Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

HHS Public Access

Author manuscript

Am J Primatol. Author manuscript; available in PMC 2015 May 28.

Published in final edited form as:

Am J Primatol. 2008 September ; 70(9): 879–883. doi:10.1002/ajp.20575.

Characterizing Human–Macaque Interactions in Singapore

Agustín Fuentes[1,*], **Stephanie Kalchik**[1], **Lee Gettler**[2], **Anne Kwiatt**[3], **Mckenna Konecki**[4], and **Lisa Jones-Engel**[5]

[1]Department of Anthropology, University of Notre Dame, Notre Dame, Indiana

[2]Department of Anthropology, Northwestern University, Evanston, Illinois

[3]Museum Studies, New York University, New York, New York

[4]Pritzker School of Medicine, University of Chicago, Chicago, Illinois

[5]NPRC, University of Washington, Seattle, Washington

Abstract

Previous studies have noted substantial human–macaque interactions involving physical contact in Bali, Indonesia; Gibraltar; and Mt. Emei, China [Fuentes, American Journal of Primatology 68:880–896, 2006; Zhao, Tibetan macaques, visitors, and local people at Mt. Emei: problems and countermeasures. In: Paterson and Wallis, editor. Commensalism and conflict: the human–primate interface. Norman, OK: American Society of Primatologists. p 376–399, 2005]. The aim of this study was to conduct preliminary observations in order to begin to characterize interaction patterns between humans and long-tailed macaques (*Macaca fascicularis*) in Singapore. Unlike Bali, Gibraltar, and Mt. Emei, Singapore occasionally enforces fines and penalties and engages in an education campaign in an effort to minimize physical contact between humans and macaques. Observers stationed at two sites in Singapore conducted 92 5 hr of observation that included 730 human–macaque interactions over 16 days. Data recorded include interaction characteristics, demographic and behavioral variables, presence of feeding by humans, and presence of automobiles. Although feeding by humans was relatively infrequent overall, it generally occurred most often by individuals in cars and when human children were present. Data analysis suggests that interactions involving physical contact between macaques and humans are rare in Singapore, in contrast to the findings from Bali, Gibraltar, and Mt. Emei. This low level of physical contact suggests a low risk of macaque–human pathogen transmission in Singapore.

Keywords

human–primate interactions; zoonotic pathogen transmission; Macaca fascicularis; Singapore

© 2008 Wiley-Liss, Inc.

[*]Correspondence to: Agustín Fuentes, Department of Anthropology, University of Notre Dame, 648 Flanner Hall, Notre Dame, IN 46556-5611. afuentes@nd.edu.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

INTRODUCTION

The nation of Singapore is located at the southern tip of the Malay Peninsula (1118°N, 103150′E). Although having a population of over 4,500,000 people in a total land area of 682.7km^2, Singapore retains at least 20km^2 of forested area, including two national reserves surrounded entirely by urban development. A substantial and increasing number of people frequent these forested areas annually [Chatterjee, 2007]. In addition to the human population, there are approximately 1,470 long-tailed macaques (*Macaca fascicularis*) present in and around the forested zones [Sha, 2008]. These macaques interact with humans largely along roadsides and in urbanized recreation parks on the forest fringes. Notably, they also act as seed dispersers in the forest setting, a role that may be of increasing importance for plant species as humans continue to impact the remaining forested landscapes [Lucas & Corlett, 1998]. The National Parks Board, Singapore (NParks), is currently engaged in a substantive macaque management program including public education campaigns and macaque population assessments.

The combination of extremely high human density and the intersection of urban and forested areas result in extensive overlap between human and macaque ranges, raising the concern that zoonotic pathogenic transmission might be heightened [Engel et al., 2006]. Interactions involving contact such as biting and scratching by macaques increase such potential for pathogen transfer. When physical contact interactions (such as biting, scratching, climbing, or mucosal splashing) take place between macaques and humans, humans are potentially susceptible to infectious agents such as simian foamy virus (SFV), simian retrovirus, *Cercopthecine herpesvirus* 1 (Herpes B), and other nonviral pathogens, with SFV transmission having been already documented [Engel et al., 2006; Jones-Engel et al., 2005]. Macaques are potentially at risk of infection from close physical or spatial contact with humans, whose transmittable diseases include measles and influenza [Fuentes, 2006; Jones-Engel et al., 2001]. Laws against feeding the macaques are at least occasionally enforced (via fines) in an effort to minimize the potential macaque–human contact interactions and potential close proximity, thus reducing the risk of interspecies pathogen transmission.

One aim of this study is to assess the risk of pathogen transmission by evaluating the patterns of interactions between humans and macaques, especially in the context of humans feeding macaques. We hypothesized that the macaques will search for possible food (handouts or refuse) wherever people are present. In particular, we expected that macaques in Singapore associate approaching cars with food and will present themselves to slowing cars with hopes of possible feeding.

Previous macaque–human interaction studies were undertaken in Padangtegal, Bali, Indonesia; the Gibraltar Upper Rock Nature Reserve, Gibraltar [Fuentes, 2006]; and Mt.Emei, China [Zhao, 2005]. The Bali and the Gibraltar sites attract large tourist populations each year. In Bali, temple staff members provide daily provisions for the macaques (*M. fascicularis*). There is a rule against tourists feeding the Bali temple monkeys, but temple staff intercede in instances of feeding only if the macaques become aggressive toward the humans feeding them. In Bali the interactions between macaques and humans frequently involve physical contact and human-directed aggression by the macaques. In

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Gibraltar, macaques (*Macaca sylvanus*) are provisioned daily and the publicized penalty for feeding the macaques is not enforced. The macaques in Gibraltar display lower rates of aggression than those in Bali, but there is still a substantial amount of physical contact between macaques and humans [Fuentes, 2006]. At Mt. Emei, religious pilgrims and some tourists occasionally bring food provisions for the local macaques (*Macaca thibetana*), who often react with aggression while attempting to obtain food from humans.

Singapore differs in its relationship with macaques relative to Bali, Gibraltar, and Mt. Emei because few ‘‘tourists’’ interact with the macaques. The monkeys are not ‘‘marketed’’ as a tourist attraction, and NParks makes a concerted effort to educate the public in regards to interactions with the macaques. Unlike Bali and Gibraltar, the macaques of Singapore are not provisioned by the government or an agency. The macaques are able to feed from the substantial forest resources found in Singapore but often forage in urban areas near the reserves. In addition, unlike Bali and Gibraltar, the fines and/or penalties for feeding the macaques in Singapore are at least occasionally enforced (as many as 150 fines per year, personal communication, NParks). In addition, because the macaques are not advertised as a tourist attraction and few macaques reside in and around the major tourist venues, interactors with macaques in Singapore are more likely to be residents than tourists. Urban residents of Singapore frequently gather in the parks and reserves for recreation. One might expect, owing to familiarity with the monkeys, that residents are less attracted to the macaques and are thus less likely to participate in feeding than are tourists [Fuentes and Gamerl, 2005]. Accordingly, we predicted that instances of feeding would be observed at a lower frequency than in Bali, Gibraltar, or Mt. Emei. Because of our expectation for a low frequency of macaque feeding by humans in Singapore, we also expected infrequent physical contact interactions between macaques and humans. Here we present data from a brief observational study of macaque–human interaction in Singapore.

METHODS

Four observers collected interaction data from 5–22 August 2007 at two locations in Singapore (Upper Pierce Reservoir (UPR) Road and Old Upper Thomson (OUT) Road). Both locations were selected as they are prime areas where human–macaque interactions occur (A. F. personal observation, 2006, 2007, personal communication, NParks). The UPR Road is a 1.7km stretch running from the OUT Road to the UPR Park. The road is bounded on either side by forest and all interactions take place along the roadside/forest edge or in the parking lot at the end of the road adjacent to the park and the reservoir. The OUT Road is a 3.0km road running along the eastern edge of the Lower and UPR Park forests. It is bounded entirely by forest on its western edge and by a mixture of forest, urban apartment buildings, large roads, shopping areas, and stretches of forest on its east. Interactions took place at the road’s edge, forest edge, and in and around apartment buildings adjacent to the road.

Observers rotated across locations utilized by macaque groups on UPR and OUT in 3-hr blocks between 8 AM and 6 PM daily. To control data collection, observers behaved inconspicuously so that residents would not feel that they were being watched and purposely avoid interactions with macaques. Observations were initiated only when a group of macaques was on, or visible from, the roadside. Observation days were divided into 30-min

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

sample periods during which the following information was collected using the All-occurrences method [Altmann, 1974]: total number and age/sex class of humans and macaques present, all interactions, feeding by humans, area use, and vehicle type, frequency, and action (slowing or stopping near the macaques). Additional behaviors were noted ad libitum. Noncontact interactions were defined as when at least one macaque and one human oriented toward each other, and exchanged behavior (visual monitor, threat, approach, retreat, toss food, retrieve food) without any physical contact. Contact interactions were defined as any behavior that resulted in physical contact between a human and a macaque.

At the end of each observation day, observers compared all groups observed, their locations, and numbers to estimate the number of macaque groups in the area. Additionally, one observer drove a car through the entire research area (UPR and OUT) 15 times (six during the late morning, nine during midday and afternoon) noting the location and numbers of macaques visible from the roadside between 7 and 12 August 2007. Macaque groups were considered separate if they were observed at the same time more than 150m distant from one another with each group consisting of more than five individuals not spread more than 50 meters apart.

RESULTS

We collected 185 30-min samples (92.5 hr) of interaction data. The subjects included eight separate macaque groups (16–37 individuals in size) whose range encompasses the UPR Road and OUT Road. Individual macaques are counted multiple times in the data set as multiple samples were collected for the same groups. We present the data as raw totals and as averages per sample to provide a strong estimate of the density of human interactions.

When humans and macaques were present in the same place at the same time, humans were more likely not to feed macaques than to feed them. Out of the 2,658 macaque records (see above) during samples, 934 contained feeding. This is significantly less than the 1,724 without ($\chi^2 = 234.801$, $P<0.05$). However, when human feeding of macaques did take place the mean number of macaques present per sample was higher than samples with no provisioning activity. This relationship is true for all three age/sex classes (male, female, and immature) (Fig. 1).

The number of human children observed was highest in samples where feeding occurred. Out of 794 children (450 males and 344 females, defined as appearing 14 years of age or younger), 543 were present during samples where humans fed macaques, whereas only 251 were present in nonfeeding samples. The difference in the number of children during feeding vs. nonfeeding samples is statistically significant ($\chi^2 = 107.385$, $P<0.05$). The mean number of children present during each sample with feeding was 10.86. This is substantially greater than the average number of children present for samples where no human feeding took place, which was 1.87. However, it is important to note that we rarely observed the children actually feeding the macaques. All children were observed in cars with adults, and it was the adults who threw food to the macaques in nearly all cases.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Of the 749 cars observed slowing or stopping during samples, 468 of them were recorded during samples where humans fed macaques (Fig. 2). This is significantly greater than the 281 cars recorded when no feeding occurred ($\chi^2 = 46.688$, $P<0.05$). However, of the 468 that slowed or stopped during feeding events actual feeding was observed from only 80 individual cars. The mean number of cars recorded as slowing or stopping during samples containing human feeding of the macaques was 9.26. This is substantially higher than the average number of such cars observed in samples where such feeding did not take place ($\bar{x} = 2.13$).

One hundred thirty-three people on foot were observed in samples where there was human feeding of macaques. This was significantly less than the 172 people on foot when no feeding occurred ($\chi^2 = 4.9787$, $P<0.05$). However, of those 133 people present during feeding samples only 11 individuals (adult male humans) actually fed the macaques. The average number of observed people on foot was also higher in samples where human feeding took place, at 2.66 vs. 1.28 when feeding did not take place (Fig. 2).

Seven hundred twenty-four instances of noncontact interaction between macaques and humans were observed. These noncontact interactions included macaque behaviors such as approach toward humans, visual monitoring of humans, moving away from humans, collecting food provided by humans (w/o contact), and threats. The vast majority of these interactions were characterized by a distance of at least 1–2m between the humans and the macaques. Of these instances, 420 took place in samples when humans were feeding the macaques. This is significantly greater than the number of noncontact interactions that took place in samples without feeding (304, $\chi^2 = 18.586$, $P<0.05$). During samples containing human feeding of the macaques, the mean number of noncontact macaque–human interactions was 8.3 but was only 2.31 in samples with no feeding (Fig. 3). There were 27 noncontact threats by macaques toward humans and only six contact interactions throughout the entire observation period. Of the six contact interactions, only three involved any skin–skin contact; none involved a bite or possible scratch. All were in the context of humans handing food to macaques.

DISCUSSION

Number of Macaques Present During Feeding vs. Nonfeeding

On average, when humans offered food, there were more macaques present than when humans did not offer food. We suggest that macaques are more likely to be present (or to move to a given location) where human food is available. It is also possible that when food is made available more macaques will move out of the forest toward the roadside.

Presence of Children

There were significantly more children present overall during feeding than nonfeeding samples ($\chi^2 = 107.385$, $P<0.05$) and on average the number of children present during feeding samples was substantially higher than the number of children present during nonfeeding. It is possible that parents engage in feeding to entertain their children and/or that feeding is initiated by children's interest or urging. It is important to consider that

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

although there is a formal policy against feeding macaques, the informal practice of rangers and wardens in this area when children are present during feeding is to warn the accompanying adults about the fine rather than to apply a fine directly (personal communication, NParks).

Presence of Cars and People on Foot

When feeding occurs people primarily feed macaques from cars at the two sites. Most often, the humans would roll down one car window slightly and throw food onto the side of the road where the macaques retrieved it. Macaques likely learn to associate slowing cars with the possibility of feeding (see www.wildsingapore.com). On average, there were significantly more cars present during samples with human feeding than nonfeeding samples. Overall, there were fewer people on foot present during instances of feeding than nonfeeding ($\chi^2 = 4.9787$, $P<0.05$). However, there were slightly more people on foot present on average during each instance of feeding than nonfeeding. This is likely because of the pattern of one person in a car or on foot feeding the macaques, causing more macaques to appear and attracting more cars and people to stop and watch.

Food and Interaction with humans

The macaques are significantly more likely to interact (contact and noncontact) with humans when food is present ($\chi^2 = 18.586$, $P<0.05$). These interactions rarely involved physical contact between macaques and humans. On average, there were more interactions during human feeding than nonhuman feeding contexts. This suggests that in Singapore, as in Bali, Gibraltar, and Mt. Emei, food presence may be a prime instigator of macaque–human interaction. Contact interactions mainly involved tourists in Bali and Gibraltar and religious Pilgrims at Mt. Emei, but the human interactors observed in Singapore were largely Singaporean. The overrepresentation of residents and the relatively low level of feeding in Singapore may be causally related to the high level of noncontact interactions. The tourist-based interaction pattern in Bali and Gibraltar and the centrality of food conflicts at Mt. Emei are suggested to be the underlying causes of the high level of contact interactions and aggression [Fuentes, 2006; Zhao, 2005]. It is critical to emphasize that in all four locations food is a prime player in instigating macaque–human interactions.

Risk of Interspecific Pathogen Transmission

Because of the pattern of interactions at UPR and OUT (noncontact, mostly with humans in cars, and frequently with windows mostly up and/or 1–2m distance between the humans and macaques) our observations suggest that there is a relatively low risk of zoonotic pathogen transmission in Singapore, at least at these locations. The overall rate of feeding and interaction is low and the occasional instances of feeding at these sites do not appear to provoke physical contact interactions between macaques and humans as they do in other countries. Thus, the risk of zoonotic pathogen transmission through macaque– human contact is likely to be minimal in the forest edges of Singapore.

However, because of the spatial overlap between humans and macaques at these forest edges, there remains a risk to the macaques via aerosol-distributed human pathogens (especially respiratory pathogens) [Jones-Engel et al., 2006]. The fact that macaques will

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

enter rubbish bins and utilize human water sources in these forest edge environments also places them at risk of contracting human pathogens. In addition, the various shared contact surfaces in UPR Park (such as benches and low walls) present both macaques and humans with structural venues for potential bidirectional pathogen transmission. However, these risks are dependent on the overall health of the Singaporean human populations, the enforcement of laws prohibiting contact with the monkeys, and the effective management of rubbish and water sources in the areas where the forests (and monkeys) overlap with human habitations.

ACKNOWLEDGMENTS

We specifically thank Sharon Chan and Benjamin Lee for guidance and assistance on this project. We also thank the staff of the National Parks Service for their facilitation and assistance and the government of Singapore for granting us permission to conduct this research. Gregory Engel, Michael Schillaci, and John Sha also contributed to making this project possible. We thank Benjamin Lee for his extensive commentary on earlier drafts of this article. This research was conducted in compliance with the University of Notre Dame IACUC 07-060.

Contract grant sponsors: University of Notre Dame Faculty Research Program Grants; Dean of the College Arts and Letters at the University of Notre Dame.

REFERENCES

Altmann J. Observational study of behavior: sample methods. Behaviour. 1974; 49:227–267. [PubMed: 4597405]

Chatterjee K. Assessment and demarcation of trail degradation in a nature reserve, using GIS: case of Bukit Timah Nature Reserve. Land Degrad Develop. 2007; 18:500–518.

Engel G, Hungerford LL, Jones-Engel L, Travis D, Eberle R, Fuentes A, Grant R, Kyes R, Schillaci M. Macaque Risk Analysis Workshop Group. Risk assessment: a model for predicting cross-species transmission of simian foamy virus from macaques (*M*. fascicularis) to humans at a monkey temple in Bali, Indonesia. Am J Primatol. 2006; 68:934–948. [PubMed: 16900504]

Fuentes A. Human culture and monkey behavior: assessing the contexts of potential pathogen transmission between macaques and humans. Am J Primatol. 2006; 68:880–896. [PubMed: 16900502]

Fuentes A, Gamerl S. Disproportionate participation by ages/sex class in aggressive interactions between long-tailed macaques (*Macaca fascicularis*) and human tourists at Padangtegal Monkey Forest, Bali, Indonesia. Am J Primatol. 2005; 66:197–204. [PubMed: 15940713]

Jones-Engel L, Engel GA, Schillaci MA, Lee B, Heidrich J, Chalise M, Kyes RC. Considering human to primate transmission of measles virus through the prism of risk analysis. Am J Primatol. 2006; 68:868–879. [PubMed: 16900498]

Jones-Engel L, Engel G, Schillaci MA, Babo R, Froelich J. Detection of antibodies to selected human pathogens among wild and pet macaques (*Macaca tonkeana*) in Sulawesi. Am J Primatol. 2001; 54:171–178. [PubMed: 11443632]

Jones-Engel L, Engel G, Schillaci MA, Rompis ALT, Putra A, Suaryana K, Fuentes A, Beers B, Hicks H, White R, Allen J. Primate to human retroviral transmission in Asia. Emerg Infect Dis. 2005; 7:1028–1035. [PubMed: 16022776]

Lucas PW, Corlett RT. Seed dispersal by long-tailed macaques. Am J Primatol. 1998; 45:29–44. [PubMed: 9573441]

Sha, J. Status of the long-tailed macaque (*Macaca fascicularis*) in Singapore and the human–macaque conflict situation. Singapore: Final Report to the National Parks Board; 2008.

Zhao, QK. Tibetan macaques, visitors, and local people at Mt. Emei: problems and countermeasures. In: Paterson, JD.; Wallis, J., editors. Commensalism and conflict: the human–primate interface. Norman, OK: American Society of Primatologists; 2005. p. 376-399.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

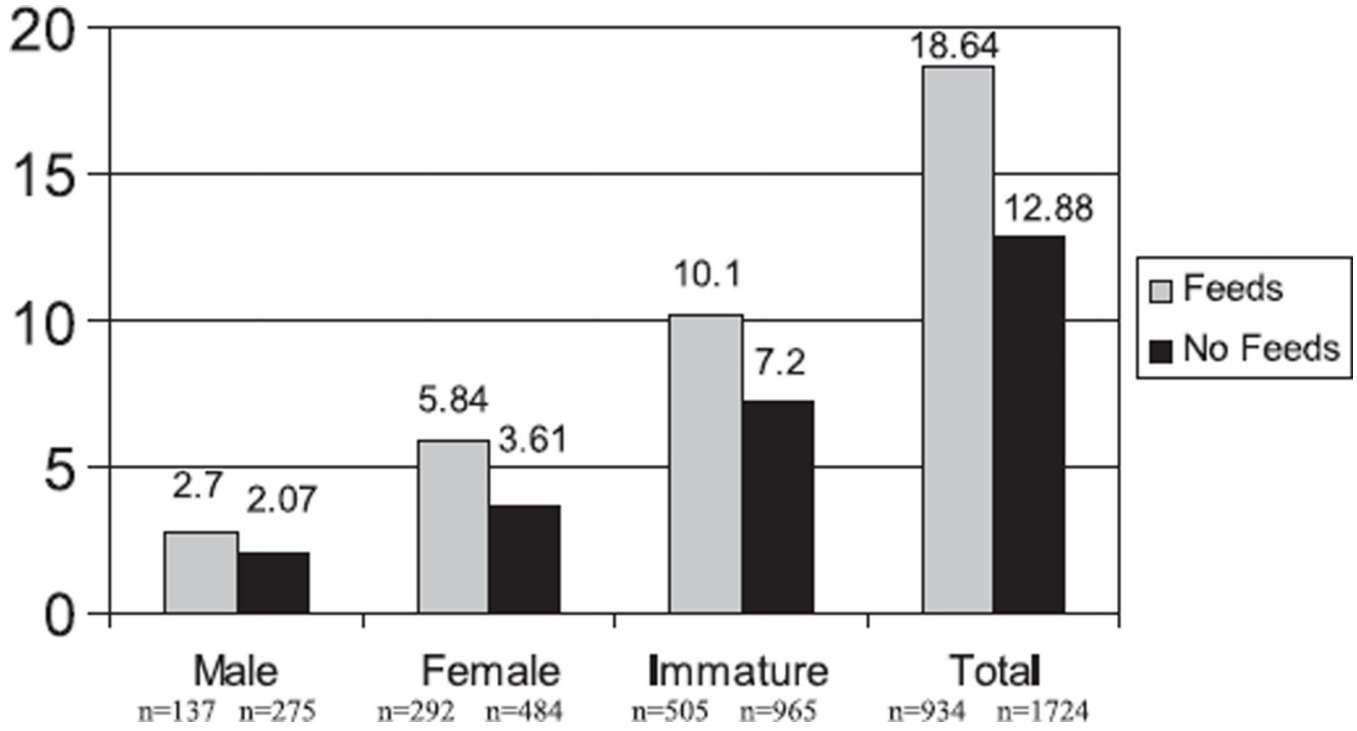

Fig. 1.

Mean number of macaques present during instances of feeding and nonfeeding by humans.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

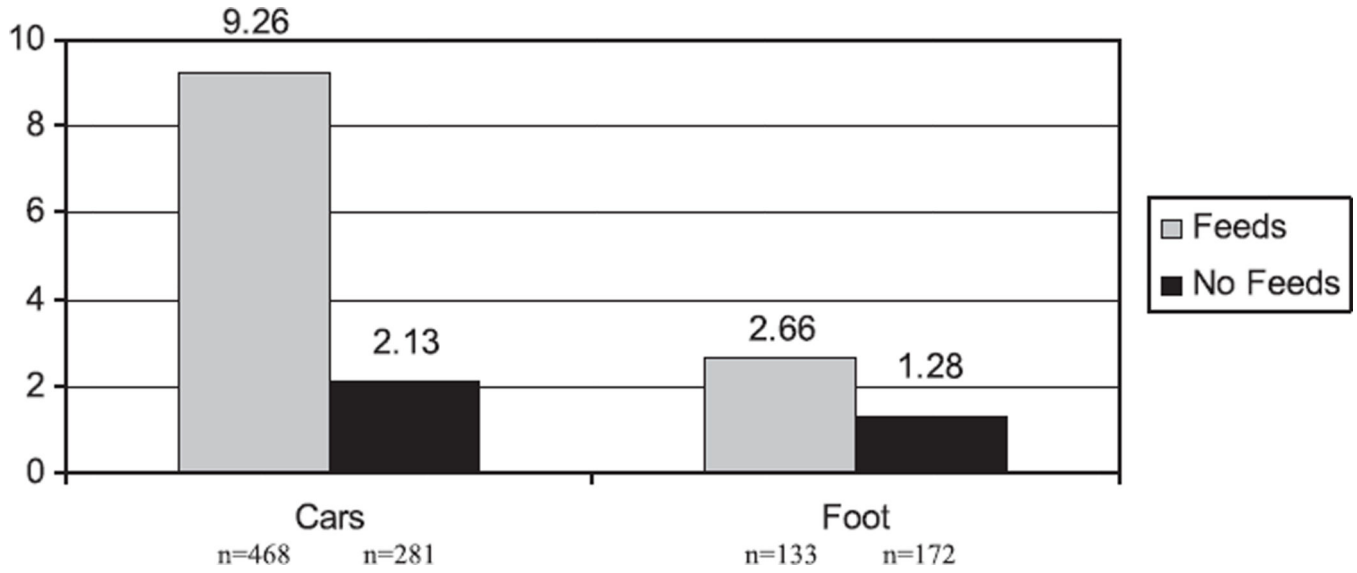

Fig. 2.
Mean number of cars and people on foot during feeding and nonfeeding by humans.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

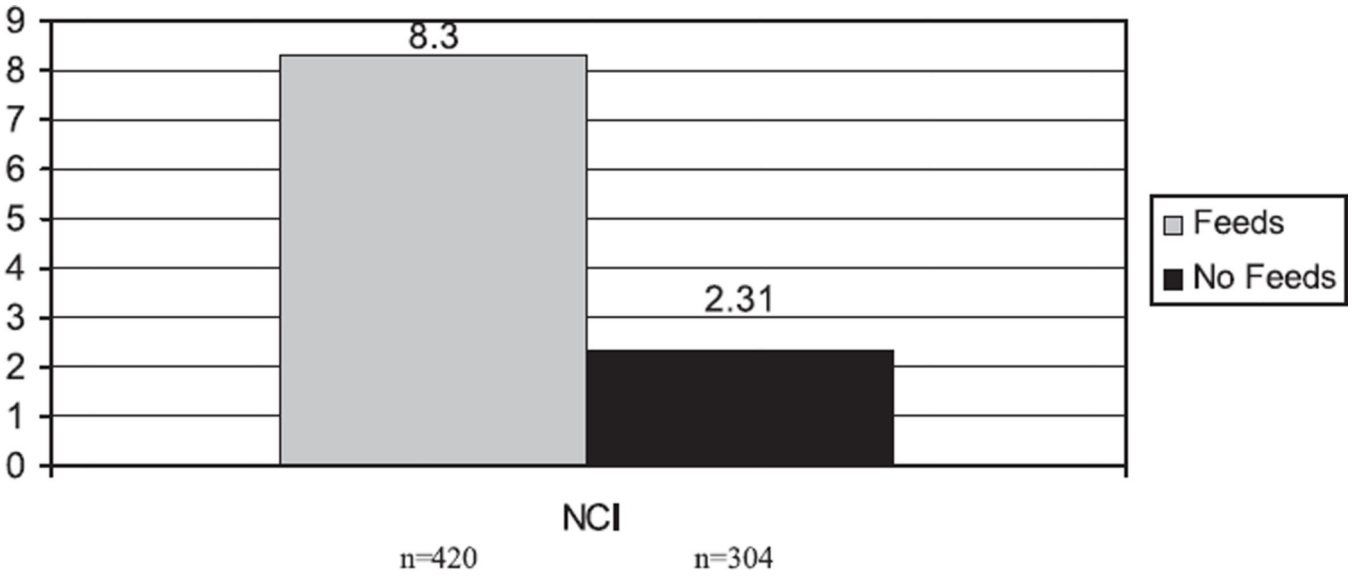

Fig. 3.
Mean number of noncontact interactions (NCI) during feeding and nonfeeding by humans.