “tameness” (i.e., low levels of fearful or aggressive behaviour toward humans), which has been proposed by some researchers as being instrumental in leading early dogs to diverge from wild progenitors during an initial phase of domestication (Coppinger & Coppinger, 2001). Indeed, findings from a long-term experiment on captive silver fox (*Vulpes, vulpes*) have shown selection for tameness can have far-reaching genetic effects in canids; while controlling for effects of environmental and rearing conditions, Belyaev and colleagues selectively bred fox that exhibited the tamest behaviour during behavioural testing (Trut, 1999). In addition to producing increasingly docile individuals, selective breeding for tameness led to multiple changes that included, but were not limited to, morphological traits that deviated from the typical wild fox form (e.g., floppy ears, curled tails, coats with de-pigmented patches, under-bites), multiple breeding-related changes (e.g., younger age at sexual maturity, greater average number of offspring per litter, additional out-of- season estrus observed in some females), as well as relative differences suggestive of a dampened physiological response to stress and tendency for aggression (e.g., decreased basal levels of plasma corticosteroid, increased serotonin in the brain).

A further process implicated in dog domestication involves the intentional selection for human-desired behavioural or morphological traits. Intentional selection of traits, though not necessarily mutually exclusive to natural selection processes (Trut, 1999), has been described as a later phase of domestication (Dobney & Larson, 2006) and is thought to have led to the extensive breed diversification of dog populations (Wilton et al., 2010).

1.3.2 Differences Between Dogs and Wolves

Despite being close relatives, a multitude of differences pertaining to physical traits, physiology and developmental processes offer some insight into the ways that dogs are distinct from wolves. Examples of such differences include the following: (1) dogs generally have smaller head sizes and brain volumes than wolves (Coppinger & Coppinger, 2001), as well as other morphological traits (e.g., coat characteristics; ear, muzzle, and tail shapes) that are strongly divergent from the typical lupine form; (2) dogs and wolves have shown anatomical differences in sensory organs. For instance, Peichl (1992) found ganglion cell number and distribution in the retina differed across dogs and wolves; (3) dogs and wolves have shown differences in timing of developmental stages. For example, Lord (2013) found wolf pups, in comparison to dog pups raised under the same conditions, began exploring their environments at an earlier age when fewer sensory modalities were functional; (4) dogs and wolves have shown differences pertaining to digestion processes. Specifically, dogs were found to have genetic modifications indicative of an increased capacity to breakdown starchy food resources (Axelsson et al., 2013; Freedman et al., 2014); (5) dogs and wolves have demonstrated differences in fertility patterns. Female dogs may enter estrus multiple times per year (e.g., Daniels and Bekoff, 1989; Pal, Ghosh & Roy, 1999), at any time of year (i.e., they are non-seasonal breeders; Ortega-Pacheco, Segura-Correa, Jimenez-Coello & Forsberg, 2007), whereas, female wolves have just one seasonal estrus cycle per year (Seal, Plotka, Packard & Mech, 1979). In addition, male dogs are fertile year round (Haase, 2000; Ortega-Pacheco, Segura-Correa, Bolio-Gonzalez, Jiménez-Coello & Forsberg, 2006), while male wolf fertility shows a maximal peak during the natural winter breeding period and then declines thereafter in the spring and summer (Haase, 2000).

Observations from experimental work have directly indicated that some aspects of dog and wolf social behaviour can be differentiated. In relation to interspecies interactions with humans, Kubinyi, Virányi, and Miklósi (2007) found dog pups demonstrated greater attachment behaviour (i.e., close proximity and contact) toward their caregiver compared to wolf pups of the same age and level of human social experience. This result possibly suggests a genetic or epigenetic basis for dog pups to form more extensive attachments with humans. Some studies (e.g., Gácsi et al., 2009; Hare, Brown, Williamson & Tomasello, 2002; Miklósi et al., 2003; Virányi et al., 2008) have also reported data that support an enhanced ability for dogs to follow cues given by humans. Although, since there have been contradictory findings (Udell, Dorey & Wynne, 2008) and ongoing discussions of methodological-related criticisms (Hare et al., 2010; Kaminski & Nitzschner, 2013; Miklósi & Topál, 2011; Reid, 2009; Udell & Wynne, 2010), future studies are needed to clarify this observation. Experimental work focused on intraspecific contexts has also reported contrasts between dog and wolf social behaviour. For instance, Range and Virányi (2014) found wolves, relative to dogs raised under the same conditions, were more likely to copy the actions of a conspecific to access a food reward hidden in a test box. This suggests that wolves may have a greater propensity to follow the actions of conspecifics.

Comparisons between observations of free-ranging dog groups and wolves have also highlighted a number of contrasting aspects of intraspecific social behaviour. For instance, wild wolf packs most often have one pair of monogamous breeders (i.e., only one pair of wolves breed per pack per season; Harrington, Paquet, Ryon, & Fentress, 1982), while dogs have been found to engage in mostly non-monogamous mating strategies including polyandry, polygyny, and both male and female promiscuity (Harrington, Paquet, Ryon, & Fentress, 1982; Pal, 2011; Pal et al., 1999). Also, cooperative hunting has been reported in wolves (Mech, 2007), yet it has not been observed among dogs. Dogs instead tend to hunt small animals or scavenge for food individually (e.g., Butler, du Toit and Bingham, 2004; Pal, Gosh and Roy, 1998). Additionally, dogs, relative to wolves, demonstrate reduced participation of fathers in pup rearing. For instance, though male wolves commonly regurgitate food to pups, male dogs rarely do so (Lord et al., 2013; Mech, Wolf, & Packard, 1999; Packard, 2003; Pal, 2005).

1.3.3 Implications of Dog and Wolf Differences

The strong inclination towards sociality in domestic dogs is likely due to their wolf ancestry; however, as argued by others previously (e.g., Bradshaw et al., 2009; van Kerkhove, 2004), accumulating evidence shows it is probable that domestication-related processes have created major differences between dogs and wolves. Therefore, uncritical, sweeping assumptions regarding the patterning and functions of dog social behaviour based on our understanding of wolf social behaviour are highly inappropriate. Hence, an understanding of dog social behaviour, including that which occurs in an intraspecific context, requires the study of dogs in their own right.

1.4 Current Approach to Dog Research

Companion dogs (or "family dogs") have been strongly featured in domestic dog behaviour research (Fugazza & Miklósi, 2014; Smuts, 2014). Of the companion dog research concerned with social behaviour and communication, laboratory-based methods have dominated to date. Experimental studies have focused on a wide-range of topics, such as aspects of social cognition and learning (e.g., Heberlein & Turner, 2009; Pongrácz, Bánhegyi, & Miklósi, 2012; Topál, Byrne, Miklósi, & Csányi, 2006), attachment (e.g., Gácsi, Maros, Sernkvist, Faragó, & Miklósi, 2013), tail movements (Leaver & Reimchen, 2008; Quaranta, Siniscalchi & Vallortigara, 2007), and vocalizations (e.g., Faragó et al., 2010; Pongrácz, Molnár, & Miklósi, 2006; Yin & McCowan, 2004). Undoubtedly, such studies have provided interesting and important findings. For example, an experiment on tail-wagging in response to emotional stimuli found tail-wagging direction (i.e., left or right biased amplitudes) varied depending on whether dogs who were constrained in a wooden test box were singly introduced to an unfamiliar dog, unfamiliar cat, unfamiliar human, their human owner, or remained alone (Quaranta et al., 2007). Since amplitudes of tail-wagging movements were associated with stimuli that could be expected to elicit an approach (i.e., owner) or withdrawal (i.e., an unfamiliar “dominant” dog), results suggested tail-movements during encounters with particular social stimuli reflected aspects of the dog’s inner emotional state. However, such findings, taken alone, tell us little of when and how such behaviours actually occur during uncontrived, non-laboratory (or “real life”) situations. In order to achieve “ecological validity”, or an understanding of the extent to which the results of lab-based studies might reflect real-life behaviour, an ethological approach to examining behaviour is required. Good descriptions of naturally occurring behaviours (i.e., ethograms) are paramount for understanding of why behaviours occur; as discussed in-depth by Bekoff (2014), observing animals and developing detailed ethograms of their behaviours is an irreplaceable phase of research that provides a basis for hypotheses, experiments, and ultimately is necessary to build robust explanations of behaviour. Further, ethological studies concerned with carefully describing the behaviour of dogs under natural conditions are particularly crucial for the progression of dog behaviour research, as there is still no generally accepted ethogram of dog behaviour (Fugazza & Miklósi, 2014). Given that dogs are readily identifiable and observable in a wide variety of environments, there are substantial opportunities for researchers to further apply ethological methods to the investigation of dog social behaviour (Bekoff, 2014).

A review of the literature indicates that it is commonplace for dog social behaviour to be labelled and analyzed according to presumed function. For example, play, aggression, dominance and submission are categorizations of behaviour found in dog literature that imply knowledge of biological function (e.g., Bauer & Smuts, 2007; Duffy, Hsu & Serpell, 2008; Goodwin, Bradshaw & Wickens, 1997; Horowitz, 2009;

Shyan, Fortune, & King, 2003). Scant work has attempted to construct analyses based on purely neutral characterizations of dog behaviour in social contexts (i.e., descriptions and labels of behaviour based on form or appearance and not function; Martin, Bateson & Bateson, 1993). However, because many dog social behaviours have not been studied in an adequate level of detail, it is likely that the functions of some behaviours are not fully comprehended. For example, recent discussions (Norman, Pellis, Barrett & Henzi, 2015; Smuts, Bauer & Ward, 2015) have indicated more investigation is needed to better understand why dogs engage in roll-over behaviour (i.e., during dog-dog play). It is also not clear if labelling behaviours *a priori* as dominant or submissive is entirely appropriate, since if and how dominance applies to dogs is still being debated and has not yet received thorough empirical evaluation, especially in companion dogs (e.g., Bradshaw et al., 2009; Schilder, Vinke & van der Borg, 2014; Smuts, 2014; van Kerkhove, 2004). Further studies that assess behaviour from a neutral perspective would be helpful as they would provide insight into dog social patterns without making assumptions that are potentially inaccurate. Since it is impossible to ask dogs about their behaviour, such studies would be invaluable for developing a truly objective database of information upon which the understanding of dog social behaviour could progress.

1.5 Overview of This Work

The present study used ethological methods to study dog-dog social behaviour in a public off-leash dog park. To do this, I continuously video recorded focal dogs during the beginning minutes of a dog park visit. I chose to focus observations on the early minutes of a focal dog's visit as dog social activities in the dog park studied often appeared noticeable and variable upon, or shortly after a dog’s arrival. Also, to my knowledge, no other study has broadly characterized dog behaviour specifically during the initial minutes of a dog park visit.

Video coding was used to assess focal dog involvement in general dog park activities (e.g., time dogs spent alone, with other dogs or humans), and the rates of a range of specific behaviours exchanged between focal dogs and other dogs. I attempted to label and define observed activities and canid behaviours according to their form or appearance rather than function. For example, when a dog went from standing to laying on his or her side/back with belly exposed, the behaviour was coded as a roll-over, and not as a form of submission; the latter term has been used previously to classify roll-over behaviour in dogs (e.g., Goodwin et al., 1997). Since dog-dog social behaviours in dog parks have been understudied, and thus are not fully understood, motivationally-neutral descriptions of behaviour allowed me to document and analyze dog behaviours without making potentially erroneous assumptions about why such behaviours were performed. As far as I am aware, this is the first dog park study to use a strictly motivationally-neutral approach to analyze broad aspects of dog-dog social behaviour.

Finally, I investigated factors that might influence general activities and rates of canid behaviours (i.e., dog density, focal dog sex, age, size, and neuter status). In doing so, the present study elaborates on the very limited amount of work that has previously examined the selected factors in relation to dog-dog social behaviour in dog parks.

Although there were some general expectations (outlined in Chapter 2) regarding the findings of this study, no specific predictions were made due to a lack of comparable data. In any case, this study provides further data on dog-dog social behaviour in dog parks, a social context that is regularly experienced by many companion dogs that has been understudied to date. More broadly speaking, this study also offers greater information on companion dog social behaviour patterns that occur when dogs are not overly-controlled or completely restrained by owners, and free to choose to engage in interactions with conspecifics.

1.6 Co-authorship Statement

This research study was carried out under the supervision of Dr. Carolyn Walsh and Dr. Rita Anderson of the Canine Research Unit, Department of Psychology, Memorial University of Newfoundland. With their help, I developed the research questions and methodology used for this project, which are described in detail in Chapter 2 of the thesis. Details of this project were also presented to my third committee member, Jackie Weir, Department of Environment and Conservation, Government of Newfoundland and Labrador, who also provided feedback. Study data were collected and organized either by me or under my supervision. These data included video recordings of dogs, and information about dogs collected through on-site observations or by speaking with dog owners/handlers in the park. Throughout the course of this study, questions or concerns were directed toward Dr. Carolyn Walsh, Dr. Rita Anderson, or me. All sections of this thesis were written by me. Throughout the process of writing all chapters of this thesis, and when analyzing and reporting data described in Chapter 2, I incorporated feedback and made revisions based on edits offered by my supervisors and committee member, as necessary. Dr. Carolyn Walsh and Dr. Rita Anderson are co-authors of the chapters in this thesis as they provided significant intellectual contributions, materials required for data collection, organization and analyses.

Chapter 2 : Social Behaviour of Dogs in a Public Off-Leash Dog Park Setting

2.1 Introduction

As indicated by popular websites (e.g., http://dogpark.com; The City of Calgary, n.d.), dog parks are commonly found across Canada and the United States. Though specific characteristics of these settings vary considerably (e.g., size, terrain, fenced or open-field, and extent of vegetation), these dog parks generally refer to public outdoor spaces recognized as off-leash areas, which are large enough so that dogs may engage in chasing and other energetic social behaviours. Companion dogs that are unfamiliar to each other (i.e., pets living in separate human households), as well as dogs from multi-dog households of various ages and breeds are frequently present in these parks together. Despite the popularity of dog parks, only a small number of studies focused on dog-to-dog social behaviour in dog parks have been carried out by behavioural researchers (Bauer & Smuts, 2007; Bradshaw & Lea, 1992; Horowitz, 2009; Lisberg & Snowden, 2011; Ottenheimer Carrier, Cyr, Anderson & Walsh, 2013; Shyan et al., 2003).

2.1.1 Why Study Dog-Dog Behaviour in Dog Parks?

Observing dogs in dog parks provides an opportunity to better understand naturally-occurring dog social behaviours. In particular, dog parks allow researchers to unobtrusively view spontaneous social exchanges between companion dogs when human control of dogs is relaxed (i.e., dogs can be observed to interact without explicit interference from owners). Dogs are also able to perform a broad range of socially-relevant behaviours in dog parks, including those that may not be condoned in other types of settings. For example, indoor settings that might allow for dog-dog social encounters (e.g., training arenas) presumably restrict elimination behaviours (i.e., related to urination and defecation). Dog parks also attract a wide-ranging sample of individuals and thus, are suitable for investigating a range of questions relating to various characteristics of dogs (i.e., sex, age) or partner relationships (i.e., level of familiarity). Further, the informal manner with which researchers may acquire observations at dog parks (i.e., pre-arranged commitments from study participants are not necessary) allows the study of individuals that may be less prone to volunteer bias. As a result, findings from dog park studies may potentially have greater generalizability than findings from studies that obtain samples through a more active recruitment process.

Dog parks also allow for the study of a unique social situation among non-human animals. That is, in dog parks, dogs originate from different households, and thus, often have limited or no familiarity with each other. Yet, despite this, dogs in dog parks appear to casually interact with very little serious conflict (e.g., Bradshaw & Lea, 1992; Shyan et al., 2003). This situation is arguably not common among other species, as non-aggressive interactions between stranger conspecifics have not been widely documented. Instead, except in some circumstances (e.g., wild wolves dispersing from different groups may meet and form mated pairs in wolf free areas; Fritts & Mech, 1981), encounters between unfamiliar conspecifics have largely been described as hostile in a range of species. For instance, in various wild species of social mammals (e.g., African lions, grey wolves, Ethiopian wolves, and chimpanzees), encounters between established territory residents and conspecific intruders typically involve significant threats and/or physical aggression (Grinnell & McComb, 2001;Grinnell, Packer & Pusey, 1995; Mech, 1994*;* Sillero-Zubiri

& Macdonald, 1998; Wilson & Wrangham, 2003). Conflict has also been regularly observed between free-ranging domestic dogs during encounters in areas where different groups compete for the same resources (Bonanni, Natoli, Cafazzo & Valsecchi, 2011; Bonanni, Valsecchi, & Natoli, 2010).

The apparent low level of conflict between dogs in dog parks may potentially be explained by the fact that dog parks are neutral territories (i.e., not home to any one dog and typically contain few valued resources). However, findings from experimental work on captive and farm animals (e.g., marmosets, domestic horses and pigs) suggest that initial introductions between unfamiliar conspecifics in neutral spaces (i.e., test pens/enclosed areas separate from usual housing of test animals) may still prominently feature aggressive behaviour (Cilia & Piper, 1997; Hartmann, Chistensen & Keeling, 2009; Jensen, 1994). Therefore, the low level of conflict between dogs in dog parks is intriguing. Further examination of what dogs do in dog parks will help elucidate how companion dogs navigate a social setting that includes novel or unfamiliar conspecifics, and clarify the types of social behaviour patterns and relationships that form in this unique social context.

More information and discussion of intraspecific social behaviour patterns in dog parks will also help provide information about the impacts of dog parks on dog welfare. Although dog parks have been promoted for providing areas where companion dogs can engage in exercise and socialize (The American Society for the Prevention of Cruelty to Animals [ASPCA], 2015), concerns over dog park use have also been raised. For example, infectious disease, injury or death due to serious aggression or predatory behaviour, injury through involvement in vigorous activities (i.e., play), acquisition of poor social habits (e.g., development of fear-based aggression toward other dogs), and exposure to an unnecessary stressful life experience have all been raised as potential welfare issues (ASPCA, 2015). Therefore, it might be helpful to clarify the beneficial and detrimental effects of dog parks so that handlers/owners may make informed decisions about whether dog parks are suitable for their particular pets.

2.1.2 Overview of Previous Work

To my knowledge, just six studies published in the peer-reviewed literature to date have focused on investigating dog-dog social behaviours in dog parks (Bauer & Smuts, 2007; Bradshaw & Lea, 1992; Horowitz, 2009; Lisberg & Snowden, 2011; Ottenheimer Carrier et al., 2013; Shyan et al., 2003). Together, these studies have provided a range of information. For instance, there has been some investigation into how much time dogs spend with other dogs compared to being involved in other activities in a dog park. In the same park studied here (Quidi Vidi dog park), Ottenheimer Carrier et al. (2013) constructed time budgets of focal dog activity over a 20 min period, determining the percentages of time focal dogs spent in dog dyads, dog groups, with humans, in mixed (dog-human) groups, and alone. They reported that dogs spent approximately 33% of time alone, 23% of time exclusively with other dogs, 20% of time exclusively with humans, and 24% of time with both dogs and humans, suggesting that most of a dog’s time in the park is allocated to social activities, which are split among dog and human partners.

Specific canid behaviours exchanged between dogs in dog parks have also been investigated in previous studies. For example, behaviours within dog-dog dyads during bouts of activity identified as play have been given some attention (Bauer & Smuts, 2007; Horowitz, 2009). These studies reported on a variety of behaviours organized according to various play behaviour categories; Bauer and Smuts (2007) examined play signals, attacks/pursuits (i.e., behaviours used to actively attain or maintain a winning position), and self-handicapping (i.e., behaviours used to actively attain or maintain a losing position), while Horowitz (2009) evaluated play signals and attention-getting activities, which covered various forms of physical contact, postural or movement displays, and chase behaviours. In addition, Shyan et al. (2003) recorded the incidences of aggressive events, and Lisberg and Snowden (2011) reported urinary marking behaviours that occurred in a dog park entryway. Two other studies have had a broader behavioural scope. Bradshaw and Lea (1992) investigated the frequencies and sequences of a range of canid behaviours from categories they described as general/locomotory, visual signals, auditory signals, and olfactory communication during dog-dog dyads not restricted to any particular context (i.e., play bouts). Ottenheimer Carrier et al. (2013) examined canid behaviours initiated by focal dogs including mounting, play, agonistic, and stress behaviours over a continuous 20 min period.

The available research has also indicated that various factors influence social behaviour between dogs in dog parks. Of these, dog sex and age have been the most salient influences, as both factors have been associated with multiple canid behaviours in different dog park studies. Both Ottehnheimer Carrier et al. (2013) and Bauer and Smuts

(2007) reported influences of dog sex and age on a range of behavioural variables. For instance, Ottenheimer Carrier et al. (2013) found the percentage of time focal dogs spent in dyads with conspecifics was higher in younger males compared to females of any age. They also reported that only male focal dogs initiated mounting, and that frequencies of play signals and stress behaviours decreased with increased focal dog age. Bauer and Smuts (2007) found male compared to female dogs were less frequently involved in dyadic play bouts, and during these play bouts, attack/pursuit play behaviours were performed more frequently with increasing age, while self-handicapping play behaviours occurred less frequently with increasing age. Bauer and Smuts (2007) also reported that mounting was associated with males, where mounting during play was 16 times more frequent among male-male dyads than female-female dyads. Two other studies have reported sex influences on various chemosensory-related behaviours; Lisberg and Snowden (2011) found that male dogs performed urinations, urination inspections, and countermarked conspecific urine more frequently than female dogs in a dog park entryway, and Bradshaw and Lea (1992) found males performed a greater proportion of head to tail events (i.e., one dog positions nose close to anal or genital area of another dog) during dog-dog dyads. Although not reviewed in detail here, other factors such as dog personality scores (Ottenheimer Carrier et al., 2013), site location (Bradshaw & Lea, 1992), and relative characteristics of dog dyads (i.e., relative ages, sizes and dominance statuses of dog partners; Bauer & Smuts, 2007; Shyan et al., 2003) have been associated with the occurrence of a variety of canid behaviours in dog parks.

Overall, previous work has indicated that dogs spend a considerable amount of time during a visit involved directly with other dogs, that a complex range of canid social behaviours are exchanged between dogs in dog parks, and that dog interactions in dog parks are influenced by multiple factors. However, given the few studies in this area, it is clear that much more work is needed to develop a more comprehensive and nuanced understanding of the behaviours that are exchanged between dogs in dog park settings.

2.1.3 Present Study

The purpose of the present study was to elaborate on and extend the previous body of work that has investigated dog social behaviours in dog park settings. To carry out this work, individual focal dogs were continuously observed and video-recorded for the first 400 s following entry to a public off-leash dog park. Observations were restricted to the early minutes of a dog park visit, as dogs appeared to regularly attract and seek out various types of social contact with other dogs during this time, suggesting it was an important time period within a visit to investigate. Further, no other study has focused on describing wide-ranging aspects of dog behaviour during the initial stage of a dog park visit.

The intention here was not to test specific hypotheses, but to provide basic information on aspects of dog-dog social behaviour that occurred during the time period studied. This type of descriptive work is important, as good descriptions of behaviour are an essential first step in developing lasting theories about why behaviour occurs (Bekoff, 2014). As the functions of many dog social behaviours in dog parks, or elsewhere, have not received adequate empirical evaluation, a motivationally-neutral approach was used in this work to ensure that evaluations of dog behaviour were not based on potentially false assumptions. Notably, no previous dog park study has used a purely neutral approach to characterize broad aspects of dog-dog social behaviour.

Detailed analyses of behaviour were conducted from video recordings, similar to the manner of other studies of freely-moving dogs (e.g., Bauer & Smuts 2007; Horowitz, 2009; Ottenheimer Carrier et al., 2013; Pullen, Merrill & Bradshaw, 2013). Video coding was used to address three main questions:

(1) How did focal dogs spend their time?

(2) What did focal dogs do when with conspecifics?

(3) How did dog density and biological factors influence dog behaviours?

To examine how focal dogs spent their time in Quidi Vidi dog park, dog activities were classified according to time spent active exclusively with dogs, exclusively with humans, in mixed dog-human groups, alone, and activity directed outside the park, which are activity states similar to those used by Ottenheimer Carrier et al. (2013).

In order to assess what focal dogs did when with other dogs in the dog park, a variety of specific canid behaviours were coded. Rates at which behaviours were both initiated and received by focal dogs were measured; rates of behaviours *received* from conspecifics by individual focal dogs observed continuously during a visit in a dog park have not been reported by other peer-reviewed published studies. For this aspect of the study, I intended to represent a range of social behaviours exchanged between focal dogs and conspecifics. Some behaviours were selected because they were iconic canid social behaviours (e.g., elimination, snout-muzzle contact to anogenital area, play bows, rolling-over, chase) and I wished to evaluate them during the early minutes of a dog park visit. Other behaviours were selected because they had either been previously identified as socially relevant in popular sources (e.g. spontaneous dropping to the ground has been referred to as a “calming signal” in the popular literature; Rugaas, 2005) or otherwise appeared to occur regularly in the park (e.g., pulling the rear away from another dog’s face/head), yet had been given little empirical attention in the published literature and thus were considered worthy of closer examination. Conditions were less than ideal for collecting quality audio recordings (i.e., windy conditions and lack of close proximity to individuals). As a result, vocalizations (with exception of the vocalization component used to identify lunge approaches) were not analyzed in this work.

Influences of dog density in the dog park (average number of conspecifics in the park during focal observations) and multiple biological factors on time budgets and canid behaviours were also examined. Biological factor influences investigated included focal dog sex, age, size, and neuter status. Since the duration of time dogs spent with conspecifics (in dyads) was previously associated with a sex by age interaction in the Quidi Vidi dog park (Ottenheimer Carrier et al., 2013), influences of focal dog sex by age interactions were also tested for time budget states, as well as all behavioural variables.

The limited comparable research made hypothesis testing difficult. However, I generally expected that activity with conspecifics would account for a significant portion of focal dog time, given the flurry of dog-dog activity often witnessed at the dog park gates. Since Bradshaw and Lea (1992), Bauer and Smuts (2007), Horowitz, (2009) and Ottenheimer Carrier et al. (2013) found frequencies of particular canid behaviours in dog parks were highly variable, I expected that specific canid behaviours (i.e., initiated and received by focal dogs) would also occur with variable frequencies in the present work. I expected that chemosensory behaviours would be particularly frequent given the importance of chemosensory cues to canids (Harrington & Asa, 2003) and the findings of Bradshaw and Lea (1992), who reported high frequencies of nose contact to dog head ("head to head") and anogential ("head to tail") areas within dog dyads. There were no expectations about how dog density and biological factors would influence dog-dog social behaviour; this was because although some factors of interest (e.g., dog age and sex) have been associated with dog behaviour in dog parks, widespread, consistent patterns of their influences are not yet understood.

2.2 Methods

2.2.1 Subjects

Of the 220 different dogs observed in the dog park during the study period, 69 different individuals were opportunistically selected as focal dogs (see Procedure); 42% of focal dogs were female (n=29), 58% male (n=40). Sixteen percent (n=11) of focal dogs were sexually intact. Age was known for 45 focal dogs (65.2%); age ranged from 4 months to 9 years, 2.58 +/- 2.53 years (mean +/-SD), with a median age of 1.5 years.

Eighty percent (n=55) of dogs were visually estimated to be 25lbs or over and 20% (n=14) were estimated to be under 25lbs. More than half (55.1%; n=38) were of mixed-breed. The most common breeds represented among purebred and mixed breed focal dogs included Labrador retriever (20.2%; n=14), beagle (13%; n=9), and husky (11.6%; n=8). Other breed types were represented among less than 10% of focal dogs (i.e., the breeds were recorded for fewer than 7 pure or mixed breed focal dogs). Nine focal dogs (13%) attended the park with other dogs simultaneously supervised by the same owner/handlers. Total visit durations of focal dogs (n=47 for which both exit and entry times were recorded) during the visit in which focal dog observations were made, lasted an average of 26 ±2 min (median of 22 min).

2.2.2 Procedures

2.2.2.1 On-site procedures

All observations took place at the Quidi Vidi dog park, an off-leash public dog park located in St. John’s, Newfoundland, Canada. The park is situated near a popular lakeside walking trail and access is free to the general public. The park consists of a 45 X 65 meter area, with a chain-link fence, sandy terrain and scattered grass patches throughout and along the fence perimeter (Figure 2.1). Double-gated entrances at opposite sides of the park provided an area for owners to unleash their dogs prior to entry into the larger communal area. During the period of this study, the park contained a water fountain, several benches, garbage cans, and fire hydrants situated in different corners of the enclosure. Toys introduced to the park by owners were usually limited to tennis balls. Park conditions generally allowed dogs to be highly visible.

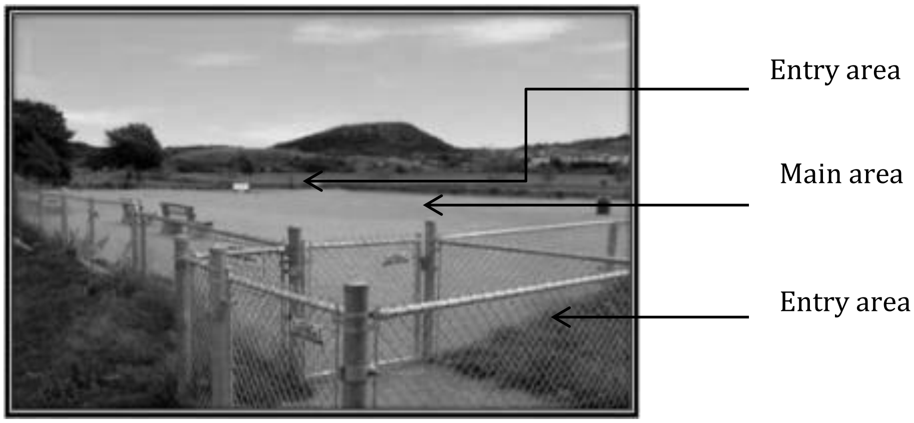

Figure 2.1 Quidi Vidi Dog Park
(Memorial University of Newfoundland Canine Research Unit, n.d.)

Dog park observations were made in sessions that lasted about two hours each (one session per day), beginning in late June and ending in early August 2007. Session length was sometimes affected by weather (i.e., sessions were ended if it rained). In total, approximately 50 observation hours occurred on 25 different days at the park. Observation sessions were always carried out by the same two individuals (MH and KL) and occurred at different times of the afternoon to minimize systematic effects of time of day on observed behaviour. Observation sessions were usually held between 1:00pm to 5:00pm and only on weekdays; during this time period dogs and owners tended to enter the park at a rate that made data collection manageable. When possible, arrival and departure times of all dogs that attended the park during each observation session were recorded to the nearest minute as judged from the time that dogs physically passed through one of the inside park gates.

Focal dogs were most often selected by choosing the first dog to enter the park when the camera was set-up and not being used to record other dogs. However, once a reasonable sample of individuals for independent analyses was achieved, focal dogs that previously entered the park were occasionally selected over never-before-seen dogs to preserve the possibility of having repeated observations; however, in the end, such repeated-measures analyses of the same focal dogs were not undertaken in this work. All focal dogs were recorded by the camera within 20 s of passage through an inside park gate. The intention was to record individual focal dogs for a minimum of five continuous minutes, as pre-study observations suggested 5 min would be adequate time to capture a significant amount of initial dog-dog activities. The video camera operator continued to record the focal dog beyond the minimum 5 min when new focal dogs had not entered. As a result, the actual duration of continuous recording of focal dogs lasted between 6 min 40 s and 10 min. To make certain that focal dogs had an opportunity to encounter at least one other dog that was to some degree unfamiliar, video recording commenced (and continued) only when at least one other dog *not* from the same household as the focal dog was present at the park.

A Sony Handycam DCR-SR60 mounted on a tripod that enabled video remote control was used for all video recording at the park. Video recording was always conducted from a stationary position located near a bench, intermediate to both gate locations and situated away from areas where owners and dogs tended to congregate. Such a location was chosen in order to achieve optimal camera angles. Throughout the study period, there was no obvious indication that any dogs in the park were affected by the presence of the camera or observers. Dogs did not appear to discriminate between researchers and other non-owner humans present, nor did any dog appear to react overtly to the camera equipment (i.e., dogs did not stare/bark at the camera). All video collected was initially downloaded to an iMac computer in individual clips in an MPEG-2 format.

In order to inform all dog owners about our purpose at the park, several steps were taken. Posters were placed on outside gates during each observation session. These posters outlined the study goal (i.e., to study dog-dog behaviour), assured owners that participation was voluntary, encouraged owners to approach the researchers if they did not want themselves or their dog(s) to be on camera, and provided contact information. When circumstances permitted (i.e., researchers were not otherwise occupied with other tasks), they approached and explicitly asked for the owner's permission to observe their dog(s). This was also used as an opportunity to ask owners about their dog's sex, age, breed and neuter status. Finally, handouts that outlined the study and included contact information were made available to all park patrons. This protocol adhered to suggestions made by Memorial University's Institutional Animal Care Committee (#07-11-CW). Researchers were also granted permission from the City of St. John's to use the park as a study site.

2.2.2.2. Video coding procedures

The behaviour of each of the 69 off-leash focal dogs was coded from video for 400 consecutive seconds (6 min 40 s) from their entry into the park. This period was set at 400 s because it was the minimum duration of time that all focal dogs were captured continuously on video. The start of a focal dog's observation period corresponded closely with the time that the focal dog first entered into the communal area of the park. As confirmed from video, the observation period of most focal dogs (n=48, 70%) began exactly as they moved through the inside park gate off-leash. For some focal dogs (n=21, 30%), the start of the observation period was delayed from a focal dog's initial entry through the inside park gate. Delays between entries into the communal area and start of video observation periods lasted from 30 s (20 focal dogs) to 45 s (1 focal dog). Of these focal dogs, 12 were kept on leash until after the gate had opened and so observations began as soon as dogs were unleashed; for 9, entries were not captured on video but recordings began within 20 s of entry (known due to video recording procedures).

Only one observation period of each focal dog was included in analyses. For dogs that were chosen as focal dogs on multiple occasions (i.e., different study days), the single observation period was selected at random. All behavioural coding was conducted by the same observer (MH). Video playback of each focal dog was viewed on a 24 inch flat-screen computer monitor using MPEG Streamclip, Windows version 1.2 (Cinque, 2008).

2.2.2.3 Development of behavioural definitions

Definitions of focal dog behaviour were developed through careful observation of a randomly-selected sample of video clips. Previously published descriptions of canid behaviours were incorporated into behavioural codes when such descriptions accurately represented the form of the behaviours or components of behaviour that were of interest. Sources that directly influenced behavioural definitions are referenced accordingly (see Tables 2.1 and 2.2). Effort was made to label and describe behavioural phenomena neutrally (i.e., with reference to form instead of function). However, to avoid potential confusion, exceptions to neutral labelling were made if the behaviour was well-known in the literature and well-suited to what was being described. For instance, although functionally-based, play bow was used as a label as the canid play bow has been widely documented (e.g., Bauer & Smuts, 2007; Bekoff, 1977; Horowitz, 2009). In any case, non-neutrally labelled behaviours were not necessarily interpreted as indicating their implied function (e.g., play bows were not necessarily interpreted as indicating play). Notably, some behaviours or components of behaviours have been studied since they were originally selected for coding in the present work (e.g., "chase-me" was not a published term when this study was first undertaken). Therefore, when appropriate, labels and definitions of behaviour (or behavioural components) in the present work have been updated to reflect labels and definitions that became available so that terminology and definitions would be consistent. To improve behavioural coding accuracy, coding was practiced on randomly selected video clips from the study sample. These clips were also viewed just prior to actual coding sessions in order to help prime the observer.

2.2.2.4 Activity time budgets

To create time budgets (Table 2.1), the 400 s observation periods of the focal dogs were coded according to six mutually exclusive general activity states related to both social and non-social activities. The focal dog was considered to be involved with a particular individual if both he/she and the individual were visually estimated to be within one adult Labrador retriever ("Lab") body length (approximately 1 m) or less, and at least one obvious exchange of social behaviour occurred (identified exchanges of social behaviour included when the focal dog was involved in some form of snout-muzzle contact, non-contact, joint movement, or physical contact with the individual in question). Note that an exception to the distance rule was made if the focal dog and partner(s) became separated during movement and the lagging individual continued without pause toward the corresponding partner until a 1 Lab length or less distance was re-established. In all, three separate states accounted for all focal dog social activity in the park: time with dogs (the focal dog was exclusively involved with one or more conspecific partners), time with humans (the focal dog was exclusively involved with one or more human partners), and time in mixed groups (the focal dog was involved with at least one dog and human concurrently).

The remaining activity states coded included time alone, time involved in activity directed outside the park, and indeterminable activity. Focal dogs were considered to be alone either if they were not within 1 Lab length of any individual and not momentarily separated during movement with any individual, or when within 1 Lab length of others (dogs and/or humans) but no behaviour exchanges associated with social states were observed. Activity directed outside the park was coded when the focal dog was alone with his/her face pointed toward events occurring outside the park or placed his or her snout/muzzle and/or paw through the chain link fence. Finally, indeterminable activity captured time that the behaviour of the focal dog could not be properly discerned due to poor visibility (i.e., focal dog was occluded from view or camera jumped); this category was coded for the purpose of calculating measures of behaviour only (see below).

Jwatcher coding software, Version 1.0 (Blumstein, Daniel, & Evans, 2007) was used to code the six general activity time budget categories for each focal dog in real time.

Table 2.1

Definitions of focal dog activity states and subsets of canid behaviours selected for event coding. Focal dogs and partners were within one adult Labrador retriever ("Lab") body length, except when noted. For focal dog's role in exchanges I= initiator, R= recipient, and P= mutual participant.

Activity State	Behaviour exchanges (focal dog role)	Description	Canid behaviour events coded
With dogs	Snout-muzzle contact (I or R)	Places snout or muzzle toward or on any area of conspecific's body. Mouth opens and closes slightly. Licking may occur.	Snout-muzzle to anogenital area Snout-muzzle to head
	Non-contact (I or R)	Stands still orients[a] toward conspecific (adapted from "orientate" in Bradshaw & Lea, 1992), or orients[a] toward conspecific with obvious postural changes, movements, and/or vocalizations.	Drop belly to ground Exaggerated away Hunched posture Lunge approach Play bow Pull rear away Roll-over Run/leap self-present Sit
	Joint movement (1-I or R; 2-P)	Dogs move around park in same direction while: (1) One approaches the other, who is moving away (adapted from "chase" in Bradshaw & Lea, 1992). Alternatively, (2) both travel toward the same target (e.g., run after same ball, stop at water fountain or gate at end of movement).	Chase (excludes when walking)

(Table continues)

Activity State	Behaviour exchanges (focal dog role)	Description	Canid behaviour events coded
	Physical contact (I or R)	Physically contacts area of conspecific's body with any part excluding the snout or muzzle.	Leap-on Mount Open-jaw Paw body Paw head Paws around body Pin Slam Wrestle
With humans	Snout-muzzle contact (I)	Places snout or muzzle toward or on any area of a human's body.	None
	Non-contact (1-I; 2-R)	(1) Stands still orients[a] toward human (adapted from "orientate" in Bradshaw & Lea, 1992) or orients[a] toward human with obvious postural changes, movements, and/or vocalizations. Alternatively, (2) human shouts focal dog's name or gestures toward focal dog (e.g., hand clapping, holding out ball).	None
	Joint movement (1-I or R; 2- P)	Focal dog and human move around park in same direction while: (1) One individual approaches the other, which moves away (adapted from "chase" in Bradshaw & Lea, 1992). Alternatively, (2) both individuals travel toward the same target (e.g., run after same ball, stop at water fountain or gate at end of movement).	None
	Physical contact (1-I; 2-R)	(1) Physically contacts human with any part excluding the snout or muzzle. Alternatively, (2) human physically contacts focal dog, including with collar pulls or picking up.	None

(Table continues)

Activity State	Behaviour exchanges (focal dog role)	Description	Canid behaviour events coded
Mixed groups		Behaviour exchanges under “with dogs” concurrently with any behaviour exchange under “with humans” e.g., focal dog initiates snout-muzzle contact to person A while receiving snout-muzzle contact from dog A.	Events listed under “with dogs”
Alone		Not within 1 Lab length of any individual and not momentarily separated during ongoing movement from any individual. Or, within 1 Lab length of others (dogs and/or humans) but no behaviour exchanges under “with dogs”, or “with humans” occur. At the same time, not engaged in “activity directed outside park”.	None
Activity directed outside park		Orients[a] head toward events occurring outside park, or places snout/muzzle and/or paw through fence. At the same time, not within 1 Lab length of any individual and not momentarily separated during ongoing movement from any individual. Or, within 1 Lab length of others (dogs and/or humans) but no behaviour exchanges under “with dogs”, or “with humans” occur.	None
Indeterminable		Focal dog is not clearly in view and behaviour cannot be determined.	N/A

Note. Exception to the “1 Lab length rule” during movement when focal dog and partner(s) momentarily separated and individual behind persisted until 1 Lab length was re-established.

[a] Focal dog’s face squarely points or is turned toward partner or named location such that looking was possible (i.e., other or location was estimated to be within dog’s horizontal field of view; approximately a 240 degree angle for dogs, Sherman & Wilson, 1975).

2.2.2.5 Canid behaviour events

Frequencies of canid behaviour events exclusive to social exchanges between focal dogs and conspecifics were also coded (see Tables 2.1 and 2.2). For this, a subset of canid behaviours were selected from the four categories of behavioural exchanges (i.e., snout-muzzle contact, non-contact, joint movement, and physical contact) used to identify focal dog social activity states that involved conspecifics (i.e., focal dog time with dogs, and in mixed groups). Multiple canid behavioural events were scored from each of these four categories, with the exception of joint movement. For joint movement, I focused on recording only forms of chase that occurred at a pace faster than walking, as such were salient and easy to selectively code; also, chase at a pace faster than walking represented one of the more high energy, dynamic forms of activities that focal dogs and conspecifics became involved in together and, thus, appeared important to represent in canid behaviour analyses. For physical contact events, a comprehensive set of *unidirectional* forms of physical contact, as well as wrestle events, were scored. Unidirectional contact was recorded if the dog initiating a named form of physical contact (e.g., open-jaw contact) did not receive any form of physical contact from their conspecific partner at the same time. In contrast, one recorded physical contact event, wrestle, involved the focal dog and a conspecific simultaneously exchanging physical contact events, and thus, was categorized as *bidirectional*. Upon coding the frequency of specific forms of unidirectional physical contact initiated and received by focal dogs, broad categories which represented the total frequency of all forms of unidirectional physical contact initiated and received by focal dogs were also tallied for analyses.

In addition to canid events exclusive to focal dog-dog exchanges, elimination events by focal dogs were recorded as they occurred during any time budget activity state throughout the focal period; these were coded with Jwatcher at the same time as activity states (Table 2.2).

Frequencies with which focal dogs initiated and received the selected subset of canid behaviour events were coded by entering information directly into an MS Excel (97-2003 Workbook) worksheet. All focal dog social exchanges with conspecifics were first re-identified according to the definitions for focal dog activity with dogs and in mixed groups during activity state coding (Table 2.1). The start and end of exchanges within the observation period to the nearest second, and the identities of conspecifics involved or associated with exchanges were recorded to aid in consistent video review. Once all relevant social exchanges were re-identified, canid events of interest, the identity of conspecifics with which the focal dog initiated or received events, and the activity state during which the event occurred were then recorded for each exchange. Notably, only canid events scored during the state with dogs were of further interest. Canid events scored during the state mixed groups were excluded from final tallies of behaviour in order to construct analyses focused purely on intraspecific patterns.

Table 2.2

Description of canid behaviours selected for event coding. All events initiated and received by focal dogs were scored with exception of elimination (focal dog initiated only); focal dogs were both initiators and recipients for wrestle events.

Behaviour exchange Category	Canid behaviour event	Description
Snout-muzzle contact	Snout-muzzle to anogenital area	Places snout or muzzle toward or on the area underneath another dog's tail or mid to rear underbelly (i.e., anal or genital areas). Mouth opens and closes slightly; licking may occur.
	Snout-muzzle to head	Places snout or muzzle toward or on another dog's head or face. Mouth opens and closes slightly. Licks may also occur.
Non-contact	Drop belly to ground	From standing, fully lowers forelimbs and hind limbs to the ground simultaneously so that belly also touches ground; tail base in neutral position or higher; oriented toward partner; excludes drops combined with hunched posture.
	Exaggerated away[a]	1) Leaps away from partner; head toward partner (same as "exaggerated retreat" in Horowitz, 2009) or in direction of movement. Or, 2) moves away from partner with looks back (i.e., orients head toward partner) and reduced pace/loping stride (same as "chase me" in Horowitz, 2009); in both cases tail base in neutral position or higher and entire tail may be laterally wagging, or looping in circles.
	Hunched posture[a]	Rounds shoulders or whole back; tail base lower than a neutral position; entire tail may laterally wag; partially lowers head and/or body (bends all legs or just hind legs) toward ground.
	Lunge approach	Runs or leaps towards front of other dog while rapidly thrusting the head forward toward partner to vocalize; frequently combined with a snap (quickly brings teeth to touch; adapted from Fentress, Ryon, McLeod, & Havkin, 1987) almost invariably toward other dog's head. Vocalization high pitched or growl-like; if behaviour was repeated without pause, counted as same event.
	Play bow	Crouches down touching (or almost touching) forelimbs to ground with rear end high in air; oriented toward partner (adapted from Bauer & Smuts, 2007).

(Table continues)

Behaviour exchange Category	Canid behaviour event	Description
	Pull-rear away	As partner approaches or contacts rear end, focal dog swings rear end away from partner; ends up with head oriented toward partner's head/face.
	Roll-over[a]	From standing rolls onto back or side with forelegs pointing in air or pulled in close to the chest; genitals exposed.
	Running/leaping self-present	Runs or leaps toward front of other dog (adapted from "self-present" by Horowitz, 2009). In contrast to lunge approach no rapid head thrust with vocalization or snapping. In contrast to pull-rear away, partner was not approaching or contacting rear upon initiation.
	Sit[a]	Lowers rear to ground with hind legs folded, forelegs straight so that the front end of dog is held erect (Anderson, Russell, White & Weir, 2001).
Joint movement	Chase (excludes when walking)	Follows partner at a pace faster than walking for a minimum of two strides.
Physical contact	Unidirectional[b]	
	Leap-on	Rears up and places front paws around partner's head; back not rounded and no pelvic thrusting (adapted from Horowitz, 2009).
	Mount	Rears up and places forelegs on the back of partner in a front, lateral or rear mount position; back is rounded and may be accompanied by pelvic thrusting (adapted from Bauer & Smuts, 2007)
	Open-jaw contact	Places open jaw on partner's body so that teeth may make contact, excluding when towards neck/abdomen of partner laying belly up on ground (when component of pin). Does not cause obvious injury.
	Paws around body	Rears up and places front paws around partner's body (excludes head); back not rounded and no pelvic thrusting.
	Paw body	Front paw(s) or foreleg(s) not wrapped around partner's body as with paws around body. Instead, uses front paw(s) or foreleg(s) to tap, strike, or push partner's body (excluding head). Or, rests front paw(s) or foreleg(s) on partner's body without rounding back or pelvic thrusting.

(Table continues)

Behaviour exchange Category	Canid behaviour event	Description
	Paw head	Front paw(s) or foreleg(s) not wrapped around partner's head as with leap-on. Instead, uses front paw(s) or forelegs(s) to tap, strike, or push partner's head or neck. Or, rests front paw(s) or foreleg(s) on partner's head without rounding back or pelvic thrusting.
	Pin	Places front paws or forelegs on top of partner and/or initiates open-jaw contact toward partner's neck or abdominal region as partner lays belly up on the ground.
	Slam	With accelerated motion before contact (i.e., from a running start or leaping up) uses the body to strike partner (adapted from Zimen, 1982). Contact is usually made with chest, shoulder or hip but never front paws or forelegs.
	Bidirectional	
	Wrestle	Excluding snout-muzzle to anogenital area and snout-muzzle to head, focal dog and another dog simultaneously exchange any physical contact event measured (i.e., focal dog is an initiator and recipient of physical contact events). May also include vertical lip retraction, and a sustained growl-like vocalization.
N/A	Elimination	Urination indicated by squatting or raised-leg posture (Anderson et al., 2001); Or, defecation indicated by rounded back with rear off ground and visible excrement.

Note. Only non-contact events (e.g., drop belly to ground) that were not the result of force applied by a partner or encounters with environmental obstacles were scored.

[a] If the initiator was also a recipient of some behaviour exchange this type of non-contact event was scored even if not oriented toward a particular conspecific (e.g., if dog A initiated hunched posture upon receiving snout-muzzle contact from dog B, the hunched posture event was counted regardless of whether dog A was oriented toward dog B).

[b] In contrast to wrestle events, initiator of event did not receive any physical contact event from partner at the same time.

2.2.2.6 Canid event reliability assessments

Inter-observer reliability assessments were carried out on a subset of the total 42 specific canid events coded. For this, three high frequency events (recorded for at least

50% of focal dogs) and three low frequency events (recorded for less than 50% of focal dogs) were randomly selected for re-coding by a second observer for 20% (n=14) of randomly selected focal dogs. Intra-class correlations ("ICCs"; Rousson, Gasser & Seifert, 2002) for these six events were calculated to examine coding reliability between observers (Appendix, Table A1). ICC values greater than 0.70 have been a minimum criterion taken to indicate good/high levels of reliability previously in scientific literature (e.g., Buckens et al., 2013; Duff & Goyen, 2010). ICCs were greater than 0.90 for all high frequency events, indicating strong agreement among observers. For low frequency events, agreement was considerably lower. ICCs for the behaviours drop belly to ground initiated (i.e., performed) by focal dogs and pull-rear away received (i.e., another dog performed pull-rear away) by focal dogs were 0.42 and 0.53, respectively; ICCs could not be calculated for hunched posture as the second observer initially recorded zero events, in contrast to the 16 recorded by the original observer. Given the low inter-observer reliability, selected low frequency events were re-evaluated (Appendix). Following re-evaluation, inter-observer reliability of selected low frequency events was found to be acceptable (i.e., ICCs were greater than 0.70 for hunched posture initiated and pull-rear away received; agreement was reached for drop belly to ground initiated via an alternative process discussed in the Appendix).

Intra-observer reliability assessments were also carried out for all 42 canid events. The original single observer (MH) coded all canid events a second time for a different set of 14 randomly selected focal dogs (20% of the full sample). ICCs were calculated to determine the consistency with which the single observer coded and then re-coded canid events in the selected subset of dogs (Appendix, Table A2). ICCs ranged from perfect agreement (ICC=1.00, e.g., roll-over received by focal dogs) to very poor agreement (ICC= 0.19, e.g., leap-on received by focal dogs), and thus demonstrated that intra-observer reliability of canid events varied widely. For five events, ICCs could not be calculated to assess intra-observer reliability because zero events were recorded during one or both rounds of coding.

Although coding issues surrounding inter-observer reliability were resolved, some canid events were removed from analyses on the basis of poor intra-observer reliability, as re-evaluation and re-coding of unreliable behaviours was not undertaken for intra-observer reliability assessments. Instead, events with poor intra-observer reliability were removed from further analyses, as this allowed for a more time-efficient approach of dealing with these reliability issues. In total, 16 canid events were deleted because they initially demonstrated relatively low (less than 0.70, n=11) or non-computable ICCs (n=5). Seven of the 11 deleted events had ICCs between 0.60-0.69, four events had ICCs less than 0.60. These event deletions left 26 of the originally coded canid events remaining for analyses.

Following event deletions, the two higher-order canid event categories, unidirectional physical contact initiated and received by focal dogs, were re-calibrated to include only frequencies of unidirectional physical contact subtypes with sufficiently high intra-observer ICCs (greater than 0.70). For example, unidirectional physical contact initiated by focal dogs originally included the combined frequencies of eight subtypes of unidirectional physical contact events initiated by focal dogs. However, following intra-observer reliability analysis, unidirectional physical contact initiated by focal dogs was based on the combined frequencies of only two subtypes. In all, 28 canid events (26 reliable canid events plus the revised unidirectional physical contact initiated/received event categories) were analyzed further in this study (Table A2; Table 2.4 in Results contains the final 28 canid events analyzed). Issues that potentially affected canid event reliability are discussed further in the Appendix.

2.2.2.7 Behavioural measures

The percentage of time a focal dog spent in a particular time budget state was based on the time the focal dog was in sight, and thus, calculated by the following formula:

$$\left(\frac{\text{state seconds}}{\text{observation seconds} - \begin{array}{c}\text{indeterminable state seconds}\\ \text{per observation seconds}\end{array}} \right) * 100$$

Similarly, a focal dog’s rate of a particular canid behaviour event per min was also based on the time the focal dog was in sight. Therefore, a focal dog’s rate of a particular canid event was calculated by the formula:

$$\left(\frac{\text{event frequency}}{\text{observation seconds} - \begin{array}{c}\text{indeterminable state seconds}\\ \text{per observation seconds}\end{array}} \right) * 60 \text{ seconds}$$

Time budgets were calculated across the entire 400 s observation period, as well as within each complete consecutive minute of the entire 400 s observation period (i.e., 0-60 s, 60-120 s, 120-180 s, 180-240 s, 240-300s, and 300-360 s). Of canid events, only elimination rates were calculated across time bins as coding with Jwatcher enabled these comparisons. Rates of all other canid behaviour events were calculated across the entire 400 s observation period only.

2.2.2.8 Demographic information and dog density

Effort was made to collect demographic information on as many focal dogs that visited the park as possible. Dog age was exclusively determined through speaking with owners. Since researchers were not available to speak with every owner, focal dog age was collected for only 45 (65%) focal dogs.

Information on dog sex and neuter status was either obtained from owners or confirmed through on-sight or video observations. Sex was determined by observing male or female genitalia and the intact neuter status of males was confirmed by observing the presence or absence of testes. Since vulval enlargment indicates females are approaching or experiencing estrus (Concannon, 2011; Jöchle & Andersen, 1977), intact neuter status was assumed only for females when vulval enlargement was clearly noticeable. Females that showed no obvious vulval enlargement were recorded as "neuter status unknown”. Neuter status was collected for only 59 (85%) focal dogs.

Breed, when not confirmed by owners, was estimated based on researcher knowledge of well-known breed types and by searching kennel club websites (e.g., http://www.ckc.ca/en/; http://www.akc.org/). Mixed breeds were identified according to the breed(s) that dogs appeared to be most similar to. At any rate, breed influences were not analyzed in this work for two reasons: (1) the method used to classify dog breed when it was not verified by owners was of concern since visual identification of dog breeds is not always accurate (Voith et al., 2013). And (2), particular pure breed types, with the exception of boxers (n=4) and beagles, (n=3), were represented by just one or two focal dogs each, and these low sample sizes did not allow for meaningful statistical comparisons.

Unfortunately, weight information was not collected at the park. Therefore, dog size was exclusively obtained through video observations; since recommended weight cut-offs for entry to some dog parks are less than 25lbs (smaller dogs) or equal to/greater than 25lbs (larger dogs), dog size was visually estimated according to these weight categories.

Since the number of dogs in the park fluctuated across observation sessions, an average measure was used to assess dog density at the park during each focal dog's observation period. Estimated dog density reflected the mean of non-focal dog counts recorded at the beginning (0 s), middle (200 s), and end points of a focal dog's observation period (400 s). Dog density was unavailable for one focal dog due to incomplete information on dog counts.

2.2.3 Statistical Analyses

PASW Statistics (v. 18; SPSS, Inc.) was used to carry out all statistical tests. Test assumptions were evaluated by visual inspection of residuals (e.g. histograms, scatterplots of residuals versus fitted values). Since data groups were sometimes unbalanced, exact or Monte Carlo p-values (when exact p-values were too computationally intensive) were accepted for all non-parametric tests. All probabilities were based on two-tailed tests and the alpha level was set at 0.05. Given that the current study was exploratory in nature, primarily concerned with detecting potentially important variable relationships, a Bonferroni correction was not used despite multiple testing as it was considered too conservative (Jaeger & Halliday, 1998).

To analyze whether time budget activity states and elimination changed over time, repeated-measures ANOVA or Friedman tests (i.e., for strongly right-skewed distributions) were used to compare percentages of time focal dogs spent in time budget states as well as focal dog elimination rates across the six 60 s time bins. If sphericity could not be assumed for repeated-measures ANOVA (via significant Mauchly's test of sphericity), Greenhouse-Geisser corrected p-values were accepted. Significant results were followed by examination of order trends (i.e., linear, quadratic) via within-subject polynomial contrasts or pairwise comparisons using Wilcoxon signed-rank tests (following Friedman tests only).

Wilcoxon signed rank tests were used to compare rates of each form of snout-muzzle contact initiated, as well as received, by focal dogs. These analyses were conducted on only snout-muzzle contact events and not other categories of behaviour in order to minimize/simplify analyses; since snout-muzzle contact events have been previously found to be highly relevant to dog-dog interactions (e.g., Bradshaw & Lea, 1992), greater detail on their relative occurrence was of particular interest.

Analyses of factor influences on behavioural variables (percentages of time in each activity state and all canid events initiated and received per min) were based on measurements made over a focal dog's full 400 s observation period. Priority was given to statistically investigating independent main effects of dog density in the park during the observation period, focal dog sex, age, neuter status, and size, as well as the interactive effects of sex and age.

The approach used to statistically analyze independent effects of interest depended on how behavioral variables were distributed across independent variable groups. ANOVA models (one or two-way) were used to investigate independent variable effects when parametric assumptions (i.e. normality, homogeneity of variance) were met. If parametric assumptions were violated, ANOVA models were carried out on effectively transformed data (i.e., non-normality, unequal variance corrected by $\log_{10}X+0.5$ transformation). When suggested transformations (Tabachnick & Fidell, 2013) were ineffective, largely due to high number of zero values, non-parametric tests were used to test independent variable effects on the original data. Kruskall-Wallis tests were used on right skewed distributions when homogeneity of variance across groups could be reasonably assumed. Median tests were used on right skewed distributions when variance was highly unequal between independent variable groups as this test makes no distributional assumptions (Mehta & Patel, 1996).

If a two-way ANOVA detected a significant two-way interaction, the interaction was tested by creating and testing a new four-level grouping variable based on all sex and age combinations (younger females, younger males, older females, older males). The effects of this new grouping variable on the dependent variable of interest were assessed via a one-way ANOVA to which least-squared difference (LSD) post-hoc tests were applied so that statistical differences between all pairs of cell means could be explored. When a two-way ANOVA could not be used to investigate sex and age in the same model, due to assumption violations, main and interactive effects of focal dog age and sex were evaluated univariately with non-parametric tests on the same focal dog subset (n=45) as would have been included in the two-way ANOVA. Although the interaction could not be explicitly tested by non-parametric tests, interactive effects were explored by conducting non-parametric tests separately for all sex and age comparison combinations (e.g., younger males vs older males, younger males vs older females, etc.). This procedure allowed all pairwise differences between various sex and age combinations to be detected. Since the data from only 45 focal dogs could be used to test the focal dog sex main effects during evaluations of sex by age interactions, the main effect of focal dog sex was also tested on the full focal dog sample (n=69).

In addition to analyzing elimination rates, proportions of focal dogs that eliminated at least once in the park by focal dog sex were tested with Pearson Chi square tests on the full sample of dogs (n=69). This allowed elimination patterns related to focal dog sex to be compared to reports from previous work that conducted a similar analysis (Lisberg & Snowden, 2011).

Although initially recorded on a continuous scale, focal dog age and dog density were converted to categories for the present analyses given that this allowed for non-parametric tests that deal only with categorical independent variables (i.e., Kruskall-Wallis, median tests) to be carried out when appropriate. Median values of focal dog age and dog density were used to create focal dog age and non-focal dog density comparison groups. Thus, focal dogs were partitioned into age groups of less than 18 months old (younger focal dogs) and 18 months or older (older focal dogs). Age was not divided according to developmental categories (e.g., pups vs. adults) as it is unclear how category boundaries of developmental stages should be defined in groups of dogs of variable breeds/sizes since different breed/sized dogs may have different rates of development. For dog density, data from focal dogs with an average of less than 4 conspecifics present during their observation periods (lower dog density) were compared to data from focal dogs that had an average of 4 or more conspecifics present (higher dog density).

2.3 Results

2.3.1 Activity State Analyses

2.3.1.1 Total activity time budgets (n=69, all focal dogs)

During the 400 s that commenced upon or shortly after dog park entry, focal dogs on average (±SE), spent 50% (± 2%) of time alone, 40% (±2%) of time with dogs, 7% (±1%) of time with humans, 3% (±0.4%) in mixed groups and 1% (±0.3%) in outside directed activity (Figure 2.2). Because activity directed outside the park was rare, it was subsequently excluded from all other analyses.

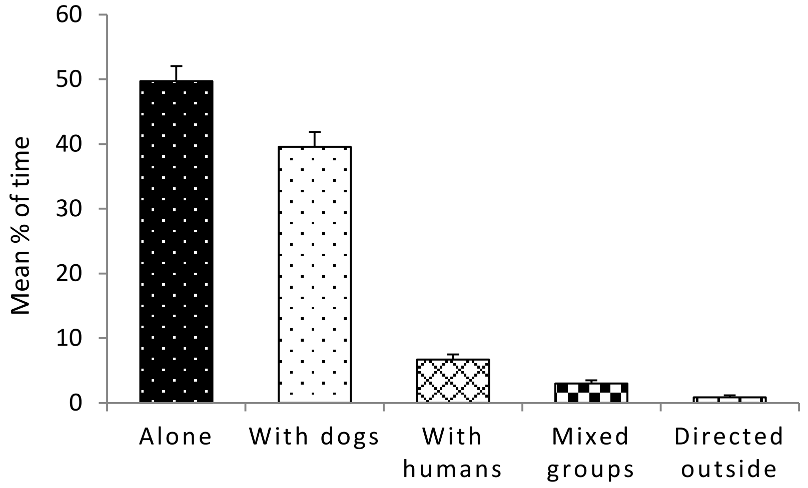

Figure 2.2 Mean % (±SE) of time focal dogs (n=69) spent in time budget states over the entire 400 s observation period.

2.3.1.2 Activity Time Budgets Across Time Bins (n=69, all focal dogs)

The way focal dogs spent their time significantly differed across the observation period (Figure 2.3). The percentage of time focal dogs spent with dogs linearly decreased ($F_{1, 68}=49.318$, $p<0.001$) and the percentage of time spent alone linearly increased ($F_{1, 68}=34.54$, $p<0.001$) across time bins. The percentage of time spent with humans and in mixed groups did not change across the six 60 s time bins.

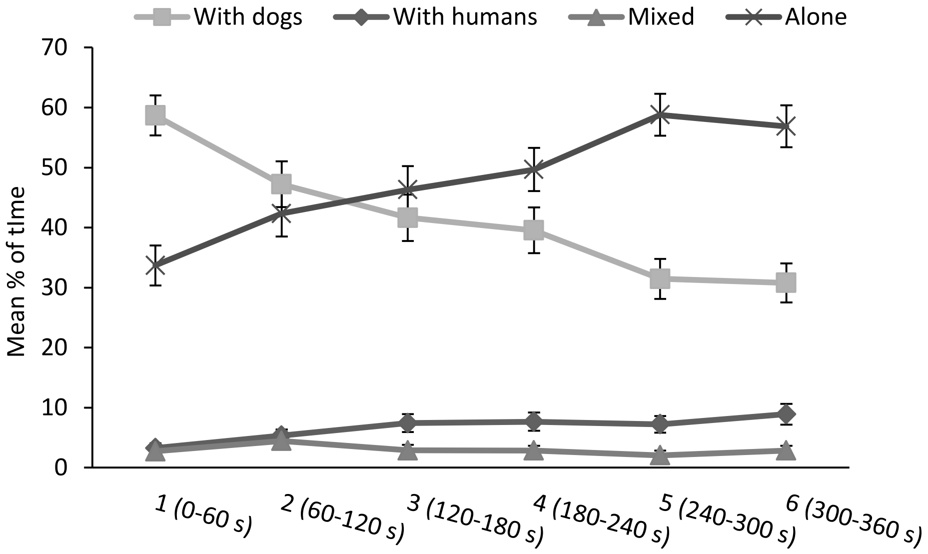

Figure 2.3 Mean % (±SE) of time focal dogs (n=69) were involved in time budget activity states during six 60 s time bins across the 400 s observation period.

2.3.1.3 Focal dog sex and age (n=45, focal dogs of known sex and age)

Time with dogs. A main effect of focal dog age, as well as a significant interaction between focal dog sex and age, was detected for the percentage of time focal dogs spent with dogs across the 400 s observation period (F values in Table 2.3). Post-hoc tests showed that older female focal dogs spent a significantly smaller percentage of time with dogs compared to all other groups, i.e., younger female focal dogs, younger male focal dogs and older male focal dogs (Table 2.3; Figure 2.4a). The percentage of time spent with dogs did not differ between any other focal dog sex by age comparison groups.

Table 2.3

Influences of focal dog sex and age on percentage of time focal dogs spent with dogs and alone. Detected effect(s), group sample size (n), F values, p-values, and statistical tests are reported. Statistically significant test statistics and p-values are **bolded**.

States	Comparison group (n)	Detected effect(s)	F	p-value	Test
With dogs	YF(11)	Sex *Age	**5.82**	**0.020**	2WA
	OF(10)	YF>OF	**14.90**	**<0.001**	LSD
	YM(10)	YF=YM	0.44	0.511	LSD
	OM(14)	OF<OM	**7.88**	**0.008**	LSD
		OM=YM	0.32	0.575	LSD
		YM>OF	**9.75**	**0.003**	LSD
		YF=OM	1.69	0.201	LSD
		Age[a] Y>O	**10.18**	**0.003**	
Alone	Y(21) O(24)	Age Y<O	**7.59**	**0.009**	2WA

Note. [a] detected in the presence of a sex by age interaction.
F=female; M=male OF= Old female; O=Older (greater than or equal to 18 months);
Y=younger(less than 18 months);
2WA=two-way ANOVA including sex and age; LSD= least squared difference post-hoc test.

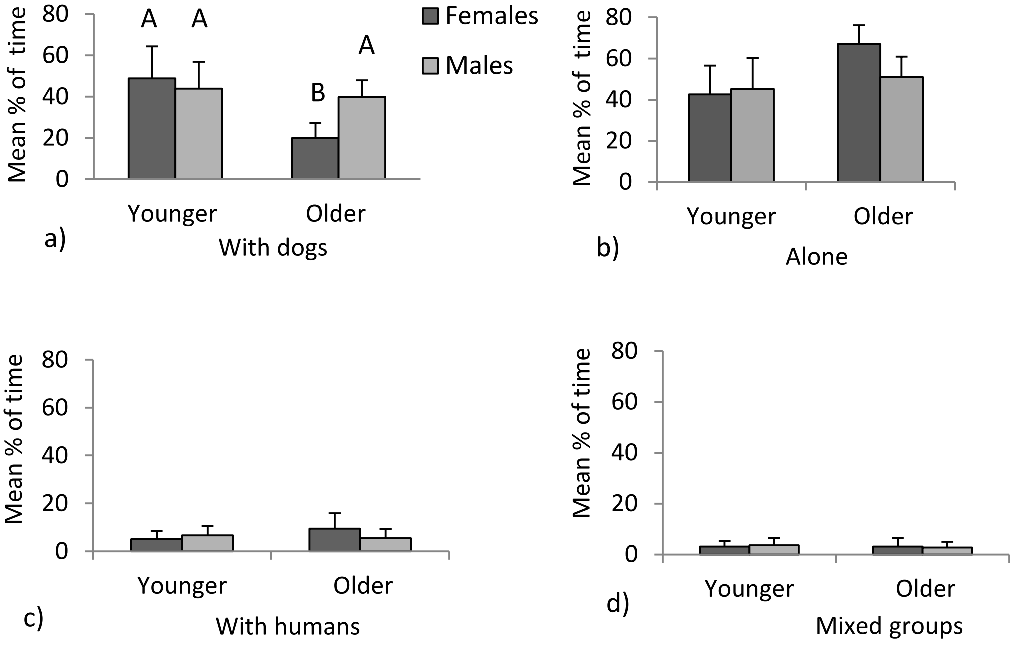

Figure 2.4 Mean percent of time (95% CIs) in time budget states a) with dogs, b) alone, c) with humans, and d) mixed groups over the 400 s observation period by focal dog sex and age. Different letters above bars indicate a significant difference, $p<0.05$ Younger female (n=11) and male (n=10) focal dogs were less than 18 months (median ages 11 and 12 months, respectively), and older female (n=10) and male (n=14) focal dogs were greater than or equal to 18 months (median ages 32 and 42 months, respectively).

Time alone. Focal dogs in the older age group spent a significantly greater percentage of time alone compared to younger focal dogs across the 400 s observation period (Table 2.3; Figure 2.5). There was no significant interaction between focal dog sex and age for the percentage of time spent alone (Figure 2.4b). However, there was a non-significant trend for older females to spend more time alone than other sex-age groups (Figure 2.4b).

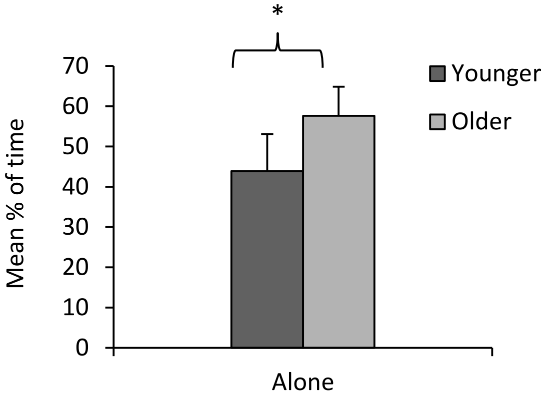

Figure 2.5 Mean percent of time (95% CIs) spent alone over the 400 s observation period for younger (n=21) and older (n=24) focal dogs, * $p<0.05$. Younger focal dogs were less than 18 months (median age 12 months.) and older focal dogs were greater than or equal to 18 months (median age 36 months).

<u>Time with humans and in mixed groups.</u> No main effects or interactive effects related to focal dog sex or age were detected for time with humans and in mixed groups. (Figure 2.4 c & d).

2.3.1.4 Dog density (n=68 focal dogs), focal dog size (n=69, all focal dogs), and neuter status (n=59 focal dogs)

Neither dog density, size, nor neuter status significantly influenced the percentages of time focal dogs spent in any activity states.

2.3.2 Canid Event Analyses

2.3.2.1 Canid event frequencies (n=69, all focal dogs)

Percentages of focal dogs that initiated and received canid events over the 400 s observation period varied considerably (Table 2.4). Nearly all focal dogs initiated at least one snout-muzzle event toward conspecifics: 91% of focal dogs initiated snout-muzzle to anogenital area and 94% initiated snout-muzzle to head events. Virtually all (99%) focal dogs received snout-muzzle to anogenital area and snout-muzzle to head events from conspecifics. Focal dog involvement in other recorded events was much more variable, and generally, occurred less frequently. The percentage of focal dogs for which non-contact events were recorded ranged from 4% (roll-over received by focal dogs) to 59% (exaggerated away initiated by focal dogs). The single type of joint movement coded, chase, was initiated and received by 55% and 78% of focal dogs, respectively. Unidirectional physical contact was initiated by 23% of focal dogs, whereas it was received by 42% of focal dogs. The percentage of focal dogs for which unidirectional physical contact subtypes were recorded ranged from 4% (mounts received by focal dogs) to 32% (paw body received by focal dogs). The physical contact event, wrestle, was recorded at least once for 22 % of focal dogs. Finally, 62% of focal dogs eliminated at least once during any time budget activity state.

Table 2.4

Percentage of focal dogs (n=69) that initiated, received, or participated in canid events and event mean rates. Mean rates represent the mean frequency of events per minute, calculated for the 400 s observation period upon or shortly after dog park entry.

Canid event rate	Initiated		Received	
	Percent of focal dogs	Mean rate (±SE)	Percent of focal dogs	Mean rate (±SE)
Snout-muzzle con.	**99%**	**1.64(0.14)**	**100%**	**2.02(0.16)**
To anogenital area	91%	0.72(0.07)	99%	1.04(0.10)
To head	94%	0.92(0.09)	99%	0.97(0.08)
Non-contact	**80%**	**0.90(0.14)**	**68%**	**0.47(0.08)**
Drop belly to ground	6%	0.01(0.01)	--	--
Exaggerated away	59%	0.37(0.07)	45%	0.20(0.05)
Hunched posture	--	--	--	--
Lunge approach	9%	0.04(0.02)	12%	0.03(0.01)
Play bow	23%	0.08(0.02)	--	--
Pull-rear away	48%	0.20(0.04)	33%	0.11(0.03)
Roll-over	--	--	4%	0.01(0.01)
Run/leap self-present	41%	0.20(0.05)	36%	0.12(0.03)
Sit	--	--	--	--
Joint movement	**55%**	**0.29(0.05)**	**78%**	**0.61(0.07)**
Chase	55%	0.29(0.05)	78%	0.61(0.07)
Physical contact	**33%**	**0.27(0.09)**	**48%**	**0.48(0.10)**
Unidirectional	23%[a]	0.11(0.04)	42%[a]	0.32(0.07)
Leap-on	--	--	--	--
Mount	--	--	4%	0.01(0.00)
Open-jaw	16%	0.09(0.04)	22%	0.11(0.03)
Paw body	--	--	32%	0.13(0.03)
Paw head	--	--	16%	0.05(0.02)
Paws around body	9%	0.02(0.01)	--	--
Pin	--	--	--	--
Slam	--	--	10%	0.02(0.01)
Bidirectional	22%	0.16(0.05)	22%	0.16(0.05)
Wrestle	22%	0.16(0.05)	22%	0.16(0.05)
Elimination	**62%**	**0.03(0.04)**	n/a	n/a

Note. "--" canid events excluded due to insufficient reliability.

Except for elimination, **bolded** categories are intended for descriptive purposes only (i.e., were not statistically analyzed) and are proportions of dogs for which at least one reliable canid event in that category was recorded.

[a] Percentage of dogs for which at least one reliable unidirectional physical contact subtype in italics was recorded.

2.3.2.2 Rates of snout-muzzle events initiated and received (n=69, all focal dogs)

Rates of snout-muzzle contact to anogenital area events were initiated by focal dogs at significantly lower rates than snout-muzzle contact to head events (Z=2.07, p=0.036; Table 2.4). However, rates of snout-muzzle contact to anogenital area events received by focal dogs did not differ from rates of snout-muzzle contact to head events received by focal dogs (Z=0.45, p=0.656; Table 2.4).

2.3.2.3 Elimination rates across time bins (n=69, all focal dogs)

Elimination rates of focal dogs did not differ over the observation period, as no differences were detected among the six 60 s time bins (data not shown; Friedman test: $X^2_{5, N=69}$=7.09, p=0.21).

2.3.2.4 Main effects of dog density (n=68 focal dogs)

Dog density was associated with several canid events measured over the 400 s observation period. Not surprisingly, snout-muzzle behaviours occurred at higher rates at higher (vs. lower) dog densities (F and Chi square values shown in Table 2.5; Figure 2.6). Focal dogs in the higher density group received significantly higher rates of snout-muzzle to anogenital area and snout-muzzle to head events from conspecifics than those in the lower density group. Focal dogs in the higher density group also initiated marginally higher rates of snout-muzzle to head events toward conspecifics. The only snout-muzzle event that did not differ across density groups was snout-muzzle to anogenital area initiated by focal dogs (Figure 2.6).

Table 2.5

Dog density influences on canid events. Detected effect(s), F or χ^2 values, p-values, and statistical test used (ANOVA or nonparametric) are reported. For lower dog density (L), n=33; higher dog density (H), n=35. Statistically significant test statistics and p-values are **bolded**.

Canid event	Detected effect(s)	F	χ^2	p-value	Test
Snout-muzzle to anogenital area received	Density H>L	**6.71**	--	**0.012**	1WA$^{\mathbf{t}}$
Snout-muzzle to head Initiated	Density H>L	3.66	--	0.060	1WA$^{\mathbf{t}}$
Snout-muzzle to head received	Density H>L	**5.08**	--	**0.028**	1WA$^{\mathbf{t}}$
Lunge approach initiated	Density H<L	--	**5.72**	**0.023**	MT
Unidirectional physical contact initiated	Density H>L	--	**9.54**	**0.003**	MT
Open-jaw contact initiated	Density H>L	--	**4.84**	**0.045**	MT

Note. L=mean of less than 4 dogs present; H=mean of greater than or equal to 4 dogs present.

1WA=One-way ANOVA; MT= Median test; $^{\mathbf{t}}$=analysis performed on Log_{10}X+0.5 transformed data.

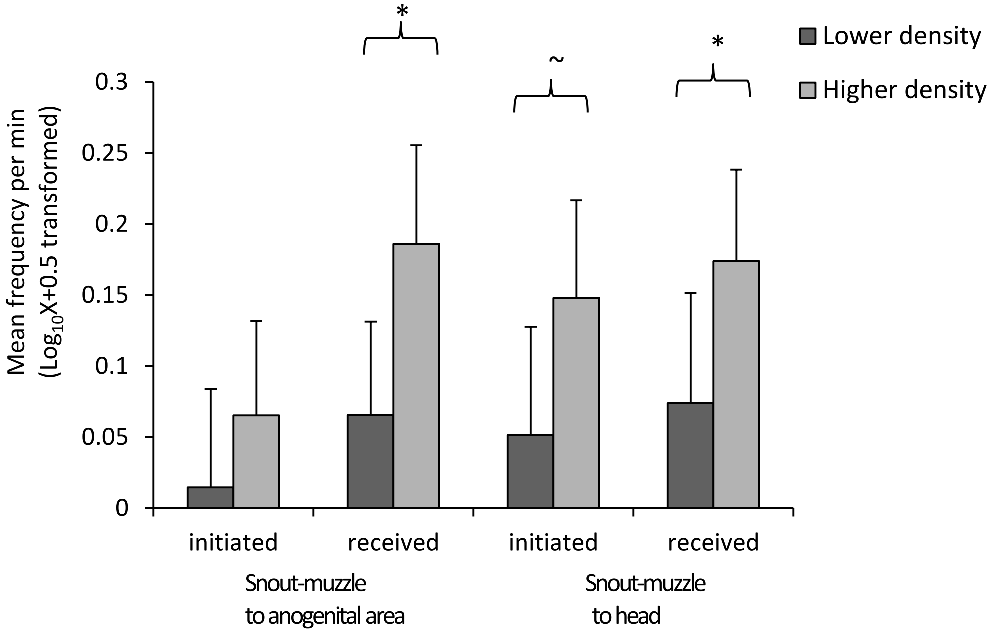

Figure 2.6 Mean rates (95% CIs) of snout-muzzle contact events initiated and received by focal dogs over the 400 s observation period at lower and higher dog densities, *$p<0.05$,~$p=0.05$-0.06. Focal dogs at lower densities (n=33) were with a mean of less than 4 conspecifics (median = 2.6). Focal dogs at higher densities (n=35) were with a mean of greater than or equal to 4 conspecifics (median = 5.3).

Median tests showed rates of total unidirectional physical contact initiated by focal dogs, and one of the subtypes of unidirectional physical contact, open-jaw contact initiated by focal dogs, occurred at significantly higher rates in the higher density group (Table 2.5; Figure 2.7). Only lunge approach events initiated by focal dogs occurred at significantly higher rates in the lower compared to higher density group (Table 2.5; Figure 2.7). Notably, no focal dogs initiated lunge approach in the high density group. No significant influences of dog density were detected for rates of joint movement or focal dog elimination events.

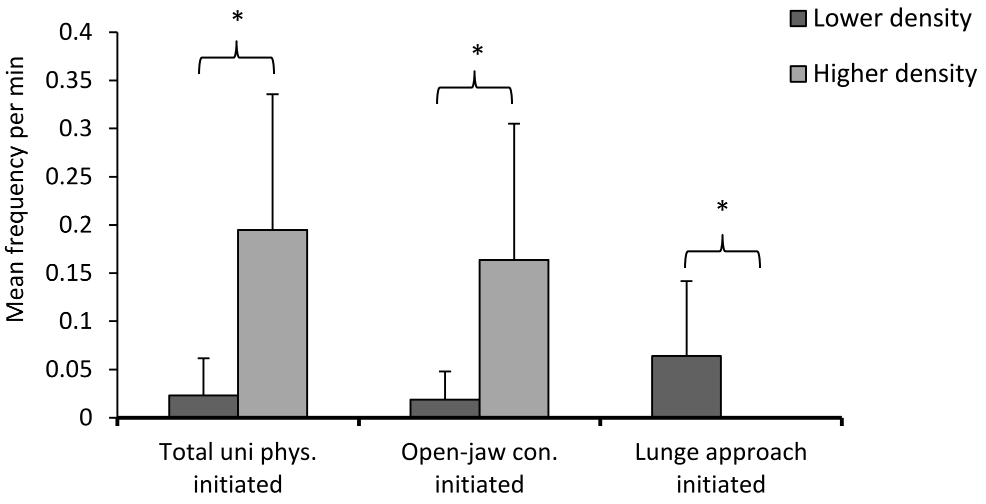

Figure 2.7 Mean rates (95% CIs) of unidirectional physical contact, open-jaw contact, and lunge approach, initiated by focal dogs over the 400 s observation period at lower and higher dog densities,*p< 0.05. Focal dogs at lower densities (n=33) were with a mean of less than 4 conspecifics (median = 2.6). Focal dogs at higher densities (n=35) were with a mean of greater than or equal to 4 conspecifics (median = 5.3).

2.3.2.5 Focal dog sex by age (n=45, focal dogs of known sex and age)

Two sex by age interactions related to the canid events, chase and wrestle, measured over the 400 s observation period were revealed. Younger focal dogs generally initiated chase at higher rates than older focal dogs (Chi square values in Table 2.6; Figure 2.8a). Younger females initiated chase at higher rates than older females, and at marginally higher rates than older males (Table 2.6; Figure 2.8a). Younger males also initiated higher rates of chase than older females (Table 2.6; Figure 2.8a). Rates of chase events initiated did not significantly differ between younger males compared to older males or between older females compared to older males. Younger focal dogs had higher rates of wrestle events than older focal dogs (Table 2.6; Figure 2.8b). However, higher rates of wrestle events were only detected for younger female focal dogs compared to older female (no wrestle events were recorded for older females) and older male focal dogs (Table 2.6; Figure 2.8b). No significant sex by age influences were detected for rates of any snout-muzzle contact events, non-contact events, or focal dog elimination.

Table 2.6

Focal dog sex, age, size, and neuter status influences on canid events. Detected effect(s), F or χ^2 values, p-values, group sample size (n), and statistical tests (ANOVA or nonparametric) are reported. Statistically significant test statistics and p-values are **bolded**.

Canid events	Comparison group (n)	Detected effect(s)	F	χ^2	p-value	Test
Chase initiated	YF(11)	Sex*Age	--	--	--	--
	OF(10)	YF>OF	--	**5.69**	**0.016**	KW
	YM(10)	YF=YM	--	0.50	0.513	KW
	OM(14)	OF=OM	--	0.02	0.924	KW
		OM=YM	--	2.50	0.118	KW
		YF>OM	--	3.74	0.054	KW
		YM>OF	--	**7.20**	**0.023**	MT
	Y(21) O(24)	Age[a] Y>O	--	**7.8**	**0.004**	KW
Wrestle	YF(11)	Sex*Age	--	--	--	--
	OF(10)	YF>OF	--	**9.55**	**0.004**	MT
	YM(10)	YF=YM	--	4.07	0.080	MT
	OM(14)	OF=OM	--	0.12	0.239	MT
		OM=YM	--	0.03	0.804	KW
		YM=OF	--	2.22	0.474	MT
		YF>OM	--	**4.57**	**0.049**	MT
	Y(21) O(24)	Age[a] Y>O		**5.28**	**0.039**	MT
Snout-muzzle to head initiated	Y(21) O(24)	Age Y>O	**4.61**	--	**0.038**	2WA[t]
Elimination	Y(21) O(24)	Age Y<O	**4.37**	--	**0.043**	2WA[t]

(Table continues)

Canid events	Comparison group (n)	Detected effect(s)	F	χ^2	p-value	Test
Drop belly to ground initiated	F(29) M(40)	Sex F>M	--	**5.86**	**0.028**	MT
Paws around body initiated	F(29) M(40)	Sex F<M	--	**4.76**	**0.036**	MT
Elimination	F(29) M(40)	Sex M>F	**11.77**	--	**0.001**	$1WA^{t}$
Running/leaping self-present received	S(15) L(59)	Size S>L	--	**4.70**	**0.039**	MT
Snout-muzzle to anogenital area initiated	Nt(47) In(12)	Neuter status Nt<In	3.81	--	0.056	$1WA^{t}$

Note. ^{a} detected in presence of sex by age interactive effects
Nt= neutered; In= intact; F=female; M= male; O=older (greater than or equal to 18 months); Y=younger(less than18 months); L= larger (greater than or equal to 25lbs); S=smaller (less than 25lbs).
KW=Kruskall-Wallis; MT= median test; 2WA=two-way ANOVA including sex and age; 1WA=one-way ANOVA; ^{t}=analysis performed on $Log_{10}X+0.5$ transformed data.

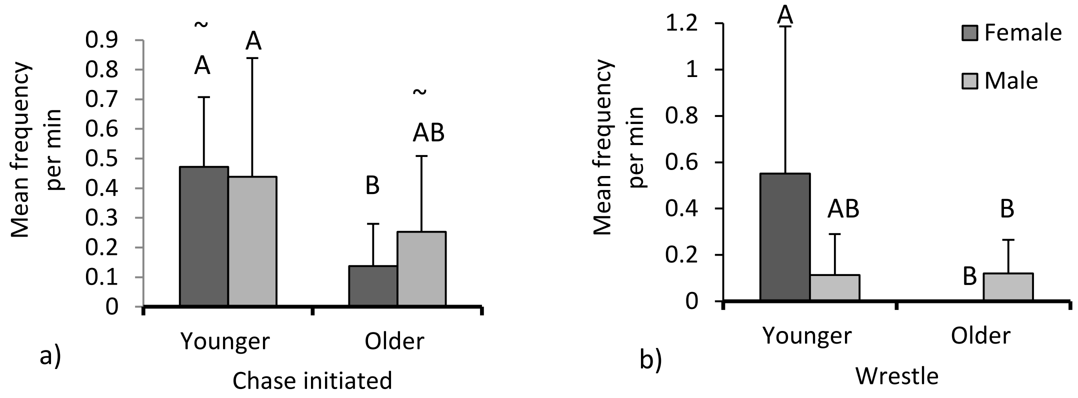

Figure 2.8 Mean rates (95% CIs) of focal dog initiated chase (a) and wrestle events (b) over the 400 s observation period by focal dog sex and age. Different letters above bars indicate a significant difference (p<0.05); ~ above the same letter indicates a marginal difference (p=0.05-0.06).Younger female (n=11) and male (n=10) focal dogs were less than 18 months (median ages 11 and 12 mos., respectively), and older female (n=10) and male (n=14) focal dogs were greater than or equal to 18 months (median ages 32 and 42 months, respectively).

2.3.2.6 Main effects of focal dog age (n=45, focal dogs of known sex and age)

As measured over the 400 s observation period, main effects of focal dog age were also detected for two canid events for which no sex by age interactions were evident (F and Chi square values in Table 2.6). Younger focal dogs initiated significantly higher rates of snout-muzzle contact to head events toward conspecifics than older focal dogs (Table 2.6; Figure 2.9a). Older focal dogs had significantly higher rates of elimination compared to younger focal dogs (Table 2.6 Figure 2.9b). No significant main effects of focal dog age, in the absence of a sex by age interaction, were detected for any non-contact, joint movement, or physical contact events.

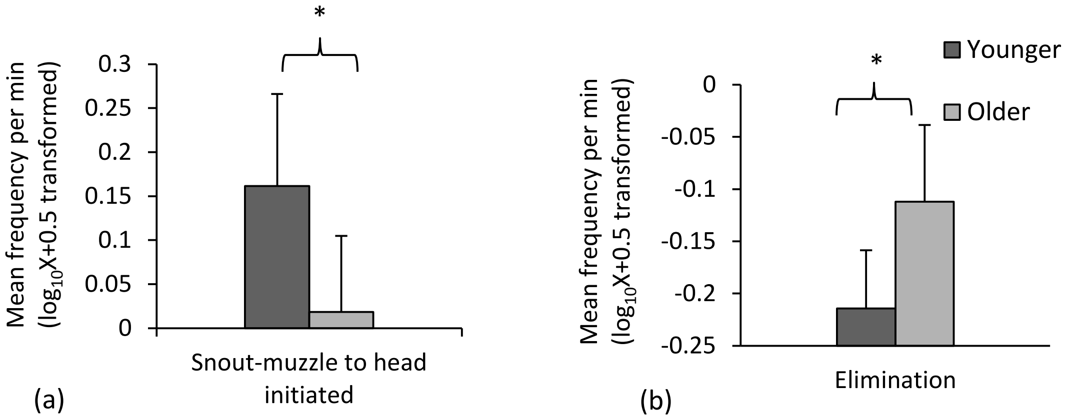

Figure 2.9 Mean rates (95% CIs) of snout-muzzle to head events initiated (a) and elimination (b) over the 400 s observation period for younger (n=21) and older (n=24) focal dogs, *p<0.05. Younger focal dogs were less than 18 mos (median age 12 months.) and older focal dogs were greater than or equal to18 months (median age 36 months).

2.3.2.7 Main effects of focal dog sex (n=69, all focal dogs)

When main effects of focal dog sex were analyzed in the reduced subset for which focal dog age was collected (n=45), no sex differences were detected for any events. However, three canid events were associated with focal dog sex in the analysis of the full sample of 69 focal dogs over the 400 s observation period. Male focal dogs never initiated drop belly to ground; hence, the rates for female focal dogs (mean frequency of 0.032 per min) were significantly higher (Table 2.6). Conversely, paws around body was never initiated by female focal dogs, and thus, rates were higher among male focal dogs (mean frequency of 0.035 per min; Table 2.6). Rates of focal dog elimination were higher among male compared to female focal dogs (Table 2.6; Figure 2.10). Similarly, a greater proportion of male compared to female focal dogs (75% vs 45%, respectively) eliminated at least once in the park (Pearson Chi square: $\chi^2_{1, N=69}=6.52$, p=0.013). No significant main effects of focal dog sex were detected for any snout-muzzle contact or joint movement events.

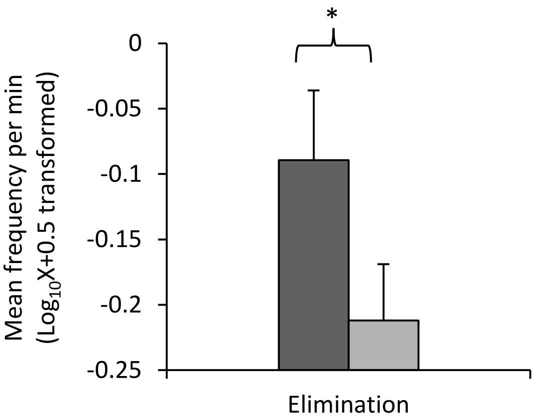

Figure 2.10 Mean rate (95% CIs) of elimination initiated over the 400 s observation period for male (n=40) and female (n=29) focal dogs, *p<0.05.

2.3.2.8 Main effects of focal dog size (n= 69, all focal dogs) and neuter status (n=59 focal dogs)

Based on measurements over the 400 s observation period, both focal dog size and neuter status were associated with just one type of canid event each. Smaller focal dogs received higher rates of running/leaping self-present events from conspecifics compared to larger focal dogs (Table 2.6; Figure 2.11), and intact focal dogs initiated marginally higher rates of snout-muzzle to anogenital area events toward conspecifics compared to neutered focal dogs (Table 2.6; Figure 2.12).

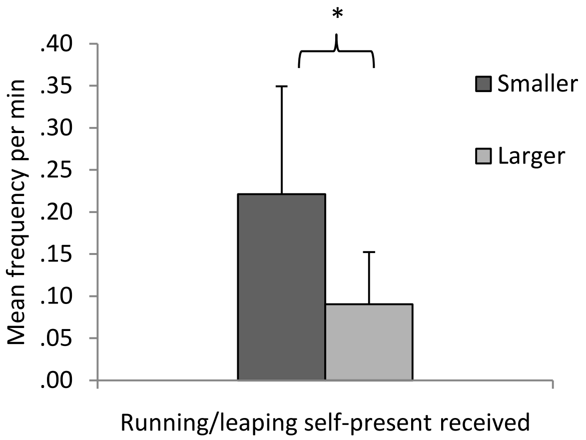

Figure 2.11 Mean rate (95% CIs) of running/leaping self-present received by smaller (n=15) and larger (n=54) focal dogs over the 400 s observation period, *p<0.05. Smaller focal dogs were less than 25 lbs and larger focal dogs were greater than or equal to 25lbs.

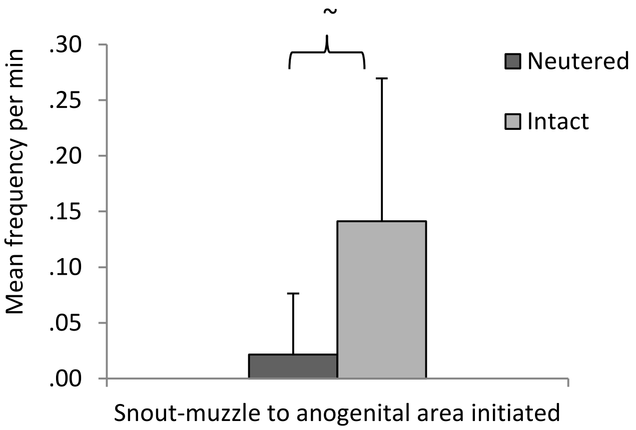

Figure 2.12 Mean rate (95% CIs) of snout-muzzle contact to anogenital area events initiated by neutered (n=47) and intact (n=12) focal dogs over the 400 s observation period, ~p=0.05-0.06.

2.4 Discussion

The present study describes selected dog-dog behaviours in a motivationally-neutral manner during the first minutes of a public dog park visit for 69 focal dogs. Time budget analyses indicated that focal dogs did not engage in all dog park activities equally, and that involvement in some activities changed over the first 6 min upon (or very soon after) park entry. Activity between focal dogs and conspecifics included a range of canid behaviours that occurred with varying degrees of frequency. Dog density in the park and focal dog sex, age, size and neuter status influenced some activities and behaviours that focal dogs initiated toward or received from conspecifics in the park.

2.4.1 How Did Focal Dogs Spend Their Time?

How focal dogs spent their time was investigated by measuring the percentage of time that focal dogs spent with dogs, with humans, in mixed (dog-human) groups, and alone.

Over the first 400 s commencing upon or very close to park entry, focal dogs on average spent half (50%) of the time alone, almost 40% of the time involved in direct social exchanges with other dogs only, and the remaining time with humans (7%) in mixed (dog-human) groups (3%), and activity directed outside the park (1%). Social exchanges exclusively between focal dogs and conspecifics were highest during the first minutes and then decreased steadily over subsequent minutes, levelling out to approximately 30% by the fifth minute. The opposite trend was observed for the percentages of time that focal dogs spent alone, which increased to approximately 60% of their time in the fifth and sixth minutes of observation period. Comparable to findings here, Westgarthe et al. (2010) found that dogs on walks (both on- and off-leash) interacted less frequently with humans compared to other dogs. Also, greater levels of contact and interactive behaviours (i.e., play or sniffing) have been previously reported for dog pairs introduced in a non-dog park context during the first several minutes compared to later minutes, especially between unfamiliar dogs (Pullen et al., 2013). The inverse association between time focal dogs spent alone and exclusively with other dogs over the observation period suggests that initial social exchanges between focal dogs and other dogs are gradually replaced by transitioning between social encounters, exploring of the environment, observing others in the park, or possibly resting. However, since activities performed in the alone state were not explored in this work, thorough examination of what dogs do when alone should be addressed by future studies.

Ottenheimer Carrier et al. (2013) reported time budgets for focal dogs observed in the Quidi Vidi dog park from the start of a dog’s visit for a continuous 20 min period. On average, their focal dogs spent approximately 33% of time alone, 23% of time with other dogs, 20% of time with humans and 24% of time in mixed groups. These time budgets differ considerably from those measured here over the first 400 s following or close to entry; focal dogs in the present study, on average, spent both more time alone (+17%) and with dogs (+16%), and less time with both humans (-13%) and in mixed groups (-21%). Extrapolating from trends in time budgets observed across the first 6 min of focal dog visits in the present study cannot approximate the overall time budget percentages reported by Ottenheimer Carrier et al. (2013). Therefore, some other factor(s) besides observation period duration must be responsible for discrepancies in time budgets across studies. Most importantly, it is necessary to consider that time budget differences may have been due to how time budget states were defined.

There were two main differences between coding definitions used to code time budgets in the present study and Ottenheimer Carrier et al. (2013). First, Ottenheimer Carrier et al. (2013) counted games of fetch as time spent with humans, even when dogs moved beyond 1-1.5 Lab lengths from their human partner. However, in the present work, a dog running after a ball thrown by a human was no longer considered to be involved with the human once the dog moved beyond 1 Lab length from the human and the human did not follow. Compared to Ottenheimer Carrier et al. (2013), this coding difference may have resulted in lower estimates of focal dog time spent in human-based states. Second, social activities in Ottenheimer Carrier et al. (2013) were based only on whether or not focal dogs and individuals were within 1-1.5 Lab lengths of each other. In contrast, social activities were judged in the present study by whether focal dogs and individuals were both within 1 Lab length *and* whether or not identified behaviour exchanges occurred. This more restrictive criteria may have led to lower estimates of time focal dogs spent in all three social states (with dogs, with humans, and mixed groups) and higher estimates of focal dog time spent alone. An additional but minor coding definition difference in time budgets across studies is that Ottenheimer Carrier et al. (2013) did not include a category akin to activity directed outside the park. However, the inclusion of this category in the present work likely had a negligible impact on any time budget differences calculated across studies as it only accounted for a small portion (1%) of focal dog time. In any respect, future work should apply coding definitions used by Ottenheimer Carrier et al. (2013) to a 400 s observation interval or, conversely, apply the definitions used by the present study to a 20 min observation interval, in order to more definitively determine whether coding definitions lead to time budget differences observed across studies.

Despite potential definitional issues across studies, it is also possible that extrapolations of time trends in time budgets found in the present study could not approximate overall time budgets of Ottenheimer Carrier et al. (2013) because trends in focal dog activities change beyond the first 6 min (360 s) of a visit. For example, beyond the initial 6 min, the percentage of time focal dogs spend alone may begin to show a negative relationship with visit minutes, and percentage of time focal dogs spend with humans and in mixed groups may begin to increase more sharply. Such changes in trends do make some practical sense. After all, an eventual decrease in time spent alone and with dogs would not be surprising as focal dogs might begin to find the park environment and other dogs in it less novel, or become tired the longer that they are in the park. An increase in human-based activities (i.e., with humans, in mixed groups) over-time would also not be unexpected, since focal dog owners might increase their efforts to engage dogs in order to get them to leave. The relative differences between overall time budgets in both the present work and Ottenheimer Carrier et al. (2013) are not inconsistent with this hypothesis.

The percentages of time focal dogs spent with other dogs was influenced by an interaction between focal dog sex and age; older females spent less time exclusively with dogs compared to all other sex/age combinations. There was also a main effect of age on percentage of time that focal dogs spent alone, where compared to younger dogs, older dogs spent more time alone. Despite there being no sex by age interaction detected for the percentage of time focal dogs spent alone, older females did show a non-significant tendency towards the highest percentage of time spent in the alone state. Therefore, it appears that much of the time that older female focal dogs did not spend with dogs was spent being alone. It does not seem plausible that the lower level of intraspecific activity in older females was due to decreased physical ability, as even older females were relatively young (median age of less than 3 years). Nor were older females older than the older males. In fact, the age disparity between younger and older females (median ages of 11 vs. 31 months, respectively) was less than that of younger and older males (median ages of 12 vs. 42 months, respectively). Thus, this pattern suggests that lower conspecific-oriented activity in older females was due to diminished interest or other reasons (i.e., older females may have been more selective about partners), not reduced physical ability. Of possible relevance to the findings in the present work, Starling, Branson, Thomson, and McGreevy (2013) reported sex and age differences in the personality trait of “boldness” in companion dogs, as assessed via owner surveys. Boldness, a trait positively associated with play, and negatively associated with avoidance and fearful behaviours, was greater in males compared to females, and decreased with age. Starling et al. (2013) did not report on sex by age interactions. Therefore, it is not exactly clear how their findings fit with sex by age interactions of the present work.

Based on regression analyses, Ottenheimer Carrier et al. (2013) also detected a sex by age interaction for percentage of time focal dogs spent specifically in dyads with dogs in the Quidi Vidi dog park. No comments can be made on precisely how percentage of time spent in dog dyads differed across age for male compared female focal dogs (e.g., whether percentage of time in dog dyads decreased or stayed the same with age for males, increased or stayed the same across age for females), as Ottenheimer Carrier et al. (2013) did not report simple regression coefficients and p-values associated with the interaction term. However, it was reported that younger male focal dogs spent a greater percentage of time in dog dyads than females of any age. These described trends indicate at least one contrast related to sex by age influences across studies, as in the present study, percentages of time spent with dogs did not differ between younger males and younger females. Presumably, as with overall time budget patterns, the differences between studies could reflect the influence of differing observation durations (i.e., observing dogs for 400 s vs 20 min), definitions of social activity (i.e., defining social activity by distance between dogs only vs distance and behaviours exchanged), and dog groupings (i.e., analysing dyadic and group activity separately or combined). In any case, although sex by age influences differed in at least one way across studies, there does to seem to be some combined influence of sex and age on focal dog activity with conspecifics that should be investigated further.

Bauer and Smuts (2007) also found that dog sex influenced the level of involvement in dog-dog interactions in a dog park setting. Specifically, they found males were involved in fewer dyadic play bouts, especially those that involved male partners.

From this, it was hypothesized that males may be more likely to avoid play to avoid dominance competitions related to intrasexual competition. However, in the present work, it was older female focal dogs that showed a lower percentage of time with dogs than all other sex by age comparison groups (younger females, younger males, and older males), which did not differ from each other. These findings suggest that older females, may be more avoidant of conspecifics when observations of activity with other dogs are not restricted to play. No statement can be made here on whether male and female focal dogs were involved equally with male and female conspecifics, as this was not assessed in the present study. Further work is needed to clarify whether dogs appear to generally avoid or engage in interactions with conspecifics of a particular sex during the beginning minutes of a dog park visit (e.g., by analyzing occurrence of focal dog dyads formed with different sex partners).

2.4.2 What Did Focal Dogs Do When They Were With Other Dogs?

In addition to investigating how focal dogs spent their time in the park, this study addressed what dogs did in the dog park with conspecifics by evaluating the occurrence of various forms of canid behaviours including types of snout-muzzle contact, non-contact, physical contact, and joint contact initiated and received by focal dogs. Focal dog elimination during any state and over time was also examined.

2.4.2.1 Snout-muzzle contact events

Unlike most other canid events, snout-muzzle contact to both the head and anogenital areas was highly ubiquitous in the dog park, having been initiated and received by the vast majority of focal dogs. This is consistent with previous work that has reported high levels of similar behaviours between dogs in dog parks. Data reported by Bradshaw and Lea (1992) indicated that the behaviours head to head (one dog positions nose close to head of other dog) and head to tail (one dog positions nose close to anal/genital areas of other dog) were among the top five most frequently coded behaviours (i.e., out of a total of 24) observed during spontaneously formed dog dyads. Also, within approximately one minute of a visit to the Quidi Vidi dog park, O'Leary (2014) found 50% of entering focal dogs initiated and 70% received anogenital investigations. There are numerous locations on the head and anogenital areas that may provide socially relevant chemosensory cues to dogs. For instance, according to a review on sources of chemosensory cues in canids (Harrington & Asa, 2003), information on the head may come from saliva, sebaceous secretions (i.e., from the lips), and/or ear-related secretions. Examples of anogenital region sources include urine, skin glands, anal sacs, and in females, vaginal secretions. It is also conceivable that remnants of substances that recently contacted the head or anogenital areas are also of interest to dogs (e.g., food or secretions from other individuals). Although not specifically addressed in this work, it is possible that information transferred during snout-muzzle contact was processed by olfaction (i.e., via sniffing), gustation (i.e., via licking), as well as other sensory systems; for instance, tactile exchanges (i.e., contact made with the snout/muzzle or tongue) may also be relevant components of this behaviour. In any case, since dogs that meet in the dog park are often from different households, the high prevalence of snout-muzzle to the head and anogenital area suggests that information obtained by such behaviours plays a key role in the social process that unfolds between dogs that are unfamiliar with one another.

Snout-muzzle to head events were initiated at a higher rate than snout-muzzle to anogenital area events. Various possibilities could account for this result. One obvious possibility could be that focal dogs were more interested in collecting or conveying information encoded in the head area. Alternatively, snout-muzzle to anogenital area may have been initiated at lower rates because focal dogs were more selective about which dogs they directed anogenital contact towards. One possibility is that because the location of the anogenital area could make individuals that approach this area less visible to the recipient, their intentions might be more likely to be misinterpreted. Therefore, avoiding anogenital contact with some individuals might help avoid potential conflict. By way of similar logic, snout-muzzle to head contact may permit some investigation of conspecifics when they are fully visible and easier to visually monitor. Notably, since focal dogs in the present sample were relatively new park arrivals, and thus likely not yet fully familiar with the current social context, they may have had particular reason(s) to be cautious about how they approached and were approached by conspecifics. Further study is needed to help verify the possible reasons that focal dogs initiated lower overall rates of snout-muzzle to anogenital area events.

Dog density influenced several forms of snout-muzzle contact. Consistent with a greater opportunity for dogs to exchange behaviour when more dogs were present, focal dogs observed at higher dog densities received more snout-muzzle contact to anogenital area events and snout-muzzle contact to head events from conspecifics, and initiated marginally more snout-muzzle contact to head events toward conspecifics compared to those observed at lower dog densities. Interestingly, snout-muzzle to anogenital area initiated by focal dogs was the only type of snout-muzzle contact event that did not show a relationship with dog density. This pattern replicates O'Leary (2014), who reported that while anogenital snout-muzzle contact received by focal dogs entering Quidi Vidi dog park increased as the number of non-focal dogs waiting by the inside park gate increased, this relationship was not observed for anogenital snout-muzzle contact initiated by focal dogs. Further work is needed to understand why initiating snout-muzzle to anogenital area events does not appear to be associated with dog density, and thus opportunity, for newly arriving focal dogs.

Not surprisingly, neuter status also affected snout-muzzle contact behaviour. Specifically, snout-muzzle to anogenital area events were initiated by sexually intact focal dogs toward conspecifics at a marginally higher rate compared to neutered focal dogs. This trend suggests that intact individuals had greater interest in information relating to another's potential as a mate (i.e., sex, sexual receptivity or quality) or competitor than neutered individuals. Bradshaw and Lea (1992) measured the frequency of head to tail events between dog dyads in a dog park setting, but did not collect information on dog neuter status. However, they did report that three times as many head to tail events were recorded for male compared to female dogs during dyadic interactions. In contrast, in the present work focal dog sex was not associated with the rate of anogenital snout-muzzle contact, either in the subset of dogs used to analyze the interaction of sex with age (n=45), or in the full sample for which sex information was available (n=69). It is possible that the association between sex and anogenital snout-muzzle contact initiated was not detectable given the sample size used in the present study as Bradshaw and Lea (1992) observed more than twice the number of dogs. It is also possible that proportion of neutered dogs differed between studies, as positive attitudes toward neutering may be more commonplace in North America than Europe (Kustritz, 2007).

Lastly, snout-muzzle contact was also influenced by age, as younger focal dogs more often initiated snout-muzzle contact to the head of conspecifics than older focal dogs. Since some forms of head contact have been proposed to function as submission in canids (Cafazzo, Valsecchi, Bonanni & Natoli, 2010), this effect might seem to be consistent with the presumed low social status of young dogs (e.g., Bauer & Smuts, 2007). However, it has not been established how canid behaviours in a dog park are connected to a dog's social status within a dog park, much less whether social status is even meaningful in this context. The likelihood of social hierarchies or dominance relationships forming among dogs when group membership is highly dynamic and tangible resources are limited, such as in a dog park (in particular where most dogs are neutered, and thus, may not be motivated to compete for mates, and/or when food resources are not present), has been given little examination. Some work has found that groups of companion dogs do sometimes form dominance relationships within dog-dog dyads, but this may be the exception rather than the rule. For instance, Bauer and Smuts (2007) reported that they could only identify 19 out of 55 dog dyads as having a dominance relationship (i.e., one was judged to be the established dominant and the other the subordinate) in an off-leash dog park. Similarly, Trisko (2011) observed dogs of various ages and breeds in a doggy day care setting and found dominance asymmetries were only apparent within 29% of dyads. Therefore, it is unlikely that higher initiation rates of snout-muzzle contact to the head of conspecifics by younger compared to older dogs indicated submission in this study. The vast amount of chemosensory information potentially located in the head area (see above), upon further examination, could prove to hold particular significance to younger dogs for reasons both related and unrelated to social status. In relation to the latter, it is conceivable that the elevated levels of snout-muzzle to head events initiated by younger focal dogs simply reflects that younger individuals were generally more curious about other dogs.

2.4.2.2 Non-contact events

The occurrence of non-contact canid events ranged widely, occurring in less than 5% to more than 50% of focal dogs. Therefore, while some behaviours in this category were recorded very rarely (i.e., roll-over received, drop belly to ground initiated, lunge approach initiated/received), others were more prominent features of interactions (i.e., running/leaping self-present approach, pull-rear away, exaggerated away, both initiated and received). Play bows, widely identified as a play signal in canids (e.g., Bauer & Smuts, 2007; Bekoff, 1977), were initiated by less than a quarter of all focal dogs, which is considerably lower than the 51% of focal dogs for which play bows were recorded by Ottenheimer Carrier et al.(2013) in the Quidi Vidi dog park over a continuous 20 min period during a visit. The difference in occurrence across studies suggests that play bows may become more relevant to social interactions during later parts of a dog park visit.

Density influenced the rate of lunge approaches initiated by focal dogs. This low frequency event only occurred at lower dog densities. As lunging has been previously identified as an agonistic/aggressive behaviour (e.g., Ottenheimer Carrier et al., 2013; Shyan et al., 2003), it is possible that lunge approaches by focal dogs were somewhat agonistic/aggressive in nature. If so, it is possible that at lower dog densities, it was more difficult for focal dogs to avoid unwanted approaches from particular conspecifics. For instance, when fewer dogs were present, conspecifics may have been less occupied with other dog partners and thus have had a greater opportunity to attempt to engage focal dogs. If the focal dog did not want to interact with a particular dog, it may have initiated a lunge approach. Future work should more closely examine the function of lunge approaches in dog parks.

Only female focal dogs initiated drop belly to ground. Since this sex effect appeared only in the analysis of the full focal dog sample, the influence of age could not be fully assessed. However, in the sample where both sex and age were known, two females that initiated drop belly to ground were in the younger age group, and one was in the older age group. Bauer and Smuts (2007) recorded 105 occurrences of a similar behaviour, “voluntary downs” (i.e., when a dog dropped partially or completely to ground without enforcement by partner), which they classified as a type of self-handicapping during dyadic play bouts in a dog park. In contrast to the present findings, Bauer and

Smuts (2007) did not find a sex difference in self-handicapping behaviours (note voluntary downs were not tested separately but did account for 62% of self-handicapping behaviours documented). An alternative function of drop belly to ground proposed in the popular literature is that it serves to calm the intensity of interactions or de-escalate potential aggression during social interactions ("laying down with belly against the ground" has been described as a calming signal by Rugaas, 2005; calming signals have received some preliminary investigation and support by Gazzano et al., 2014). Further work is needed to help clarify the context(s) under which this behaviour is used to determine its potential function (e.g., whether it is potentially used as a form of self-handicapping behaviour, as a calming signal, or something else) in the dog park. In turn, this may help inform why drop belly to ground was performed more often by female than by male focal dogs in this sample.

Finally, smaller focal dogs received more running/leaping self-present approaches than larger focal dogs. Since smaller focal dogs may have had a general physical disadvantage, it is possible that other dogs in the park, most of whom were likely in the larger size category (as extrapolated from the size composition of the focal dog sample), used running/leaping self-present approaches as a type self-handicapping behaviour when interacting with smaller focal dogs. A running/leaping self-present approach may have been an effective way of getting a smaller focal dog's attention, yet less intense compared to using physical contact, and thus, may have been a way that larger dogs restricted their use of full power/strength ("effort restriction" has been identified as a sub-category of "social self-handicapping" by Petrů, Špinka, Charvátová & Lhota, 2009). Since self-handicapping may decrease imbalances of ability between mismatched partners and thus aid in the occurrence of play (Bekoff, 2001), it is possible that larger non-focal dogs were inclined to use self-handicapping (i.e., in the form of running/leaping self-present approaches) when with smaller focal dogs in order to initiate or prolong their interactions. However, no differences in physical contact rates (i.e., wrestle, total unidirectional or unidirectional subtypes received) were detected between smaller and larger size focal dogs, which might be expected if smaller focal dogs were treated with greater restraint by larger partners. Hence, an alternative explanation for why smaller focal dogs received higher rates of running/leaping self-present approaches could be that smaller focal dogs were perceived as non-threatening. Therefore, conspecific partners may have been less deterred from approaching smaller focal dogs in a boisterous manner. Kerswell, Butler, Bennett and Hemsworth (2010) found puppies with shorter snout lengths received more pouncing from other puppies during social exchanges; they hypothesized that short snouted puppies were perceived as more “puppy-like”, eliciting more play behaviours from conspecifics. Kerswell et al. (2010) did not find a relationship between pouncing rate and size of puppies. However, puppies in Kreswell et al. (2010) were mostly between 8-9 weeks old; size may become a more salient factor in conspecific evaluation in older dogs.

2.4.2.3 Joint movement events

Chase, the only specific form of joint movement analyzed, was initiated and received by a majority of focal dogs. Chase behaviour was also one of the more common behaviours recorded by Bradshaw and Lea (1992) during dyads formed in a public off-leash area; chasing/charging behaviour was also one of the more frequently recorded behaviour subtypes classified as attacks/pursuits during dyadic play bouts recorded by Bauer and Smuts (2007) in an off-leash dog park.

In this study, younger females initiated chase more often than older females and marginally more often than older males, while younger males initiated chase more than older females but not older males; there were no differences between younger females and younger males. This pattern demonstrated that chase was a behaviour that younger individuals of both sexes engaged in at high levels. However, it also suggested there was a diminished interest for chase across age for females that was not as apparent across male age groups. Bradshaw and Lea (1992) investigated sex in relation to chase behaviour (dog age was not assessed), and, consistent with findings of the present study, did not report a main effect of sex. Bauer and Smuts (2007) looked at general effects of dog sex, age, and size on proportions of attack/pursuit play behaviours (including chase/charge behaviours) and, in line with the present findings, found no general association with dog sex and size. However, in contrast to the present findings, they did find proportions of attacks/pursuit play behaviours were generally higher for older compared to younger dogs. One possibility for this difference could be that chase behaviour in the present study was recorded under different circumstances than attack/pursuit behaviours in Bauer and Smuts (2007). That is, Bauer and Smuts (2007) restricted their observations of attack/pursuit behaviors to bouts of dyadic play and did not constrain observations to a particular time frame within a visit, whereas in the present study, all occurrences of chase initiated by focal dogs within the first 400 s were recorded. Therefore, chase may not operate as an attack/pursuit play behaviour in the present context and so may show a different age-related pattern.

Other work has also provided some information on the relationship between chasing behaviour and dog age, although, it is unclear if chasing behaviour during these interactions occurred in a dog park or some other context. Bauer, Ward and Smuts (2009) reported that chasing behaviour rates within dog dyads during play bouts had a bell curve pattern across “pup” (less than or equal to 2 months), “juvenile” (2-6 months), “sub-adult” (6-12 months), “young adult” (1-3 years), and “adult” (greater than or equal to 3 years) age groups, spiking among sub-adults (Bauer, Ward & Smuts, 2009). Exact comparisons between the present study and Bauer et al. (2009) are difficult to make since studies classified ages according to different categories. Also, the present study’s sample of focal dogs largely excluded dogs classified as pups and juveniles by Bauer et al. (2009), as only two focal dogs were less than 6 months old. Nonetheless, given that in the present study younger focal dogs had higher rates of chase than older focal dogs, and that dogs in the present work mostly covered the sub-adult, young adult, and adult age categories used by Bauer et al. (2009), the direction of age-related trends across studies does show some consistency. In any case, further work is needed to provide greater perspective on age-related patterns pertaining to chase behaviour.

2.4.2.4 Physical contact events

Not surprisingly, physical contact events also occurred variably among focal dogs. With the exception of open-jaw contact and paw body events received by focal dogs (recorded among 22% and 32% of focal dogs, respectively), individual subtypes of unidirectional physical contact behaviours (initiated and received) were recorded among less than 20% of focal dogs; wrestle events were also recorded for just 22% of focal dogs; Thus, as with non-contact events, some forms of recorded physical contact events were rare, while others were more common components of exchanges.

The general category of unidirectional physical contact initiated by focal dogs occurred at higher rates in the higher compared to lower dog density group. This effect was mostly driven by the specific subtype, open-jaw contact, as paws around body events (the only other unidirectional physical contact event initiated assessed) did not significantly differ across density groups. As with some forms of snout-muzzle contact, it is possible that increased open-jaw contact initiated by focal dogs reflects an increased opportunity for focal dogs to initiate this event when a greater number of conspecifics were present. Alternatively, open-jaw contact may have been used at higher rates because focal dogs required more noticeable tactics in order to effectively capture and maintain the attention of conspecific partners under more distracting conditions. Physical contact behaviours (including “bites”) have been previously identified as attention-getting behaviours during play in a dog park (Horowitz, 2009).

The physical contact event, wrestle, was associated with a focal dog sex by age interaction. Younger female focal dogs had higher rates of wrestle events compared to both sexes in the older age group and younger females also showed a non-significant trend ($p = .08$) towards a higher rate of wrestle than younger males. Potentially relevant to this trend, Bauer and Smuts (2007) found females were more often involved in play bouts compared to males; given that wrestling behaviours have been identified as a feature of dog-dog play (see “wrestling” and “rearing-up” in Smuts, 2014), the present results are somewhat consistent with this finding. However, Bauer and Smuts (2007) did not evaluate the interaction between dog sex and age on play, so it is unclear how age of females contributed to their reported findings.

In the full sample of focal dogs (n=69), the only main effect of sex detected in absence of a sex by age interaction for physical contact behaviours was that male focal dogs initiated higher rates of paws around body toward conspecifics compared to females. Similar to mounting behaviour, paws around body involved a dog wrapping his or her forepaws around a conspecific’s body (excluding the head). However, in contrast to mounting, no pelvic thrusting or rounding of the spine was apparent. Nonetheless, it is possible paws around body was an incomplete form of mount behaviour. The detected effect is also consistent with findings of previous dog park work that has found mounting behaviour was more frequent among males (Bauer & Smuts, 2007; Ottenheimer Carrier et al., 2013). Ottenheimer Carrier et al. (2013) proposed mounting may be the result of heightened physical and emotional arousal in a socially stimulating environment, such as the dog park, or simply an element of play, as in their dog park sample, mounting was positively correlated with frequency of play behaviours.

2.4.2.5 Elimination

Elimination events were initiated at least once by majority of focal dogs and the rate of elimination did not significantly differ across the observation period. Frequent occurrence of elimination was consistent with Lisberg and Snowden (2011), who also documented frequent urination events during entries in a dog park setting. Thus, it is plausible that elimination behaviours have social relevance (i.e., as marking) in dog parks. However, it is impossible to comment on how urination and defecation patterns might differ, as they were not distinguished in the present study.

It is worth noting that the present study provides greater perspective on previous observations of elimination behaviours made in the Quidi Vidi dog park. O'Leary (2014) observed focal dogs upon entry to the Quidi Vidi dog park and reported that just two focal dogs (7%) urinated, and none eliminated faeces. However, O'Leary (2014) observed focal dogs on average for only 14 s each, which was much shorter than the 400 s observation period used to observe focal dogs in the present study. Thus, the much lower prevalence of elimination behaviours in O'Leary (2014) compared to the present work was probably because the period in which focal dogs were observed was too brief to detect elimination behaviours, not because elimination behaviours do not occur in the Quidi Vidi dog park.

Focal dog sex also influenced elimination rate as males eliminated at higher rates than females in the full sample of focal dogs; males were also more likely to eliminate in the park at least once. Consistent with the present findings, when studying marking behaviour of mostly neutered dogs in the entryway of a fenced dog park, Lisberg and Snowden (2011) found rates of urination, as well as countermarking, were higher in male dogs. Though distinctions between various types of elimination were not made in the present work, the findings here and in Lisberg and Snowden (2011) suggest that male compared to female dogs are either more concerned or less selective about communicating information contained in eliminatory products in a dog park setting. In contrast to the present work, Lisberg and Snowden (2011) found males and females were equally likely to engage in urinations and countermarkings at least once in the park. More detailed analyses of elimination in the Quidi Vidi dog park might help address why studies differed on this observation. In any case, similar to the present work and Lisberg and Snowden (2011), previous work on free-ranging dogs and companion dogs in non-dog park contexts have also reported greater urinary/marking behaviours in males compared to females (Cafazzo et al., 2012; Pal, 2003; Ranson & Beach, 1985).

Older dogs eliminated at higher rates than younger dogs. This finding is comparable to previous work on urination patterns of wild canids and dogs in non-dog park contexts (e.g., Ethiopian wolves: Sillero-Zubiri & Mcdonald, 1998; domestic dogs: Caffazo et al., 2012; Ranson & Beach, 1985; Wirant, Halvorsen, & McGuire, 2007; Wirant & McGuire, 2004). Again, as rates of urination were not distinguished from defecation, no comment can be made on how much each form of elimination contributed to this effect. Given that scent marking has been associated with dominant or “high-ranking” individuals (Ralls, 1971), one interpretation of this pattern could be that older dogs had higher elimination rates because they were of a higher social status. Indeed, Caffazzo et al., (2012) reported that marking frequency increased with age and social rank within a group of free-range dogs. Further, as mentioned previously, higher rates of urine marking (i.e., countermarks) have been associated with higher dominance status, as presumed from tail-base positions (Lisberg & Snowden, 2011). However this interpretation should be made cautiously given our poor understanding of how social ranks generally apply to dogs in a dog park.

2.4.2.6 Summary remarks on dog density, sex, age, size and neuter status influences

Dog density, focal dog sex, age, size and neuter status were all found to influence at least one behavioural variable investigated in this study. Higher dog densities increased the opportunity for certain types of exchanges (i.e., forms of snout-muzzle contact both initiated and received, open-jaw contact initiated). However, dog density potentially had other impacts as well. For example, increased open-jaw contact initiated by focal dogs at higher densities could have been related to a change in tactic for getting the attention of conspecifics under more distracting conditions. Also, lunge approaches were initiated more often during lower dog densities and may have been used to deflect unwanted attention.

As found across other dog park studies (Bauer & Smuts, 2007; Bradshaw & Lea, 1992; Ottenheimer Carrier et al., 2013; Shyan et al., 2003), dog sex and age also prominently influenced various behaviours in the present work. Both focal dog sex and/or age influenced time budgets (i.e., percentage of time spent with dogs and alone), chemosensory behaviours (i.e., rates of elimination and snout-muzzle to head initiated), and forms of dynamic/high-energy behaviours (i.e., rates of wrestle, chase initiated, paws around body initiated). One additional canid event associated with focal dog sex was drop belly to ground initiated by focal dogs. Finally, size and neuter status were related to a single behaviour event each (i.e., running/leaping self-present approach received, and snout-muzzle to anogenital area initiated, respectively). Apparently there were no strong differences in how smaller compared to larger, and neutered compared to intact focal dogs behaved or were treated by conspecifics in the present sample. However, low power may have made some differences along these dimensions difficult to detect as there were only 15 smaller dogs and 12 intact dogs (only 4 of which were female). Needless to say, both size and neuter status are worthy of further investigation.

2.4.3 Concluding Remarks on Study Contributions

This study contributes to the small number of studies dedicated to understanding dog-dog social behaviour specifically in dog parks, and is the first to provide insights into broad aspects of dog-dog social behaviour specifically during the initial minutes of a dog park visit (i.e., time budgets of general activities, rates of a range of canid behaviours initiated and received by focal dogs during interactions with conspecifics, and factors that were associated with behavioural measures). By applying a motivationally-neutral approach, this work was able to describe and analyze behaviours initiated and received by focal dogs without making claims about how behaviours functioned, which is important given that many aspects of dog-dog social behaviour have not been sufficiently studied. Motivationally-neutral characterizations were also useful as they did not frame behaviours so that just one function was emphasized, which facilitated consideration of alternative functions when rates of behaviours were interpreted. For example, the labels snout-muzzle contact to anogenital area and snout-muzzle contact to head allowed for the hypothesis that olfaction, as well as other sensory processing (i.e., gustation, tactile stimulation) were potentially relevant aspects of these behaviours. It is doubtful that labelling the same behaviours as “sniffing anogenital area” and “sniffing head” would have led to the same questions about alternative processing.

More generally, the present study reports on companion dog social behaviours observed unobtrusively in a public space when dogs were not constrained by owners. In doing so, findings add to foundational information on dog social behaviour as it occurs in a real-world situation. The information and interpretations of behaviours provided by this work may be useful for building clearer definitions of dog behaviour in dog-dog contexts, and for designing future studies that wish to further investigate the possible functions of recorded behaviours in dog parks, as well as other contexts.

2.4.4 General Considerations for Dog Park Work

Although dog parks could play a prominent role in further developing our understanding of companion dog social behaviours in a naturally occurring situation, some caveats regarding behavioural observations in dog parks should be made. First, although naturally occurring, opportunistic samples from dog park observations may include a wide variety of dogs, it is not yet known how far observations of dog behaviour in dog parks can be generalized. For one, it is not likely that dog park observations can be generalized to all companion dogs, as dog parks may still attract a select group of dogs.

For example, not all dog owners bring their dogs to dog parks, and dogs that are brought to the park may be particularly energetic as Ottenheimer Carrier et al. (2013) and O'Leary (2014) found dogs in the Quidi Vidi dog park scored higher than average on the trait of "Extraversion" according to the personality assessment MCPQ-R (Ley, McGreevy & Bennett, 2009), which is a trait that mostly reflects activity level. It is also not clear if observations of dogs in one dog park generalize to all dog parks; the physical and social features of specific parks may contribute in complex ways to different social patterns. For instance, extent of vegetation, inclusion of physical structures (i.e., benches, water fountains, fence), size of the park area, typical density of individuals present, and characteristics of dogs and owners (i.e., personality traits, owner attitudes toward dogs, owner adherence to park etiquette/rules) unique to a particular location may influence either how dogs interact with the park environment or other dogs/humans. Study replications across different dog park and non-dog park settings are required to determine the extent to which the findings of the present study and other dog park studies may be generalized.

Second, the influence of some dog characteristics on dog social behaviour may be challenging to determine in dog park samples, as some dog groups may be underrepresented. For example, intact dogs and small dogs occurred in the Quidi Vidi dog park in low numbers. Lisberg and Snowden (2011) also found low numbers of intact dogs, especially intact females. If intact and small sized dogs visit dog parks in low numbers, differences in social behaviour between neutered and intact dogs, and dogs of different size, with exception of strong dissimilarities, may be difficult to detect without extending observation hours considerably to achieve adequate sample sizes. Other underrepresented groups may include particular breed types, as although a wide variety of breeds attended the park in the present work and parks observed in other studies (e.g., Bauer & Smuts, 2007; Shyan et al., 2003), not all are represented. Additionally, it may be difficult to obtain adequate samples of dogs from any one particular breed group to make breed comparisons in dog parks.

Third, not all types of behavioural phenomenon may be observable in a dog park. An obvious example would be that dog parks do not appear to be well-suited for studying predictive factors or characteristics of serious dog-dog aggression. Although behaviour was not coded from a motivational standpoint in this work, serious unambiguous aggression was never observed during the study period. Lack of serious aggression during the present study is consistent with observations made in other dog park studies (Bradshaw & Lea, 1992; Ottenheimer Carrier et al., 2013; Shyan et al., 2003). Indeed, aggression in dog parks may be unlikely due to the personality characteristics of dogs brought by owners to the dog park, owner intervention, and/or other factors. Thus, canine aggression may be better studied in other contexts where it is more likely to occur (i.e., multi-dog households, feral groups).

Chapter 3 : Future Directions and General Conclusion

There are many ways that research on dog social behaviour in dog parks could be expanded. First, more studies that investigate the range of behaviours that occur in dog parks by using motivationally-neutral approaches are needed so that a more complete description of dog behaviour in dog parks can be achieved.

Second, in addition to further examining the range of canid social behaviours that occur, neutral in-depth examinations of specific behaviours found in dog parks (i.e., those recorded in the present study) are needed; such examinations would be particularly instrumental for bridging our understanding of behaviours from form to function. An example of this type of analysis comes from a recent study conducted in a laboratory setting on roll-over behaviour during dog-dog play bouts. By carefully inspecting when and how roll-overs occurred (i.e., by judging movement relative to the midline axis of the body, proximal/distal limbs, and/or partners), Norman et al. (2014) were able to convincingly argue that roll-overs in their sample most often functioned as defensive tactics (i.e., to avoid nape bites from partners), and to a lesser extent as offensive tactics (i.e., to perform nap bites toward partners), play solicitation and in a non-social manner (i.e., to rest). Findings also dispelled the common notion that roll-overs only serve to indicate inferior dominance status, which further highlights the importance of carefully evaluating behaviours before presuming their social purpose. Although all behaviours observed in the present work would benefit from detailed independent investigations similar to that carried out by Norman et al. (2014), some may be of particular interest. For one, head and anogenital snout-muzzle contact should be studied in more detail since dog visitors are highly likely to exchange these behaviours (present work; Bradshaw & Lea, 1992; O'Leary, 2014). Such work should start by making finer distinctions between sites that are targeted on the head and anogenital areas, as well as between contact (i.e., via licking) which does or does not result in the exchange of saliva or other secretions; recording durations (i.e., as opposed to frequencies) at which snout-muzzle contact is performed might also offer a more precise measure of the variation in these behaviours. Even though they were rare, lunge approaches also appear especially pertinent to study in more complex detail as they were possibly indicators of agonism. As the following parameters have been found to be useful for distinguishing true agonism from non-agonism previously in human children (Fry, 1987) and adult wolves (Weir, 1994), recording the durations of exchanges, the number of individuals involved, additional body language cues (i.e., facial characteristics), the presence/absence of spectators, and vocalizations may help determine whether lunge approaches in the dog park are consistent with conflict.

Third, more precise comparisons of focal dog behaviour across different time-frames within a visit are warranted. For instance, since the present work focused on early minutes of a visit (i.e., the first 400 s) and as such may have largely captured patterns associated with dog greetings, it would be interesting to see whether observations restricted to later minutes of a visit, when dogs were more familiar with each other and the park context, consisted of similar or different patterns. More work that compares general activity time budgets and the occurrence of specific behaviours (i.e., forms of snout-contact, non-contact, joint movement, and physical contact) at different points within a visit would provide greater perspective on how behaviours of dogs change over time, and why these changes may occur. It would be particularly informative if focal dog behaviour (i.e., activity time budgets and a broad range of specific canid social behaviours) could be analyzed minute-by-minute over an extended observation interval that more nearly covers the duration of a typical visit. As done in the present study, such analyses should consider measuring rates of behaviours received by focal dogs in addition to rates of focal dog initiated behaviours, as changes in how other dogs behave toward focal dogs over time within a visit could then also be examined. Although not statistically compared in this work, the rate differences between canid events when they are initiated versus received by focal dogs might also be interesting to analyze minute-by-minute over a longer duration, as descriptive statistics suggested multiple canid events were initiated and received at different rates in the present work. For example, the canid events snout-muzzle to anogenital area, exaggerated away, pull-rear away, and running/leaping self-present approaches, all appeared to be initiated by focal dogs at noticeably higher rates than they were received by focal dogs; conversely, chase appeared to be received by focal dogs at higher rates than it was initiated by focal dogs.

Fourth, the optimal way to define social activity states used to construct focal dog activity time budgets in dog parks requires further attention, since as of yet, this is not entirely clear. However, it is evident that the different approaches used so far have both pros and cons. For one, judging social involvement based on close proximity alone (i.e., was used by Ottenheimer Carrier et al., 2013) has the likely advantage of being the easiest way to consistently code behaviour. However, it also carries with it the disadvantage of not providing any description of the social behaviours that actually occurred during the time that states were measured. An approach that uses close proximity *and* the identification of certain types of engagement (i.e., used in the present study) seems to offer some middle ground; the proximity requirement decreases ambiguity over when bouts of social activity between particular individuals start and end (improving coding consistency and ease), and requiring specific forms of engagement between individuals gives some description of behaviours represented by states. Nonetheless, this approach is also not perfect, as requiring any type of close proximity (i.e., 1 Lab length) to identify social activity may lead to the exclusion of social exchanges that occur between focal dogs and other individuals when they are not close to each other (e.g., when a human waves/whistles or another dog performs a play bow toward the focal dog from across the park). In any case, the best way to define the time that focal dogs spends involved with other dogs or humans needs to be determined through successive efforts.

Fifth, future work should also consider other forms of behaviour and areas of inquiry not yet given much attention in dog parks. For example, dog vocalizations are generally worthy of investigation. In particular, although sophisticated recording techniques may be required, subtle, close range vocalizations (e.g., “play laughs”; Simonet, Versteeg, & Storie, 2005) may potentially play an important role in communication between dogs in dog parks. Monitoring of specific tail movements during interactions may also be interesting in a dog park context, as previous work has found tail movement amplitudes may provide clues into the emotional state of dogs in response to social stimuli (Quaranta et al., 2007). As well, dog parks could be used to examine how regular opportunities to interact with conspecifics affects the mental and physical health of companion dogs, and how groups of dogs avoid conflict, both of which are areas of dog social behaviour deemed worthy of further examination by Smuts (2014). Lastly, it would also be worthwhile to conduct more detailed investigations into how the human element in dog parks operates. For example, it would be of interest to examine the range of dog-owner interactions that occur (e.g., physical or verbal contact) and whether they are subsequently associated with a dog's behaviour during dog-dog interactions (e.g., stress behaviours).

Sixth, factors that influence dog social behaviour in dog parks should be addressed more extensively. Given that it has been demonstrated that various dog demographics (i.e., dog sex, age, size, neuter status, personality scores and sex, age, size of dog partners; present work; Bauer & Smuts, 2007; Bradshaw & Lea, 1992; Lisberg & Snowden, 2011; Ottenheimer Carrier et al., 2013; Shyan et al., 2003), dog density (present work), and timing of observations relative to entry can influence observations (present work), future studies should make a special effort to measure and report information related to these factors whenever possible. Greater access to these study details, even if such are not central to a study's research questions or statistically analysed (i.e., are presented as descriptive information), may allow researchers to better evaluate, and possibly help address inconsistencies in findings across dog social behaviour studies. Future studies should also more thoroughly investigate and analyze the factors that have been found to influence dog social behaviour in dog parks. For example, as the present work included focal dogs that were relatively young (i.e., median age of older dogs was 36 months) and dog density during observations was always relatively low (i.e., even in high density conditions only an average of 5.9 dogs were present), including a wider range of dog ages (i.e., greater number of older aged dogs) and dog densities (i.e., a greater number of observations at high densities) in analyses may provide a more comprehensive view of how dog age and dog density impact behaviour. Finally, future studies should also continue to examine the influences of new factors (i.e., related to characteristics of individual dogs, characteristics of dog partners, distinctive physical/social features of parks, and time of day or season). For instance, it may be particularly relevant for future work to explicitly assess level of familiarity between specific dogs in a dog park and address how varying levels of familiarity impact the nature of social exchanges.

Given the number of questions generated by the present work, and that dog park studies remain scarce, it is obvious that observations of dogs in dog parks should be greatly increased. Dog parks hold much potential for answering questions about intraspecific sociality of companion dogs, which will help us to better understand dogs as complete and unique social beings, and possibly aid in our ability to protect or improve their welfare.

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Appendix: Reliability Issues

Re-evaluation of Events with Low Inter-observer Reliability

Re-evaluation of selected low frequency events was carried out due to low inter-observer reliability (Table A1). For hunched posture events initiated by focal dogs and pull-rear away events received by focal dogs, the original observer identified and examined a few instances of disagreement between observers. Video clips containing these instances were reviewed by the second observer and then both observers discussed these instances until the basis of the disagreement between the two observers was discerned; definitions were updated following consensus. Following this process, the second observer re-watched all 14 focal dog clips and coded the events a second time. ICCs based on repeated coding for hunched posture initiated by focal dogs and pull-rear away received by focal dogs increased to 0.87 and 0.71, respectively (Table A1). Unfortunately, the event drop belly to ground initiated by focal dogs was re-evaluated after the other unreliable low frequency behaviours were re-evaluated, at which point the second observer was only available for a limited time. Therefore, a more time-efficient re-evaluation approach was used. Since there were only two instances of disagreement, each instance was re-watched and discussed by both observers until reasons for of disagreement by the second observer were identified and definitions updated. After this, the original observer identified all instances of drop belly to ground initiated events that occurred in the remaining focal dogs (n=55). The second observer was asked again if they agreed or disagreed on whether drop belly to ground was initiated by focal dogs in those instances. Following this process, a consensus between both observers was reached on all instances of the behaviour and the event drop belly to ground initiated was concluded to be reliable.

Table A1

Intra-class correlation coefficients (ICCs) for low and high frequency canid events randomly chosen for inter-observer coding reliability assessment among a subset of randomly selected focal dogs (n=14).

Canid event	ICC	ICC (after re-code by 2nd observer)
Low frequency[a]		
Drop belly to ground (I)	0.42	--
Hunched posture[b] (I)	--	0.87
Pull-rear away (R)	0.53	0.71
High frequency[c]		
Snout muzzle to anogenital area (I)	0.93	--
Snout muzzle to anogenital area (R)	0.94	--
Elimination	1.00	--

Note. Re-evaluation of drop belly to ground initiated by focal dogs did not include an ICC.
[a] Recorded in < 50% of all focal dogs (n=69)
[b] An initial ICC could not be calculated because hunched posture initiated was scored zero times by the second observer
[c] Recorded in ≥50% of all focal dogs (n=69); found reliable upon initial coding and not re-coded.

Potential Influences on Coding Reliability

Reliability issues with behavioural coding may have occurred for a variety of reasons. For example, definitions, coding fatigue or frequency of behaviours may all affect reliability (Caro, Roper, Young & Dank, 1979). In the present work, relatively infrequent behaviours tended to be coded less reliably. For one, selected low frequency events had much lower ICCs compared to selected high frequency events during inter-observer reliability assessments (Table A1). Also, for intra-observer reliability assessments, frequencies of particular canid events showed a positive correlation with event ICCs. For instance, within the 14 focal dogs selected for intra-observer reliability assessments, there was both a significant correlation between event ICCs and total event frequencies originally coded (r=0.37, p=0.026) and coded a second time for the purposes of ICC calculations (r=0.37, p=0.025). Event intra-observer reliability ICCs also correlated with event frequencies originally coded in all 69 focal dogs (r=0.33, p=0.044). However, some infrequent events were exempt from this association. For example, lunge approach initiated and received by focal dogs, and wrestle had high reliability (ICC=0.99 for each; Table A2), likely because of their highly conspicuous natures.

There may be various explanations for why low frequency events were subject to poorer coding reliability. For example, low frequency events may have been more likely to go undetected since vigilance is lower when motor patterns are infrequent (Caro et al., 1979). In addition, it was evident that infrequent events required fewer discordant events (i.e., coding disagreements) than frequent events to be considered unreliable. For instance, the infrequent event roll-over initiated by focal dogs had one discordant event during intra-observer reliability assessments and was deemed unreliable (ICC<0.70; Table A2). Yet, the frequent event snout-muzzle contact to anogenital area received by focal dogs had 9 discordant events, but very high intra-observer reliability (ICC=0.98; Table A2). Therefore, infrequent events were particularly vulnerable to reduced reliability as a result of less-than-ideal viewing conditions sometimes sporadically and uncontrollably produced by the dynamic park environment.

Table A2

Intra-class correlation coefficents (ICCs) calculated for all 42 canid events initiated (I) and received (R) by 14 focal dogs randomly selected for intra-observer coding reliability assessments.

Reliable events (ICC >0.70)	ICC	Unreliable events (ICC≤0.70)	ICC
Snout-muzzle to anogenital (I)	0.87	Drop belly to ground (R)	--
Snout-muzzle to anogenital (R)	0.98	Hunched posture (I)	0.67
Snout- muzzle to head/muzzle (I)	0.87	Hunched posture (R)	0.61
Snout-muzzle to head/muzzle (R)	0.90	Play bow (R)	0.19
Chase (I)	0.87	Roll-over (I)	0.65
Chase (R)	0.94	Sit (I)	0.47
Drop belly to ground (I)	1.00	Sit (R)	0.30
Exaggerated away (I)	0.98	Leap-on (I)	--
Exaggerated away (R)	0.81	Leap-on (R)	0.19
Lunge approach (I)	0.99	Mount (I)	0.68
Lunge approach (R)	0.86	Paw body (I)	0.63
Play bow (I)	0.95	Paw head (I)	0.69
Pull-rear away (I)	0.90	Paws around body (R)	0.65
Pull-rear away (R)	0.74	Pin (I)	--
Roll-over (I)	1.00	Pin (R)	--
Running/leaping self-present (I)	0.84	Slam (R)	--
Running/leaping self-present (R)	0.83		
Mount (R)	1.00		
Open-jaw contact (I)	0.75		
Open-jaw contact (R)	0.93		
Paw body (R)	0.90		
Paw head (R)	0.77		
Paws around body (I)	0.80		
Slam (R)	0.77		
Wrestle (I/R)[a]	1.00		
Elimination (I)	0.96		

Note. "--" ICCs could not be calculated as the event was recorded zero times for original and/or second coding passes.

[a] Focal dogs were both an initiator and recipient for wrestle events.