ORANGUTAN – HUMAN INTERACTION IN REHABILITATION:

ORANGUTAN CONTRIBUTION TO INTERACTION AND CONFLICT

JOSHUA J. SMITH

A THESIS SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULLFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MASTER OF ARTS

GRADUATE PROGRAM IN PSYCHOLOGY

YORK UNIVERSITY

TORONTO, ONTARIO

OCTOBER, 2009

ABSTRACT

Orangutan-human interactions are potentially lethal. Developmental factors, especially early experiences and human contact, can predispose ex-captive rehabilitant orangutans to interact with humans. To better understand orangutan contributions to these interactions, I examined whether the human-directed behaviors of nine rehabilitants' (aged 5-14yrs) could be predicted by developmental factors such as age and duration/conditions of captivity and rehabilitation. Seventy-eight hours of human events were collected via focal observation. Younger vs. older rehabilitants had higher rates of interaction promoting behaviors and no response and lower rates of interaction inhibiting behaviors. Longer duration of rehabilitation was associated with higher rates of response to humans and interacted with entry age to predict higher rates of promoting behaviors for early vs. late entrants. Intense human contact during rehabilitation was associated with higher/lower rates of promoting/inhibiting behaviors respectively. In addition, rates of promoting/inhibiting behaviors differed between sexes/orangutan islands. Implications for orangutan rehabilitation and orangutan-human contact are discussed.

ACKNOWLEDGEMENTS

Tremendous thanks to my supervisor Anne E. Russon, without whom this research would not have been possible. Her invaluable comments, assistance, and deadlines kept me on track when I would otherwise have gone astray. Additional thanks to the Borneo Orangutan Survival Foundation's Orangutan Reintroduction Program at Samboja Lestari, the State Ministry of Research and Technology (RISTEK), the Indonesian Consulate, BOS Indonesia, York University, the Fieldwork Costs Fund, York Faculty of Graduate Studies, and BOS Canada. Thank you to all of the staff at Samboja Lestari, Rob Cribbie, Neil Wiener, Mike Friendly, and my research group at York. Thanks to Purwo Kuncoro for translation assistance and Ages Ferisa for logistical support during my research visit and during the preparation of this thesis. Thanks to Tessa Rossanda and BKSDA (Nature Conservation Agency, Indonesia) for assistance in gaining access to data from project files. Finally, thanks to the orangutans, my wife, and my girls for being there when I needed them and putting up with me.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ORANGUTAN – HUMAN INTERACTION IN REHABILITATION: ORANGUTAN CONTRIBUTION TO INTERACTION AND CONFLICT

Orangutans, like all of humans' great ape relatives, are dangerously close to extinction (UNEP-WCMC, 2009). Current estimates are that as few as 55,000 orangutans survive in the wild (Wich, et al., 2008). Humans' destruction of orangutans' habitat is the main cause for the decline of the orangutan. Continued loss and fragmentation of orangutans' habitat and human expansion are associated with closer and more frequent interaction and contact between humans and orangutans, resulting in potentially deadly conflict (Ancrenaz, Dabek, & O'Neil, 2007; Nelleman & Newton, 2002; Rijksen, 1995, 2001; Rijksen & Meijaard, 1999). Therefore, in areas where humans and orangutans co-exist, relationships between humans and orangutans are intrinsic features of conservation programs, plans for land management and use, subsistence and commercial agriculture, and orangutan tourism (Ancrenaz, et al., 2007; Dellatore, 2007; EIA, 1999; Felton, Engstrom, Felton, & Knott, 2003; Lackman-Ancrenaz, Ancrenaz, & Saburi, 2001; Rijksen, 1982; Rijksen & Meijaard, 1999; Russon, 2009; Salafsky, 1993; Yuwono, Susanto, Saleh, Andayani, & Utami Atmoko, 2007).

It is essential then that we understand how and why orangutans and humans interact in order to better understand and manage orangutan-human conflict. Considerable research effort has been devoted to understanding the factors that contribute to human-wildlife conflict worldwide (Hockings & Humble, 2009; Woodroffe, Thirgood, & Rabinowitz, 2005), but little has been devoted to orangutan-human conflict and even less to the orangutan-specific factors involved. This project aimed to improve our understanding of orangutan-human conflict by examining orangutan agendas in the context of ex-captive orangutan rehabilitation. Specifically, I was interested in orangutan initiatives, i.e. behaviors originated by orangutans and directed toward humans, which served either to promote or inhibit potential interaction with humans. My aim was to identify which, if any, developmental factors may predispose orangutans toward human orientation, e.g., interest in humans as well as human objects, actions and events.

THEORETICAL BACKGROUND

Orangutan – Human Conflict

Orangutan-human conflict is a special case of human-great ape conflict which is in turn a special case of human-wildlife conflict. Human-great ape conflict has been defined as any interaction between humans and great apes resulting in negative social, economic, cultural, ecological/environmental, or conservation outcomes. (Hockings & Humble, 2009). *Human*-great ape conflict definitions place humans first. The wording in this document, *orangutan*-human conflict, reflects the emphasis this document places on orangutans and their contributions to conflict.

In short form, orangutan-human conflict may be viewed as any situation where human and orangutan interests clash and the actions of one species result in detriment to the other. Most cases of conflict between humans and orangutans stem from human actions. Human interests, e.g., forest resource extraction, agriculture, and population expansion are often counter to orangutan interests and result in orangutans being displaced, dismissed, and dispatched as an inconvenience to human activities; alternatively they result in orangutans being killed as pests or captured for trade on the illegal wildlife market (Ancrenaz, et al., 2007; Rijksen, 2001; Rijksen & Meijaard, 1999). However, conflicts between orangutans and humans also occur as a result of orangutans' actions, especially crop-raiding. Conflict between wild orangutans and humans occurs in commercial enterprises like oil palm plantations (Buckland, 2005; CITES/GRASP, 2006; EIA, 1999; Felton, et al., 2003; Whitten & Ranger, 1986; Yuwono, et al., 2007) or in subsistence crop raiding (Ancrenaz, et al., 2007; CITES/GRASP, 2006; Lackman-Ancrenaz, et al., 2001; Salafsky, 1993). However, discussions of orangutan-human conflict have typically focused on methods for preventing orangutans' utilizing human crops and entering human crop areas without first assessing the factors contributing to the conflict, such as why orangutans are drawn to these food resources. To date, the contribution of orangutans to orangutan-human conflict has not been systematically addressed.

Orangutan-human interaction has potentially lethal consequences (Dellatore, 2007; Grundmann, 2005; Lackman-Ancrenaz, et al., 2001; Rijksen, 1995, 2001; Yeager, 1997). However, there have been surprisingly few studies of orangutan-human interaction. Discussions of orangutan-human interactions have typically focused on orangutan welfare, contact regulations (and violations), and human perceptions of orangutans in tourism or evaluations of rehabilitation procedures (Agoramoorthy, 2002; Agoramoorthy & Hsu, 2005; Beck, et al., 2007; Dellatore, 2007; Fernando, 2001; Leiman & Ghaffar, 1996; Rijksen, 1997; Russell, 1995, 2001, 2004; Russon & Russell, 2005; Snaith, 1999; Yeager, 1997) Orangutan-human interaction and conflict remain relatively understudied. One study that did systematically assess orangutan behaviors in relation to humans (Dellatore, 2007) found that orangutans adjusted their activity levels and ranging patterns to take advantage of human tourists as a source of easily obtainable foods. As with orangutan-human conflict, orangutan- initiated interactions and the factors that may predispose orangutans to interact with humans have not been systematically investigated.

Effects of Human Captivity

Logging, hunting, pet trade, habitat degradation and conversion, and human expansion result in some orangutans being orphaned, removed from the forest, and held captive, if not outright killed, by humans (Rijksen, 2001; Rijksen & Meijaard, 1999; Russon, 2009). Human captivity departs drastically from the developmental environment normally experienced in the wild (Russon, 2009; Snaith, 1999). Wild orangutan development is characterized by a long period of at least partial maternal dependence in a semi-solitary social environment (van Adrichem, Utami, Wich, van Hooff, & Sterck, 2006; van Noordwijk, et al., 2009; van Noordwijk & van Schaik, 2005). Under normal conditions, developmental scheduling paces orangutan abilities so that age-related changes in their physical and cognitive abilities are normally aligned with changes in their social and ecological needs and opportunities, the challenges they face in the forest, and the learning opportunities that are available to them (Russon, 1998, 2002a, 2002b, 2003a, 2006).

Human rearing in captivity disrupts the course and scheduling of normal orangutan development. Most captive orangutans have been orphaned, as a result of human action, as infants in their first four years of life (Swan & Warren, 2001). Orphans reared without a mother are deprived of important early learning opportunities and social supports (Fox, Sitompul, & van Schaik, 1999; Russon, 2003a; van Noordwijk & van Schaik, 2005). Captive environments do not normally offer opportunities to learn forest expertise (i.e., knowledge and skills), and orphaned orangutans have been shown to have poorly developed forest competencies (Bowden, 1980; Kaplan & Rogers, 1994; Rijksen & Rijksen-Graatsma, 1975). Orphans in human captivity are also unlikely to interact socially with other orangutans and thus miss out on age-appropriate social experiences, probably retarding and/or distorting their social development. Some orphaned captive orangutans have shown social deficits similar to those displayed by socially isolated monkeys, including signs of depression (e.g., listlessness, social withdrawal and fear) and decreased/deficient social behavior (Harlow, Dodsworth, & Harlow, 1965; Russon, 2009).

In addition to depriving orangutan orphans of species-normal physical and social development, abnormal rearing in captivity is detrimental because it establishes human-oriented early learning, effectively "humanizing" them and increasing the potential for disastrous future conflicts with humans (Rijksen & Meijaard, 1999; Russon, 1996, 2009). Young orangutans, especially infants, are highly dependent. Deprived of their biological mothers and raised by humans, they typically orient socially and develop attachments to humans, likely as maternal substitutes (Rijksen & Meijaard, 1999; Russon, 1996, 2009). Earlier and longer captivity typically produce more detrimental and longer-lasting effects than later and shorter captivity (Aveling & Mitchell, 1982; Grundmann, 2005; Russon, 2009). Prolonged captivity and contact with humans provides a longer period for orphans to orient socially to humans, and probably results in increased interest in humans, human objects, and human behaviors and extensive acquisition of abilities for functioning within the parameters of the human social and physical world. In lieu of foraging expertise, captive orangutans learn how to identify and process human foods. Instead of learning to manipulate forest vegetation, captive orangutans learn to manipulate human objects. Finally, without conspecific interaction, orphans interact with and develop important social relationships with humans. Orangutans in captivity are correspondingly *not* orangutan socialized, oriented, or knowledgeable.

Problems with Orangutan – Human Interaction in Rehabilitation

Orphaned, immature orangutans that survive contact and conflict with humans are generally captured and enter the illegal pet trade, typically as infants (Rijksen & Meijaard, 1999). Older immatures are generally not desired for the pet trade because they quickly become stronger than humans and difficult to manage; some may become dangerously aggressive (Russon, pers. comm.).

When detected, illegally held orphans are confiscated and sent to projects that aim to rehabilitate them for return to free forest lives. Rehabilitation involves the remediation of medical and physical problems, training in deficient social and ecological expertise necessary for survival, and establishing independence from humans (Beck, et al., 2007). Reintroduction programs aim to establish self-sustaining populations in areas within a species' historical range but where there is currently no resident population (Beck, et al., 2007). Following successful rehabilitation, groups of ex-captives may be released at either a reintroduction or an interim site (while an appropriate reintroduction site is sought) where they receive variable amounts and duration of human support as they adjust to their new environment (Beck, et al., 2007; Russon, 2009). Ex-captive orangutans may require extensive human support to acquire the expertise they need before they are ready to return to the forest. However, rehabilitation projects must be careful to balance human contact and support with increasing orangutan independence and resocialization to other orangutans in a manner that promotes the acquisition of increasingly complex orangutan- and forest-oriented skills and knowledge and appropriate social relationships with conspecifics while gradually reducing dependence on human support (Russon, 2009; Snaith, 1999).

Orphan orangutans entering rehabilitation programs have endured variable lengths of captivity, from days to years, under conditions ranging from pampered to harsh and abusive (Aveling & Mitchell, 1982; Grundmann, 2005; Rijksen, 1978, 1982; Rijksen & Meijaard, 1999). The majority of ex-captive orphans arrive at rehabilitation projects as infants under four years of age (Harrisson, 1960; Swan & Warren, 2001) and are unlikely to be able to survive independently in the forest immediately following confiscation because immature orangutans in the wild remain at least partially dependent on their mothers for up to 11 years (van Noordwijk, et al., 2009; van Noordwijk & van Schaik, 2005). However, continued human contact during rehabilitation may promote continued dependence on, attachment to and social identification with humans, which has been argued to delay, disrupt or distort the rehabilitation process (Rijksen, 1978, 1997, 2001; Rijksen & Meijaard, 1999; Russon, 2001, 2009; Russon & Galdikas, 1993).

Early orangutan rehabilitation practices promoted direct human-orangutan interaction and strong human social and ecological support (Rijksen & Meijaard, 1999;

Russell, 1995; Russon, 2007; Russon & Galdikas, 1995; Yeager, 1997). These practices have been widely criticized because of the drawbacks caused by continued human-orangutan contact, including the transmission of human diseases, failure to promote species-specific feral expertise acquisition, lack of species-appropriate socialization, and failure to dehumanize ex-captives (i.e., eliminate their social orientation to and establish independence from humans) (Aveling & Mitchell, 1982; Lardeux-Gilloux, 1995; Rijksen, 1995, 1997; Rijksen & Meijaard, 1999; Smits, Heriyanto, & Ramono, 1995; Yeager, 1997). Failure to dehumanize rehabilitants may result in rehabilitants' attempts to continue their relationships with humans and to incorporate humans into their social order (Lardeux-Gilloux, 1995; Rijksen, 2001; Russon, 2007; Russon & Galdikas, 1993). This may have a number of negative consequences including a lack of independence from human assistance (Rijkesen, 1974) and greater terrestriality (Peters, 1995; Riedler, 2007; Russon, 1996). Rehabilitant orangutans that remain dependent on humans post-release spend more time on the ground and closer to humans than ex-captives less dependent on humans, which may be linked to increased predation, deficient nesting skills, poor arboreal travel, and inefficient foraging (Peters, 1995; Riedler, 2007; Rijksen, 1978; Russon, 1996). Additionally, while provisioning may be necessary in the early stages post-release to help rehabilitants adjust to their new environment, long term reliance on human nutritional support detracts from adopting species-appropriate ranging and foraging patterns, potentially further slowing the readaptation process (Dellatore, 2007; Riedler, 2007). Finally, failure to dehumanize rehabilitant orangutans pre-release creates the potential for post-release conflicts with humans in plantations, forest concessions, and villages surrounding release sites as well as in orangutan tourism, because rehabilitants remain attracted to and do not fear humans (Dellatore, 2007; Russon & Galdikas, 1995; Snaith, 1999). Potential problems include cross-species sexual advances, aggressive encounters leading to human and orangutan injury, orangutan death, and orangutans' raiding human villages and crops (Grundmann, 2005; Lardeux-Gilloux, 1995; Rijksen, 1995, 2001; Russon, 2009; Yeager, 1997; Yuwono, et al., 2007).

More recent approaches to orangutan rehabilitation discourage non-essential human-orangutan contact and interaction, recommend that ex-captives be weaned from human assistance as soon as possible to reduce attachment to and identification with humans, and encourage the use of species-appropriate social support mechanisms such as peer socialization (Rijksen & Meijaard, 1999; Smits, et al., 1995). Orangutan rehabilitation at the Borneo Orangutan Survival Foundation's Samboja Lestari Orangutan Reintroduction Project (ORP) follows a stage-based procedure to gradually reorient ex-captives toward conspecifics and away from humans and to provide ex-captives with access to species-appropriate sources of new expertise and learning as well as social partners and potential mates. Upon arrival at ORP, ex-captives are medically examined and quarantined. Post-quarantine rehabilitation procedures differ by age and expertise, and include nursery care (baby house), socialization cages, forest school, island housing, and halfway house. Younger and less skilled individuals receive more human support and may undergo more intense and/or lengthier rehabilitation than older or more skilled ex-captives.

Rehabilitant Orangutan Agendas

While orangutan-initiated interaction with humans is understudied, rehabilitants are known to approach and seek contact with humans both pre- and post-release (Aveling & Mitchell, 1982; Dellatore, 2007; Donaghy, 2002; Grundmann, 2005; Riedler, 2007; Rijksen, 2001; Russell, 1995; Yeager, 1997). For example, released ex-captives identified as “human-bonded” actively sought humans out for social support and play (Riedler, 2007). Orangutans decide who and what they will attend to or interact with and when (Adams, 2005; Byrne & Russon, 1998; Russon & Galdikas, 1993, 1995) and pursue their own agendas. This occurs regardless of the regulations, impediments, or barriers established by humans to prevent contact between orangutans and humans (CITES/GRASP, 2006; Russon, 2000; Salafsky, 1993; Sowards, 2006; Yuwono, et al., 2007). For example, ex-captives in rehabilitation and rehabilitated orangutans in post-release environments are known to manipulate tourists, apparently to achieve specific goals, e.g., they approach tourists to solicit carrying to feeding sites (Russell, 1995; Snaith, 1999). Rehabilitants and wild orangutans also steal or solicit food from tourists (Dellatore, 2007; Donaghy, 2002; Russon, Susilo, & Russell, 2005), steal human objects, such as cameras, backpacks, and clothing, and occasionally to barter with humans, essentially ransoming the pilfered goods back to them (Russell, pers. comm.; Russon, pers. comm.).

However, orangutan-initiated interactions may be much more dangerous than manipulation and theft. Rehabilitants that have been released or that range outside of rehabilitation centers and wild orangutans have been reported to attack humans

(Dellatore, 2007; Yeager, 1997). Dellatore (2007) found that orangutans at Bukit Lawang altered their ranging patterns to remain close to human tourist areas, occasionally attacking tourists and guides to obtain human foods or objects and in response to tourist harassment. Following release, rehabilitants who interact with humans outside rehabilitation facilities may face serious injury, poisoning, and death at the hands of humans (Rijksen, 2001). Grundmann (2005) reported being told that reintroduced rehabilitants had returned to the forest monitoring post with bullet wounds and burns following contact with loggers. Conflict may also occur if free-ranging rehabilitants raid crops. Orangutan crop raiding has led plantation managers to offer bounties for killed orangutans and local villagers to kill orangutans as "pests" for raiding their gardens (Lackman-Ancrenaz, et al., 2001; Rijksen, 1995).

Several factors may contribute to orangutan-initiated interaction. Age may be an important factor in initiating interactions with humans. In the wild, interactions between adult and immature orangutans are typically initiated by immatures (Galdikas, 1984). Therefore, it is not unreasonable to expect that younger rehabilitants might initiate more interactions with humans than older rehabilitants. Infants' dependence probably makes human surrogates the focus of their interactions, as mothers are in the wild. Also, juveniles have been noted to approach humans, initiate closer contact with humans, and show a willingness to engage with and use human objects more often than adults (Lardeux-Gilloux, 1995; Sandbrook & Semple, 2006; Woodford, Butynski, & Karesh, 2002). Snaith (1999) found that juvenile rehabilitants initiated more than twice as many interactions with humans as adult rehabilitants initiated. Exposure to humans during rehabilitation probably also affect orangutans' agendas. For example, rehabilitation projects open to tourists expose rehabilitants to a large number of humans, which has been associated with problematic orangutan-human interaction (Dellatore, 2007; Rijksen, 1997; Russell, 1995).

Duration and conditions of captivity may also contribute to interactions with humans. Ex-captives arriving at rehabilitation projects at younger vs. older ages have probably experienced shorter vs. longer duration captivity respectively. Younger age at capture from the wild and longer duration of captivity have been implicated as factors contributing to human orientation and social attachment in ex-captive orangutans (Aveling & Mitchell, 1982; Grundmann, 2005; Rijksen, 1978, 1997, 2001; Rijksen & Meijaard, 1999; Russon, 2001, 2009; Russon & Galdikas, 1993; Snaith, 1999). The conditions of captivity may also contribute to human orientation. While their effects on orientation are probably different, both pampered and harsh treatment have been implicated as contributing to social orientation to, and dependence on, humans (Aveling & Mitchell, 1982; Peters, 1995; Rijksen, 1982).

Finally, duration of rehabilitation and the degree of human contact experienced in rehabilitation may be important factors in orangutans' human-directed behaviors. Prolonged interaction and identification with humans in rehabilitation have the potential to promote human orientation (Rijksen, 1978, 1997, 2001; Russon, 2001; Russon & Galdikas, 1993). Additionally, rehabilitants who require more human support, e.g., infants, and interact more frequently with humans probably experience closer relationships with humans.

CURRENT STUDY

This study sought to address the paucity of information on orangutan-human interactions, specifically orangutans' contributions to these interactions. These probably change with developmental factors, orientation to humans, and captive and rehabilitation history (Adams, 2005; Byrne & Russon, 1998; Russon & Galdikas, 1995). Orangutan-initiated human-directed behaviors were assessed to determine whether rehabilitant orangutans' interest in humans, human activities, and human foods/objects (i.e., human orientation, including attending and responding to humans) varied in relation to individual developmental and history factors. I hypothesized that human orientation would vary between individual orangutans as a function of current age, age at capture, duration and conditions of captivity, duration of rehabilitation, and the degree of human contact associated with the rehabilitation procedures experienced. Seven predictions were made.

1) Younger vs. older rehabilitant orangutans will have higher rates of human-directed behaviors that promote orangutan-human interaction.

2) Orangutans captured from the wild at younger vs. older ages will have higher rates of human-directed behaviors that promote orangutan-human interaction.

3) Longer vs. shorter duration of captivity will be associated with higher rates of human-directed behaviors that promote orangutan-human interaction.

4) Pampered vs. harsh/abusive captive conditions will result in human-directed behaviors that respectively promote vs. inhibit orangutan-human interaction.

5) Younger vs. older age at entry to rehabilitation will be associated with higher rates of human-directed behaviors that promote orangutan-human interaction.

6) Longer vs. shorter duration of rehabilitation will be associated with higher rates of human-directed behaviors that promote orangutan-human interaction.

7) Intensity of human contact during rehabilitation will be associated with different rates of human-directed behaviors. Ex-captives experiencing the most contact-intense procedures will show the greatest human orientation respectively.

METHODS

Research Setting

Data were collected between July 6th and September 22nd 2008 at ORP (1°03’00.65” S, 116°59’27.05” E), Samboja Lestari, East Kalimantan (East Indonesian Borneo), 44 km northeast of Balikpapan (See Figure 1). All observations for this study took place at ORP’s “Orangutan Islands” located within the Samboja Lestari Reforestation Project (See Figure 2). Water barriers surrounding the islands were a minimum of ten meters wide and designed to be impossible for orangutans to cross without assistance and to prevent direct orangutan-human contact outside of veterinary and management procedures. At the time of this study ORP maintained six human-made islands, and islands 3-6 were inhabited by orangutans. Orangutans on islands 3-5 were undergoing rehabilitation toward forest release, and were off limits to non-project personnel. Island 6 orangutans were ineligible for release due to positive hepatitis B status. In this setting, the islands provided an opportunity to observe rehabilitant orangutans living and interacting in social groups in semi-naturalistic settings, and to assess behaviors they directed to ORP staff and visitors.

Figure 1. Location map, Samboja Lestari Orangutan Reintroduction Program

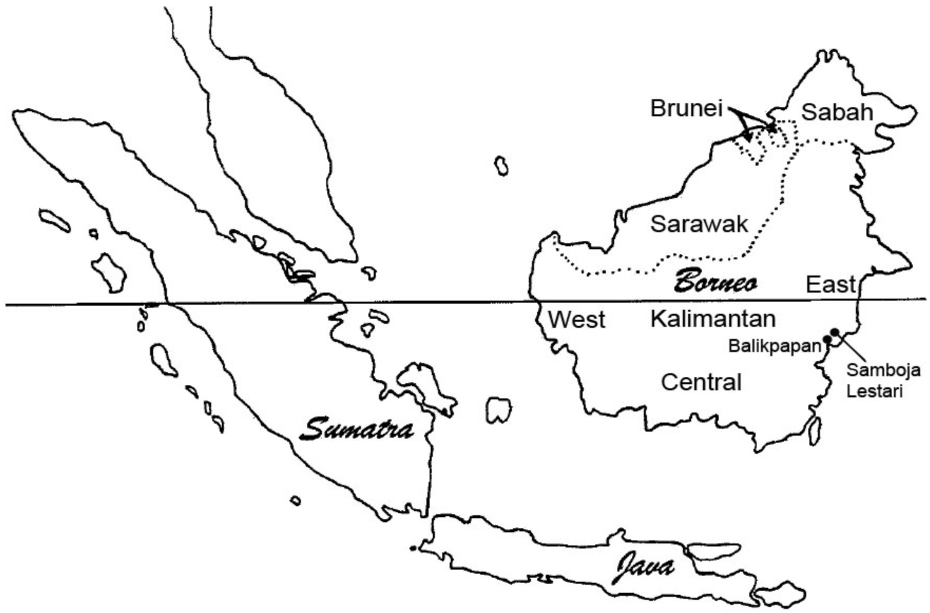
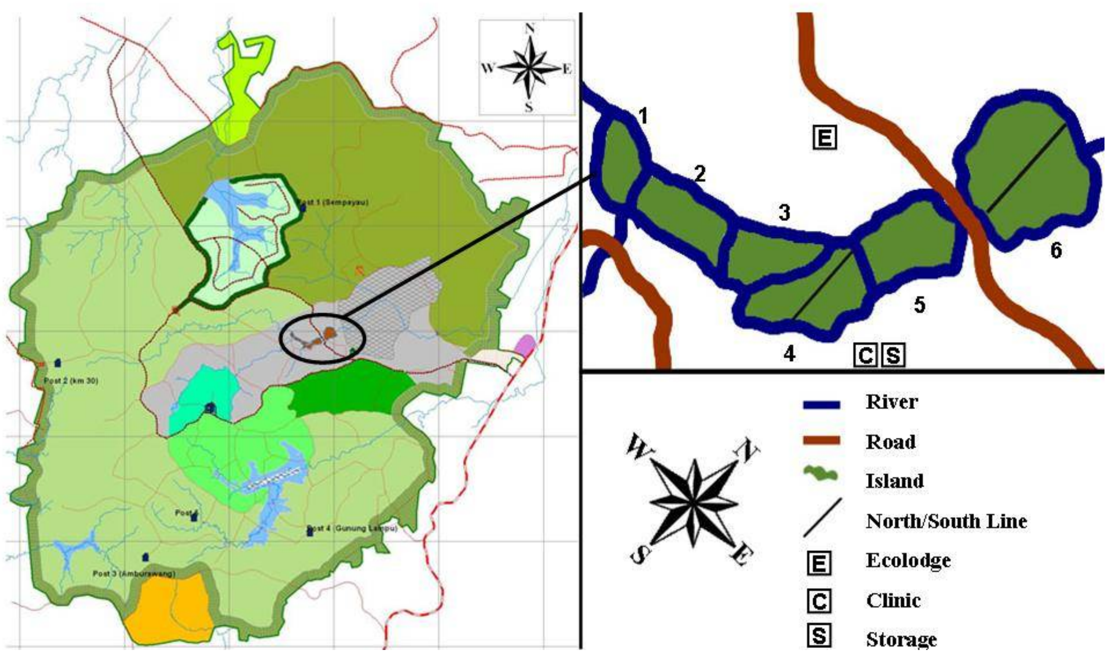


Figure 2. Samboja Lestari area map and location of the orangutan islands.



Additional ORP facilities near the islands included storage and a veterinary clinic (See Figure 2). Storage and veterinary facilities were focal areas for human activities related to the islands and were especially salient to I4, being in full sight and directly adjacent. The veterinary clinic was the base of operations for all island medical procedures and housed infant orangutans regularly transported by humans past the islands to the forest school. The storage facility served as a food holding and preparation area as well as a staff lounge area. In addition, an Ecolodge located approximately 0.25 km from the islands accommodated visitors to the Samboja Lestari projects, including ORP (See Figure 2). Ecolodge and other project visitors typically could only view orangutans on I6.

Subjects

The subjects for this study were nine ex-captive rehabilitant orangutans (five females/I6 and four males/I4) at ORP as of 06-Jul-08. Subjects were chosen based on accessibility for monitoring and high access to humans and human activities (i.e., rehabilitants most frequently exposed to humans). I6 females were selected because I6 was the only ORP area where project visitors could observe orangutans. I4 males were selected to balance the sex ratio as well as possible and because of their direct proximity to staff areas. Ages ranged from 5-14 years for females/I6 and 5-9 years for males/I4 (see Table 1). All ages are estimates based on dental eruption at intake, obtained from project medical records. As age was a key factor in this study's hypotheses, official age data were not obtained until observations had been concluded. Subject males shared I4 with four infant females (all age 4 years), one of which was removed during the first two weeks of my observations for poor health. A sixth female (age 12 years) was placed onto

I6 halfway through my visit. Detailed diagrams of subject islands are available in Appendix A.

Table 1.

Biographical Data for Subject Orangutans on Islands 4 and 6

Name	Sex	Island	Arrival Date	Dentition[1]	Arrival Age[2]	Current Age[3]	Age Range[4]	Age Class[5]	Yrs in Rehab
Nila	F	6	22-Apr-98	M1	4-6	14	14-16	A1/A2	10.25
Siah	F	6	21-Oct-01	M1	4-6	13	11-13	A	6.75
Emmy	F	6	16-Jun-97	E	1-4	12	12-16	A	11.00
Wulani	F	6	20-Mar-07	M2	6-8	10	7.33-9.33	A	1.33
Oneng	F	6	05-Apr-06	E	1-4	5	3-6	I/J	2.25
Agus	M	4	03-Feb-03	E	1-4	9	7.5-9.5	J	5.50
Jovan	M	4	24-Jul-02	E	1-4	9	7-10	J	6.00
Sipur	M	4	28-Jan-03	E	1-4	9	7.5-9.5	J	5.50
Hamzah	M	4	27-Apr-07	M1	4-6	5	5-7	I/J	1.25

[1] Dental eruption on arrival, E = deciduous dentition, 1st molar not fully erupted, M1 = 1st molar fully erupted, M2 = 2nd molar fully erupted (Fooden & Izor, 1983; Winkler, Schwartz, & Swindler, 1991)
[2] ORP age range estimates in years, based on dental eruption on arrival
[3] ORP age estimates in years, for orangutans as of July 2009
[4] Age range in years at time of study
[5] Age class, I (infant, 0-4/6yrs), J (juvenile, 4/6-7/9yrs), A1 (adolescent, 7/9-11/13yrs), A2 (adult, females 15+, males 20+) (Russon, 2003b; van Noordwijk, et al., 2009)

Design

Sampling

Data collection was strictly observational, with the exception of biographical data obtained from project records. Rehabilitant behaviors were sampled using a combination of focal individual, scan, and *ad libitum* methods (Altmann, 1974; Martin & Bateson, 2007). Observational data on orangutan activity and human-directed behaviors were collected using a modified version of focal individual sampling. Three different focal individuals were each observed per day for fixed 3-hour time periods (observation sessions), resulting in nine hours of observation per day. Time periods were chosen for the likelihood that humans would be present and defined as early day (08:00-11:00), mid day (11:00-14:00), and late day (14:00-17:00). Based on the presence of humans at I4 and I6, it was determined that the best time to observe orangutans on I4 was early day only. ORP staff activity at I4 was typically limited to early morning, with little to no activity during the mid and late day periods. Human presence (visitors and ORP staff) at I6 was much more variable throughout the day. As such, I6 observation sessions were spaced across all three time periods. Focal individual samples followed an *a priori* observational schedule to ensure an equal distribution of observation sessions by subject across days of the week and months (e.g., all orangutans observed during all months) and to ensure that, on I6, individuals were observed during all time periods. Instantaneous scan samples were scheduled at 5-minute intervals to provide information on the focal's proximity to other orangutans. *Ad libitum* observations were included throughout to provide additional incidental information on events that were relevant but not predictable.

Data Collection

Three types of data were collected; biographical/historical, general behavioral, and human orientation data. Biographical history data were obtained from ORP records after all observational data had been collected, rather than in advance, to avoid biasing observations. Observational data were recorded for general orangutan behaviors and for orangutan-initiated human-directed behaviors within independent human events. Human events were defined as starting when humans arrived at the island (individually or in a group) and ending when they departed and were out of sight to the orangutans. Examples of human events included technician feedings, project visitors' observations, veterinary procedures, media visits, etc. Multiple human events could overlap. The only cases in which multiple human events were not coded independently were instances when several human individuals/groups arrived separately but merged at the islands. Beginning and end times for the sampling period were noted along with start/stop times for all general and human-directed behaviors to create a continuous behavioral record (Altmann, 1974; Martin & Bateson, 2007). It must be noted that all human-directed behaviors were at least partially reactive in the sense that orangutans living on ORP island habitats were not free to seek out and engage humans *ad lib* as they are in some other rehabilitation programs.

Piloting and Habituation

The first week of the study period was used as a piloting, familiarization, and habituation period to determine the best locations (i.e., islands), subjects, and observations times to maximize potential for observation when humans were likely to be present and to refine measures. Data from this pilot period were not used for analyses.

Measures

Biographical Measures

Biographical measures were used to assess developmental and individual history factors as well as the degree of human exposure for each subject orangutan. Biographical measures included age estimates (in years), conditions and duration of captivity, and conditions and duration of rehabilitation.

1. Age. Age at capture from the wild, age at entry to rehabilitation, and current age (i.e., age at the beginning of the study period) are all estimates. Estimated age at capture was obtained from ORP records. Estimated age at entry was obtained from ORP intake records and was based on dental eruption at intake. Estimated current age was derived from ORP estimated age at intake adding the number of years at ORP to the estimated entry age for each subject. Ages were recorded in years and subject orangutans were grouped prior to age-based analyses using accepted age classes for Bornean orangutans, i.e., infant: 0-4/6yrs, juvenile: 4/6-7/9yrs, adolescent: 7/9-11/13yrs (Russon, 2003b; van Noordwijk, et al., 2009). Uncertainties in assigning age classes (e.g., 7/9 yrs could be juvenile or adolescent) were resolved in consultation with an expert on rehabilitant orangutans (Anne Russon) by assessing external signs of transition between age classes, e.g., changes in body shape/size, hair growth, external genitalia, and behavior.

2. Captive Conditions were classified as pampered, abusive/harsh, or unknown based on information available in project records (e.g., condition at intake, location of confiscation). Condition at intake was derived from medical assessments at intake (e.g., disease, parasite load, weight, injuries, hair condition). Additional criteria for classifying captive conditions included;

2a. Pampered: normal-overweight, relatively free of human diseases, low parasite load, full and glossy hair.

2b. Harsh: underweight, malnourished, high parasite load, higher incidence of human diseases, poor hair condition (e.g., dull, patchy).

2c. Abusive: as harsh, plus high incidence of new and healed injuries.

3. Duration of Captivity was measured in years.

4. Duration of Rehabilitation was the total time in rehabilitation (in years). Insofar as practically possible, separate duration measures were also calculated for all housing conditions experienced.

5. *Rehabilitation conditions* were classified by the degree of human contact associated with each type of housing; individual caging (including quarantine), social caging, semi-free ranging (juvenile forest school, half-way house), and human rearing (nursery, infant forest school). Degree of human contact was classified as minimal, moderate, or intense for each housing condition. Ex-captives may experience multiple housing conditions during rehabilitation, resulting in multiple human contact classifications. These classifications were used to determine human contact intensity scores and maximal exposure.

> *5a. Minimal* (individual and social caging): negligible human contact, typically limited to visual contact, interaction limited to provisioning and medical intervention.
>
> *5b. Moderate* (semi-free ranging): supplemental provisioning and limited human support (i.e., monitor and supervise orangutans' daily activities in the forest, encourage conspecific socialization, adjudicate orangutan-orangutan interactions).
>
> *5c. Intense* (human-rearing): close human contact and full human support. Babysitters (i.e., human surrogates) are available day and night to meet most or all orangutans' physical and social needs.

6. Human contact intensity was an overall assessment of human contact in rehabilitation and was measured using intensity scores and maximal exposure.

6a. Intensity scores were calculated for each subject orangutan as the sum of the proportion of total time (in years) at ORP spent in each housing condition by the degree of contact associated with each housing condition (scored as 1 - no/minimal contact, 2 - moderate contact, and 3 - intense contact), prior to placement on the orangutan islands.

6b. Maximal Exposure was defined as the greatest degree of human contact each subject orangutan experienced prior to placement on the orangutan islands, i.e., their highest housing condition score.

Orangutan Activity Measures

Measures for orangutan activity were adapted from standardized data collection measures for wild orangutans (Morrogh-Bernard, Husson, & McLardy, 2002) and an ethogram developed for immature ex-captives in rehabilitation project forest schools (Appendix B (i) and (ii)).

7. Solitary behaviors included all behaviors performed alone (i.e., without other orangutans) (e.g., nest making, playing alone) or directed at an individual's own body (e.g., self-grooming, urination/defecation).

8. Social behaviors were all affiiliative and aggressive behaviors that involved more than one individual (e.g., grooming, co-feeding, wrestling, fighting, displacement/avoidance, parallel locomotion, parallel activities, and vocal/gestural communication where the focal orangutan was either the initiator or recipient.

9. Foraging included all behaviors related to accessing (i.e., finding and retrieving food), processing (i.e., preparing food for consumption - crack coconut, strip bark, pick leaves), and consuming foods and fluids.

10. Locomotion included all behaviors used to move from one location to another (e.g., quadrupedal scrambling, bipedal walking, brachiation).

11. Resting included all periods of inactivity (e.g., hanging, sitting idle, laying down, sleeping).

Measures of Human-Directed Behaviors

Measures assessed orangutan-initiated, human-directed behaviors in six categories: visual orientation, vocal, gestural, positional, locomotor, and no response (Appendix B (iii)), using a custom ethogram (Appendix B (iv)). Orangutan behavior was considered human-directed when it was performed in response to humans' presence or activities and targeted humans. The types of behaviors that ex-captives directed toward humans were used to assess the degree to which they were oriented to (i.e., interested in) humans. For each subject orangutan, behavioral frequencies for all human-directed behaviors were converted to rates per minute (RPM) by dividing the frequency of an observed behavior by the duration of the human event(s) during which it occurred. Human-directed behaviors were classified as either promoting or inhibiting orangutan-human interaction (see Table 2). Rehabilitants with high rates of promoting/inhibiting behaviors were considered oriented toward/away from humans respectively. One ambiguous behavior was vertical locomotion (i.e., up/down). Upward movement could function as an escape behavior (inhibiting) or to enhance an orangutan's view of humans (promoting). Downward movement could be used to withdraw into low vegetation, limiting or eliminating visual contact with humans (inhibiting), or to bring an orangutan closer to humans (promoting). Vertical behaviors were coded as promoting or inhibiting based on the immediately adjacent sequential behaviors (e.g. upward movement followed by visual tracking – promoting; downward movement followed by hiding or positioning away - inhibiting).

Table 2

Interaction Promoting and Inhibiting Behaviors

Promoting Behaviors (orient to)				
Visual	Gestural	Locomotor	Positional	Vocalize
Glance (single)	Reach out	Approach	Reposition To	
Repeated Glances	Point	Follow/Parallel		
Visual Tracking	Offer	Up (better view)		
		Down (toward)		
Inhibiting Behaviors (orient away)				
Visual	Gestural	Locomotor	Positional	Vocalize
Look Away	Throw at	Withdraw	Reposition Away	Kiss squeak
	Throw down	Up (escape)	Hide	Raspberry
	Splash at	Down (escape)		Grunt
	Vegetation Display			Pig Squeal
	Object Display			Mip-Mip

12. Visual behaviors were associated with orangutans' attending to, orienting toward, and monitoring humans and their activities visually. Visual measures, with the exception of look away, were considered promoting behaviors.

12a. Glance: a singular visual contact less than 30 seconds in duration.

12b. Repeated glances: multiple, successive glances, each less than 30 seconds in duration and not separated by more than 60 seconds.

12c. Visual tracking: prolonged visual contact lasting more than 60 seconds.

12d. Look away: deliberate gaze aversion to break/avoid visual contact (line of sight) with humans.

13. Vocal behaviors recorded for this study were those recognized to indicate fear, frustration, and annoyance (i.e., inhibiting behaviors). Definitions for vocalizations were adapted from standardized orangutan vocalization repertoires (Hardus, et al., 2009; van Schaik & Gisi, 2008).

13a. Kiss squeak: a "kissing" sound produced by sucking air through puckered lips, typically indicating annoyance or frustration toward a target (e.g., humans, dangerous animals).

13b. Raspberry: a sputtering sound produced by forcibly exhaling though puckered lips (in a reverse manner to the kiss squeak), typically produced under the same conditions as kiss squeaks.

13c. Grunt (grumph): a grunting/belching sound similar to the snort of a pig, typically produced when annoyed or distressed and employed to deter predators or human observers.

13d. Pig squeal (crying): a high pitched prolonged squealing or shrieking sound similar to that of a distressed pig, typically produced in response to fear or pain.

13e. Mip-mip (fear squeak): short punctuated squeaks that produced a "mip-mip" sound, typically produced in response to fear.

14. Gestural behaviors could be either promoting or inhibiting and included arm/hand and leg/foot movements (Leavens, 2004; Leavens & Hopkins, 1998; Leavens, Hopkins, & Thomas, 2004) made with or without objects. Communicative intent was not assessed.

Head and body gestures were not considered because they could not be consistently differentiated from visual and positional behaviors.

14a. Reach out: extending the arm/leg toward humans with the empty palmar surface of the hand/foot upward.

14b. Point: extending the arm/leg toward humans with the hand/foot with the palmar surface downward.

14c. Offer: extending the arm/leg toward humans while holding an object in the hand/foot.

14d. Throw at: using the hand/foot to propel an object toward humans.

14e. Throw down: using the hand (foot) to propel an object downward in response to humans' presence/activities.

14f. Splash at: using a part of the body (hand/foot, arm/leg) or objects to propel water toward humans.

14g. Vegetation display: forcibly shake intact vegetation in a threatening manner, typically while maintaining visual contact with humans.

14h. Object Display: forcibly shake object (e.g., stick, pole, enrichment item) in a threatening manner, typically while maintaining visual contact with humans. Object display is differentiated from vegetation display in that objects are free/detached items.

15. Positional behaviors involved repositioning (i.e., movement) of the entire body without locomotion.

15a. Position toward: reposition the ventral surface of the body toward humans, typically associated with maintaining visual contact.

15b. Position away: reposition the ventral surface of the body away from humans, typically breaking line of sight and visual contact.

15c. Hide: reposition the body such that an object or another individual is between the focal individual and humans, typically placing the focal individual partially or fully out of sight.

16. Locomotor behaviors were associated with movement from one place to another in relation to humans (i.e., toward or away from humans). Human-directed locomotor behaviors were recorded separately from all other locomotion (e.g., to food sources, nest sites, other orangutans). To eliminate chance movements, locomotor behaviors were recorded as human-directed only if they started from a still position and/or involved a change of direction in response to human presence or activities.

16a. Approach: locomotion toward humans.

16b. Follow/Parallel: locomotion in the same direction as humans.

16c. Move up (view): upward locomotion (i.e., increased vertical position) followed by visual orientation to humans.

16d. Move down (toward): downward locomotion (i.e., decreased vertical position) followed by visual orientation to humans and/or approach.

16e. Withdraw: locomotion away from humans.

16f. Move up (escape): upward locomotion (i.e., increased vertical position) followed by positioning away and/or withdrawal.

16g. Move down (escape): downward movement (i.e., decreased vertical position) followed by positioning away, hiding, and/or withdrawal.

17. No Response: focal orangutan did not react to humans, when reaction would normally be expected, and continued with previous behavior.

18. OOS (Out of Sight): focal orangutan not visible to the observer.

Analyses

Although six of seven specific predictions specified promoting behaviors only, the purpose of this study was to assess the effects of developmental history factors on rehabilitants' orientation to humans. Human orientation includes behaviors that inhibit interaction as well as those that promote interaction. Therefore promoting, inhibiting, and total orientation behaviors were assessed. Additionally, rate of responding to humans, regardless of specific human-directed behaviors, may also be indicative of human orientation. Therefore, no response was assessed as an additional indicator of overall human orientation, on the assumption that lower rates of no response indicated stronger orientation to humans. All analyses, unless otherwise stated, were performed using RPM for total orientation behaviors (promoting + inhibiting), promoting behaviors, inhibiting behaviors, and no response.

Data were analyzed using regression and ANOVA techniques and were conducted in SPSS Statistics 17. It is appropriate here to point out a few considerations regarding how the data for this study were analyzed. In addition to data confounds, sample sizes were small. Normality and equality of variances could not be adequately assessed with so few cases. Given that no prior studies of orangutan-initiated human-directed behaviors exist, it was considered more important to identify all potential effects (i.e., avoid type II errors) than to potentially misidentify a chance occurrence as an effect (i.e., commit a type I error). Considering that small sample sizes can result in failure to identify significant results at conventional significance levels (i.e., $\alpha < 0.05$) (Hoyle, 1999) a more lenient alpha value ($\alpha = 0.10$) was used for all statistical analyses. Appropriate effect size measures were included for all analyses.

RESULTS

Observation Hours

A total of 406.33 hours of observation were made, which yielded 77.97 hours (4678 minutes) of human events for 9 orangutans (see Table 3). Orangutans on I6 were observed on more days orangutans on I4 because observation schedules were adjusted on a weekly basis in an attempt to balance human events across subjects (I4 males M = 10.30 days, SD =1.26; I6 females M = 18.20, SD = 2.05). A one way ANOVA revealed no significant differences in hours of human events by island/sex ($F[1,7] = 0.01$, p = 0.91, ω^2=0.00; I4 males M = 8.74, SD = 1.71, N = 4; I6 females M = 8.60, SD = 1.84, N= 5). Therefore orangutan behaviors during human events could be compared between the two islands/sexes.

Table 3

Focal Observations (Days and Hours) and Human Events (Minutes)

Name	Sex	Island	Current Age	Obs. Days[1]	Obs. Hrs.[2]	HU Min.[3]
Nila	F	6	14	20	57.67	419
Siah	F	6	13	19	54.58	655
Emmy	F	6	12	20	64.58	477
Wulani	F	6	10	16	54.92	611
Oneng	F	6	5	16	61.42	418
Agus	M	4	9	10	28.25	372
Jovan	M	4	9	10	23.67	555
Sipur	M	4	9	9	27.92	582
Hamzah	M	4	5	12	33.33	589

1. Number of observation days per subject.
2. Number of observation hours per subject.
3. Minutes of human events during focal observations for each subject.

Observation periods were early (08:00-11:00), mid (11:00-14:00) and late (14:00-17:00) day. Observation periods for I4/males and I6/females differed. I4/males were observed during early periods only, while I6/females were observed during all three periods. Three repeated measures ANOVAs were conducted to assess whether observation period contributed to differences in I6 human-directed behaviors. No significant differences in the rates of I6/females' human-directed behaviors were found between early, mid, and late observation periods for total orientation behaviors ($F[2,8]$ = 1.34, p = 0.32, ω^2=0.06; early M = 0.26, SD = 0.09, N = 5; mid M = 0.18, SD = 0.07, N= 5; late M = 0.22, SD = 0.04, N= 5), promoting behaviors ($F[2,8]$ = 1.40, p = 0.30, ω^2=0.07; early M = 0.17, SD = 0.08, N = 5; mid M = 0.12, SD = 0.05, N= 5; late M = 0.14, SD = 0.02, N= 5), or inhibiting behaviors ($F[2,8]$ = 1.04, p = 0.40, ω^2=0.01; early

M = 0.09, *SD* = 0.02, *N* = 5; mid *M* = 0.06, *SD* = 0.04, *N*= 5; late *M* = 0.08, *SD* = 0.04, *N*= 5). Therefore, I6/female human orientation behaviors were collapsed across observation periods in all further analyses.

Unexpected Factors and Confounds

A number of unexpected issues and confounds presented themselves during the course of data collection. Practicalities resulted in confounding overlaps between island, sex, age, access to visitors, and past rehabilitation conditions experienced (i.e., housing). Island 6 orangutans were all female, generally older, and because of their Hepatitis-B positive status were accessible to visitors and had experienced isolation or limited social cage housing at ORP prior to being transferred to the islands. Island 4 subjects were all male, generally younger, Hepatitis-B negative, off limits to visitors, and had generally experienced more intense human contact via housing at ORP prior to being transferred to the islands. Sex/island was significantly correlated with maximal exposure by design (r = 0. 79, p = 0.01).

Subject selection factors made age matching near impossible and did not allow for observations of multiple age classes, so age-related predictions could not be analyzed using accepted age classes (i.e., infant vs. juvenile vs. adolescent). Ages at capture from the wild were not available, so age at capture effects could not be assessed. Age at entry to rehabilitation and current age were not significantly correlated (r = 0.28, p = 0.46). Current age was significantly correlated with duration of rehabilitation (r = 0.75, p = 0.02) and approached significance with sex/island (r = 0.58, p = 0.11). Entry age was significantly correlated with maximal exposure ($r = 0.63$, $p = 0.07$). No other significant correlations were found between independent measures.

During the course of this study it became apparent that look away vs. position away and throw at vs. throw down could not be reliably distinguished as originally proposed. Typically, looking away was accompanied/accomplished by shifting the body (e.g., positioning away), not just the head, so the two were not separable. Therefore, look away and position away were combined for analyses and considered ignoring. Throwing, whether down or at, was always performed when orangutans were elevated in comparison to humans. Whether orangutans were directly targeting humans could not be determined. As such, throw at and down were combined into throw object.

Interest in humans and interest in human activities were indistinguishable under these island conditions. Hereafter, human orientation refers to orangutan orientation to humans and/or their activities. Interest in human foods and objects could not be assessed empirically because orangutans had very little access to these. Accordingly, predictions regarding human foods/objects could not be assessed because field conditions did not create this type of exposure.

Two additional unexpected factors directly affected the occurrence of human events. First, ORP experienced serious labor problems and reduced staffing during my research visit, limiting the frequency with which ORP staff engaged in island-related duties beyond basic provisioning. Staff activities, including provisioning, also did not follow a regular daily schedule. For example, one day orangutans may have been provisioned at 08:30 and the following day at 14:30. Other “regularly scheduled” activities, e.g., afternoon provisioning and enrichment activities, were highly irregular and on many days completely absent. Staff related issues were more apparent for I6 (which was farther from staff areas – e.g., clinic and storage areas) than for I4 (which was directly adjacent to staff areas). Second, non-staff visits typically occurred only on days when there was no rain and I4 was off limits to non-staff, so rain was only a factor for I6/female observations. This resulted in 25 observation days (for I6/females) where humans were present for ten minutes or less, including 11 days with zero minutes of human events. Therefore, I6/females required more observation (in fair weather) to collect hours of human events comparable to those collected for I4/males.

Human Events

While hours of human events were similar between islands, *types* of humans visiting each island and *types* of human events appeared to differ between islands. Duration of human events was significantly different between islands (F [1,326] = 34.36, $p < 0.01$). Overall, human events at I6 were, on average, more than twice the duration of those at I4 (I6: M = 18 minutes, SD = 23 minutes; I4: M = 7 minutes, SD = 9 minutes). In addition, group size during human events differed between the two islands. Group sizes at I6 were significantly larger than those at I4 1-7 (F [1,326] = 65.78, $p < 0.01$; I6: M = 4, SD = 3, *Range* = 1-24; I4: M = 2, SD = 1, *Range* = 1-7).

With rare exceptions, non-staff visits were limited to I6 (i.e., 74 of 81 non-staff human events occurred at I6). Non-staff visits did not follow a set schedule, nor were there non-staff visitors every day. When non-staff visitors were present, visits occurred irregularly throughout the day and ranged from less than five minutes to more than sixty minutes in duration. Typical non-staff visits included additional provisioning of orangutans to allow visitors to better observe, photograph, and video record orangutans. Non-staff visitors also regularly called out or otherwise attempted to attract orangutans' attention. With the exception of medical procedures, non-staff visits were significantly longer in duration than staff visits during this study (F [1,326] = 19.12, $p < 0.01$; non-staff: M = 18 minutes, SD = 14 minutes; staff: M = 9 minutes, SD = 17 minutes). Non-staff visits to I6 were significantly longer than those to I4 (F [1,85] = 4.11, $p = 0.05$; I6: M = 19 minutes, SD = 14 minutes; I4: M = 10 minutes, SD = 11 minutes).

Staff related human events also differed between the two islands. Staff visits to I6 were almost exclusively functional (e.g., provisioning, observation, and island maintenance). Functional visits were similar in terms duration (I6: M = 7 minutes, SD = 6 minutes; I4: M = 6 minutes, SD = 7 minutes) and number of staff (I6: M = 2, SD =2; I4: M = 2, SD = 1) between the two islands. Interaction during these visits typically consisted of calling orangutans to the feeding area. The most notable difference was that staff visits at I4 were often longer than those at I6. In addition, staff often came to I4 solely for the purpose of observing interactions between orangutans, especially following provisioning, whereas at I6, staff typically left immediately following provisioning. Beyond typical functional activities, I4 orangutans were exposed to staff activities that I6 orangutans were not, e.g., food deliveries, food preparation, care of nursery infants outside the clinic, and staff interactions at the storage and clinic areas. Finally, annual medical checkups were performed on I4 and I6 during my visit. Medical visits required a large number of technicians and veterinarians (typically more than ten) to be on the islands for up to 5 hours. These were typically the only opportunities for direct orangutan-human interaction and contact, and orangutan-initiated contacts were observed for both islands.

Overview of Human-Directed Behaviors

A total of 1,078 human-directed behaviors were observed, including a total of 817 interaction promoting behaviors (see Appendix C(i)), 261 interaction inhibiting behaviors, and 314 instances of no response (see Appendix C(ii)). Rates of human-directed behaviors for all subjects are listed in Tables 4 and 5.

Table 4

Human Interaction Promoting Behaviors: Rates Per Minute (RPM)

Name	Visual	Gestural	Positional	Locomotor	Total Promoting
Nila	0.06	0.00	0.01	0.02	0.09
Siah	0.10	0.00	0.01	0.04	0.15
Emmy	0.12	0.00	0.02	0.04	0.18
Wulani	0.10	0.00	0.01	0.06	0.17
Oneng	0.08	0.00	0.00	0.04	0.12
I6/Female Avg.	0.09	0.00	0.01	0.04	0.14
Agus	0.10	0.00	0.01	0.06	0.16
Jovan	0.12	0.00	0.01	0.06	0.19
Pur	0.17	0.00	0.00	0.14	0.31
Hamza	0.11	0.00	0.00	0.06	0.17
I4/Male Avg.	0.13	0.00	0.01	0.08	0.21

Table 5

Human Interaction Inhibiting Behaviors and No Response: Rates Per Minute (RPM)

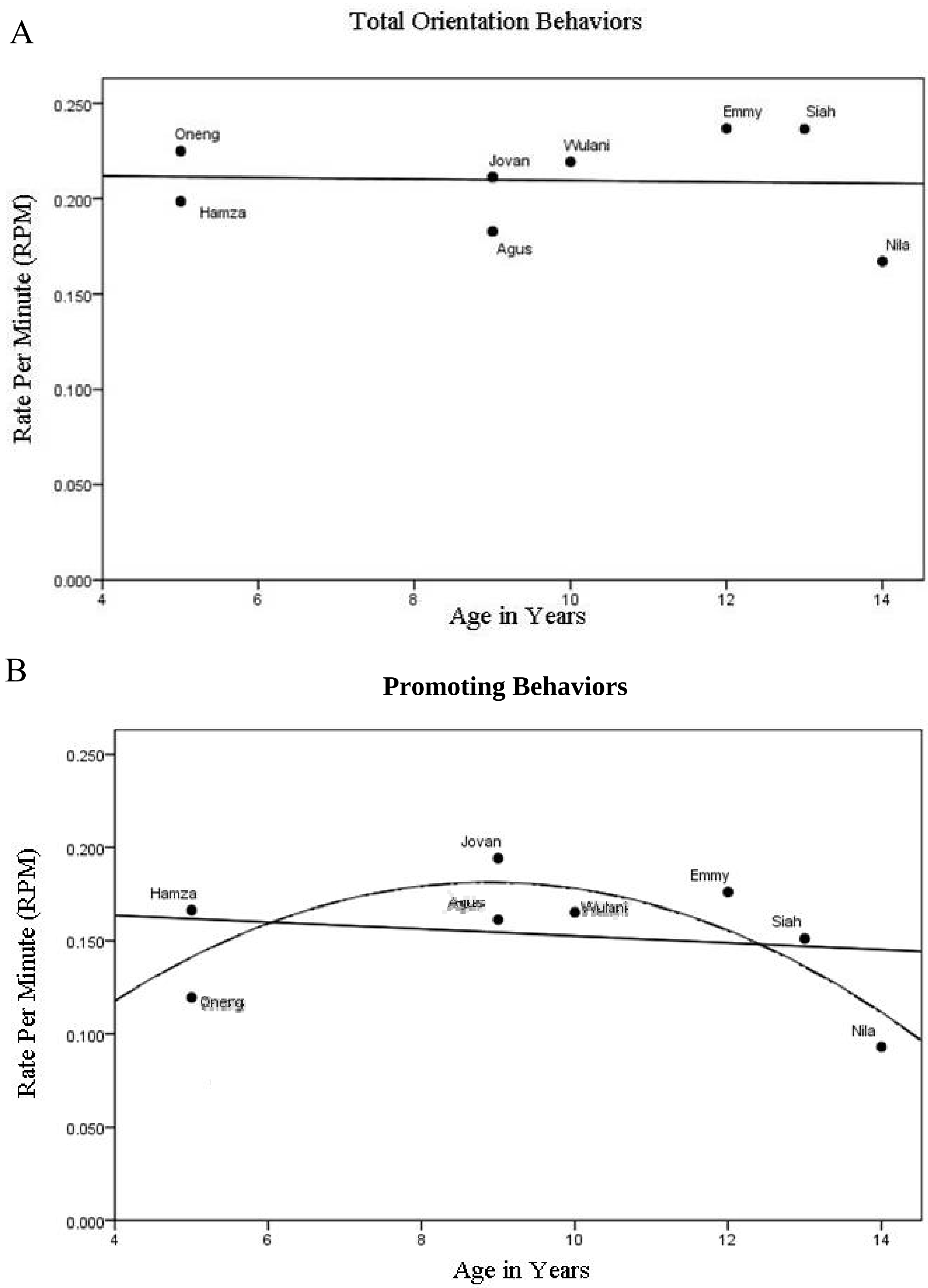
Name	Visual[1]	Vocal	Gestural	Positional	Locomotor	Total Inhibiting	NR
Nila	0.03	0.00	0.00	0.02	0.02	0.07	0.05
Siah	0.02	0.00	0.00	0.01	0.05	0.09	0.06
Emmy	0.03	0.00	0.00	0.00	0.03	0.06	0.05
Wulani	0.02	0.00	0.00	0.01	0.03	0.05	0.07
Oneng	0.03	0.01	0.00	0.02	0.05	0.11	0.09
I6/Female Avg.	0.02	0.00	0.00	0.01	0.04	0.08	0.06
Agus	0.01	0.00	0.00	0.00	0.01	0.02	0.09
Jovan	0.00	0.00	0.00	0.00	0.02	0.02	0.06
Pur	0.00	0.00	0.03	0.00	0.02	0.06	0.06
Hamza	0.01	0.00	0.00	0.00	0.02	0.03	0.08
I4/Male Avg.	0.00	0.00	0.01	0.00	0.02	0.03	0.07

1. Look away and position away combined.

Prediction One: Current Age

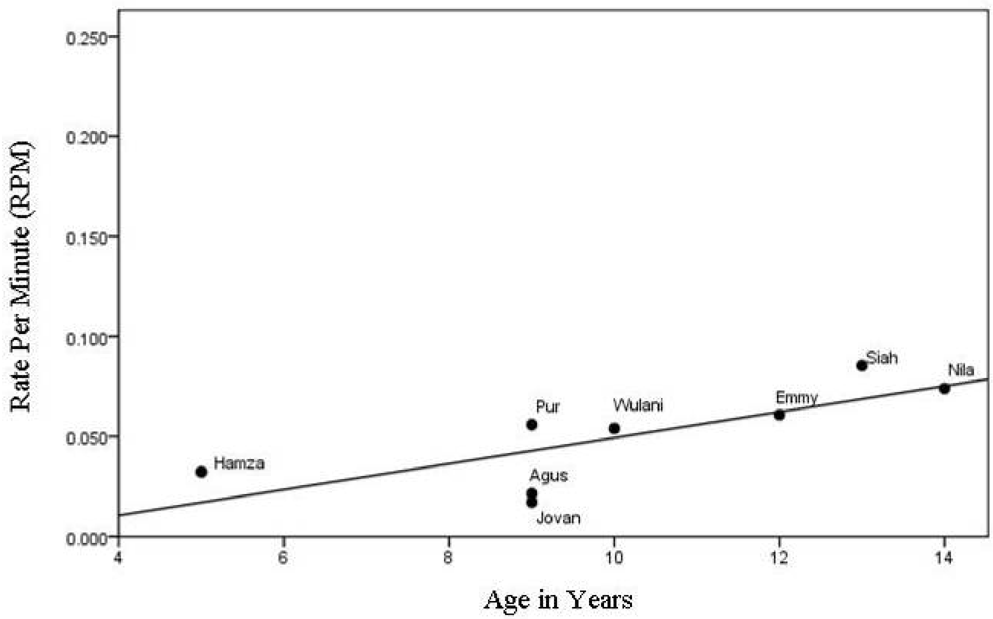
Current age was expected to influence rehabilitants' orientation to humans. Currently younger orangutans were predicted to show greater orientation to humans than currently older orangutans.The original intent was to investigate differences between orangutans of different age classes. However, subject ages were not sufficiently different to support this analysis (i.e., six of nine orangutan subjects were adolescent). As an alternative, a series of linear regressions was used to evaluate differences in human orientation as a function of orangutans' current age (in years). Scatterplots suggested linear relationships between current age and total orientation, inhibiting behaviors, and no response (see Figure 3 A, C, D respectively), and both linear and quadratic relationships between current age and promoting behaviors (see Figure 3B). Therefore, one regression each was run for total orientation, inhibiting behaviors, and no response, using current age as a predictor, and two regressions were run for promoting behaviors, the first using current age as a predictor and the second using current age and current age squared as predictors. To address colinearity between age and age squared in the second model, age values were centered before entry into the regression (Cohen, Cohen, West, & Aiken, 2003).

Figure 3. Regression scatterplots for current age and orientation behaviors.



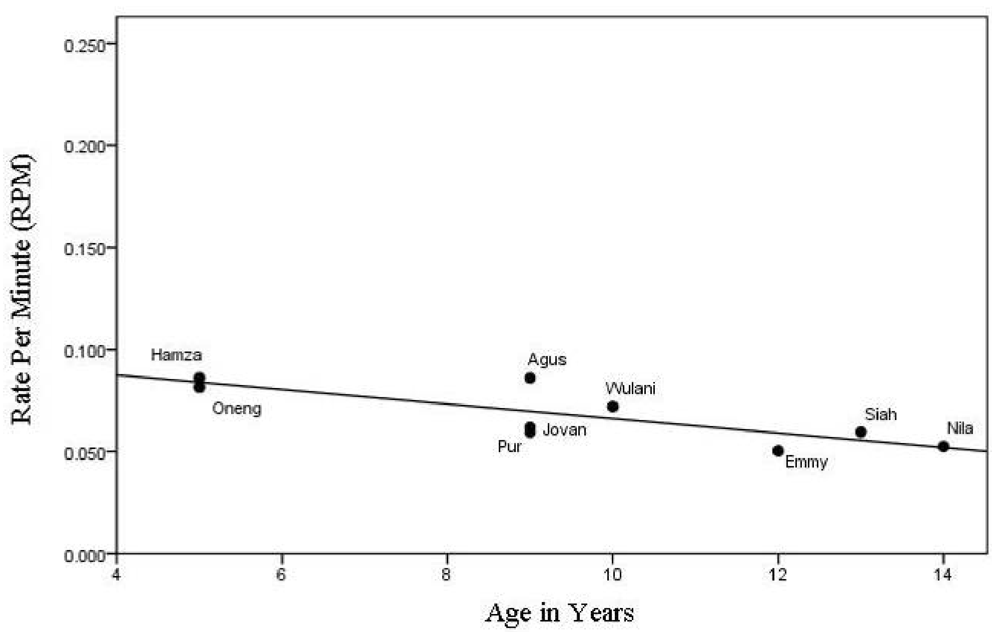
C

Inhibiting Behaviors



D

No Response



Outlier analyses for regressions revealed one outlier for total orientation and promoting behaviors (Pur), one outlier for inhibiting behaviors (Oneng), and no outliers for no response. Pur's promoting behaviors and total orientation behaviors deviated greatly from all other orangutan subjects (2.32 and 2.42 standard deviations from the mean respectively). Oneng's inhibiting behaviors were nearly double the mean for all orangutan subjects and, while not they did not deviate greatly from all other orangutan subjects (1.44 standard deviations from the mean), they approximated the pattern of older I6/females, i.e., although chronologically younger, Oneng's inhibiting behaviors resembled those of older adolescents nearing adulthood. In addition, no significant correlations were found between promoting behaviors, inhibiting behaviors, and no response (promoting/inhibiting: $r = -0.35$, $p = 0.36$; promoting/no response: $r = -0.18$, $p = 0.64$; inhibiting/no response: $r = -0.13$, $p = 0.74$). Total orientation was found to be significantly correlated only with promoting behaviors ($r = 0.88$, $p < 0.01$). Thus, although, promoting behaviors, inhibiting behaviors, and no response are conceptually related, in the sense that all were considered measures of human orientation, they are functionally independent, in the sense that rehabilitants' rate of one was not significantly associated with predictable change in the rate of the other. Therefore outliers were identified separately for each analysis. Outlying data were not included in relevant regressions (i.e., Pur was omitted from regressions of total orientation and promoting behaviors and Oneng was omitted from regressions of inhibiting behaviors).

Regression analyses revealed that current age significantly predicted inhibiting behaviors as well as no response (see Table 6). As predicted, younger rehabilitants had lower rates of inhibiting behaviors than older ones. However, contrary to predicted patterns, younger rehabilitants responded to humans less (i.e., higher rates no response) than older ones (see Figure 3 C and D). Promoting behaviors were significantly predicted by current age squared (see Table 6). The rate of promoting behaviors increased from age five, peaked around nine years, and then declined (see Figure 3 B). Total orientation behaviors were not significantly predicted by current age.

This resulted in a similar age-related pattern of behaviors for both I4/males and I6/females. Younger rehabilitants were more likely to continue their current activity when humans arrived, whereas older rehabilitants were more likely to abandon or pause their current activity to attend to humans. In addition, when younger rehabilitants attended to humans, they did typically did so by observing and visually tracking or approaching humans, whereas older rehabilitants tended to visually observe and then withdraw or ignore humans.

One human event from I6 illustrates this pattern. A group of non-staff visitors arrived at I6 and was quietly observing the orangutans, who had been feeding. Oneng (age 5) did not acknowledge the visitors and continued feeding. Wulani (age 9) abandoned her food and climbed out onto a branch over the water barrier as close as possible to the visitors and proceeded to observe them. Emmy (age 12) and Siah (age 13) looked up and then withdrew, then returned to feeding but continued to intermittently observe the visitors from partially concealed locations. Finally, Nila (age 14), after a single glance to the visitors, withdrew out of sight and remained out of sight until after the visitors departed, after which she (and the other I6/females) returned to feeding.

Had outliers been retained, findings for total orientation and no response would have remained the same as above. Findings for promoting behaviors would remain significant but including Pur's promoting behaviors would have exaggerated the curvilinear pattern found. Findings for inhibiting behaviors would have been nonsignificant with Oneng included. One explanation for this may be that Oneng's behavior more closely resembled older I6/females as a result of her frequent association with the Nila (the oldest I6/female). Alternatively, Oneng's behavioral similarity to older females may be due to a surrogate "mother-offspring" relationship between Nila and Oneng. If Nila acted as a mother figure for Oneng, Oneng's behavior may be similar to infants and young juveniles taking cues from their mother, e.g., to avoid danger (Russon, personal comment).

Table 6

Linear Regressions: Orientation Behaviors predicted by Current Age

	Predictors	*B* [3]	*SEB* [4]	*p*	sr^2 [5]	*N*
Total Orientation	Age	0.00	0.00	0.90	0.00	8
Promoting Behaviors[1]	Age	0.00	0.00	0.65	0.04	8
Promoting Behaviors[2]	Age	-0.01	0.01	0.39	0.08	8
	Age^2	0.00	0.00	0.07	0.44	8
Inhibiting Behaviors	Age	0.01	0.00	0.03	0.57	8
No Response	Age	0.00	0.00	0.01	0.64	9

1. Promoting behaviors predicted using current age only
2. Promoting behaviors predicted using current age and current age squared
3. B : unstandardized regression coefficients
4. SEB: standard error of B
5. sr^2: semi-partial r squared (variance in dependent variable accounted for by a given predictor, controlling for the effects of other predictors on the predictor of interest); $sr^2 = R^2$ for single predictor models

Predictions Two, Three, and Four: Captivity

Data on age at capture, duration of captivity, and captive conditions were not available in project records, so these predictions could not be tested.

Prediction Five: Entry Age

Younger age at entry to rehabilitation was predicted to be associated with greater human orientation than older entry age. Based on intake age range estimates, two entry age groups were identified; younger (1-4yrs) and older (4-8yrs). Using four years as a cutoff point resulted in roughly equal groups ($N = 4$ and 5 respectively) that incorporated all orangutan subjects; it roughly marks the end of infancy, so this cutoff makes reasonable psychological sense. A series of ANCOVAs were used to assess whether younger vs. older age at entry differentiated human orientation. Current age was entered as a covariate to control for its effects (see prediction one). Entry age was not significantly associated with total orientation, promoting or inhibiting behaviors, or no response (see Table 7). However, a moderate effect ($\omega^2 = 0.06$) was indicated for promoting behaviors, suggesting that the lack of significance here may be an artifact of the small sample size.

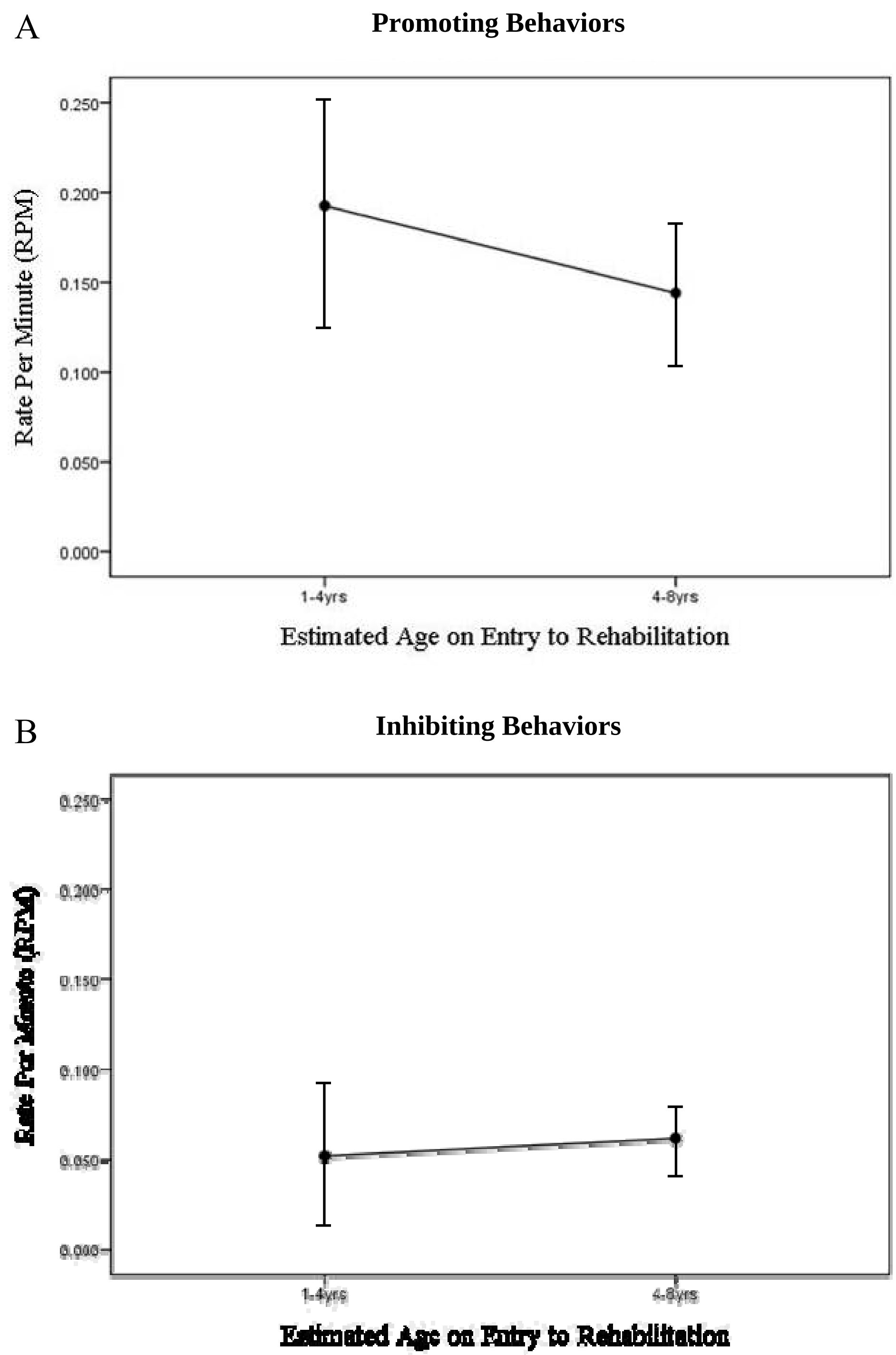
Graphic examination of behavioral trends and means for the two entry age groups suggested patterns consistent with those predicted, i.e., higher rates of promoting and lower rates of inhibiting behaviors for younger entrants (see Figure 4 A and B). Early entrants had, on average, rates of promoting and inhibiting behaviors approximately 36% higher and 17% lower, respectively, than late entrants.

Table 7

One Way ANCOVAs: Orientation Behaviors (RPM) as a Function of Entry Age

Entry Age	*F*	*df*	*p*	ω^2	*M*	*SD*	*N*
Total Orientation	0.85	(1,6)	0.39	0.00	0.23	0.06	9
1-4yrs					0.25	0.07	5
4-8yrs					0.21	0.03	4
Promoting Behaviors	1.13	(1,6)	0.33	0.06	0.17	0.06	9
1-4yrs					0.19	0.07	5
4-8yrs					0.14	0.04	4
Inhibiting Behaviors	0.12	(1,6)	0.76	0.00	0.06	0.03	9
1-4yrs					0.05	0.04	5
4-8yrs					0.06	0.02	4
No Response	0.37	(1,6)	0.57	0.00	0.07	0.01	9
1-4yrs					0.07	0.02	5
4-8yrs					0.07	0.01	4

Figure 4. ANCOVA. Orientation behaviors (RPM) as a function of age at entry to rehabilitation controlled for current age.



Prediction Six: Duration of Rehabilitation

Longer/shorter duration of rehabilitation was predicted to be associated, respectively, with higher/lower rates of human-directed behaviors that promoted orangutan-human interaction. To assess the relationship between duration of rehabilitation and human orientation, linear regressions were performed for total orientation, promoting and inhibiting behaviors, and no response using years in rehabilitation as a predictor. Because of the high intercorrelation between duration of rehabilitation and current age, current age could not be included as a predictor here. Results from prediction two suggested a possible entry age effect, especially for promoting behaviors, so entry age was included as a predictor in all four regressions. Finally, if both duration of rehabilitation and entry age predict orientation, it is reasonable to expect an interaction between the two. Therefore the duration of rehabilitation by entry age interaction was also included as a predictor in the model.

As in prediction one, and for the same reasons, outliers were identified separately for regressions of total orientation, promoting and inhibiting behaviors, and no response. Analyses revealed one outlier for total orientation and promoting behaviors (Pur), one outlier for inhibiting behaviors (Oneng), and no outliers for no response. As in prediction one, outliers were not included in relevant regressions. Regression analyses revealed no significant main effects for entry age (see Table 8). Duration of rehabilitation did not predict total orientation, promoting behaviors, or inhibiting behaviors (see Figure 5 A, B, C), but did significantly predict no response (see Figure 5 D). Rehabilitants that experienced longer vs. shorter duration of rehabilitation exhibited significantly lower rates of no response (see Table 8).

A significant interaction between duration of rehabilitation and entry age was detected for promoting behaviors (see Table 8). Longer duration of rehabilitation was associated with a significantly higher rate of promoting behaviors for rehabilitants entering at early (1-4yrs) vs. later (4-8yrs) ages (see Figure 6). While promoting behaviors declined with longer duration of rehabilitation for late entrants, early entrants' promoting behaviors increased with longer duration of rehabilitation. In fact, extrapolating from Figure 6, we see that although the rate of late entrants' promoting behaviors was initially approximately 25% higher than for early entrants, as duration of rehabilitation increased, early entrants' rate of promoting behaviors grew to more than 200% the rate of late entrants' promoting behaviors.

One pair of rehabilitants from I6, Nila and Emmy, illustrates this difference clearly. Aside from differences in entry age (i.e., Nila entered rehabilitation after four years of age, whereas Emmy entered rehabilitation prior to age four) they had very similar histories. Both were older females at the time of this study (aged 14 yrs and 12 yrs respectively), had experienced similar, long duration rehabilitation (10.25 yrs and 11 yrs respectively) and, because both were Hepatitis B positive, they likely experienced similar degrees of human contact in rehabilitation. Despite these similarities, Emmy's rate of promoting behaviors was double Nila's (RPM = 0.18 vs. 0.9 respectively).

Had outliers been retained, findings for total orientation, inhibiting behaviors, and no response would have remained the same as above. However, findings for promoting behaviors would not have been significant had Pur's promoting behaviors been included. At first glance, this result seems counter intuitive, given that Pur had the highest rate of promoting behaviors and was a member of the early entrant group. Thus, it would seem that including Pur's promoting behaviors in the analysis would have exaggerated the differences between early and later entrants. However, retaining Pur's promoting behaviors would have nearly doubled the variance in promoting behaviors while only slightly increasing the mean for promoting behaviors. Thus, while Pur's behaviors matched the statistical pattern related to the duration of rehabilitation by entry age interaction found in this study, the variance they would have added to the model would have rendered it nonsignificant.

Table 8

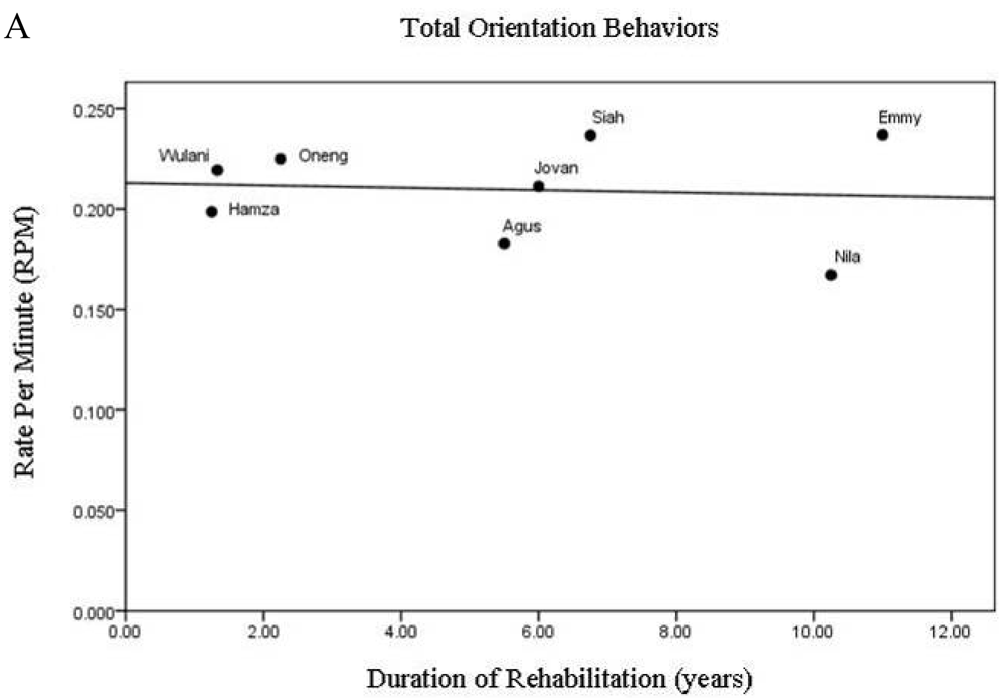
Linear Regressions: Orientation Behaviors Predicted by Duration (years) of Rehabilitation Controlling for Age at Entry to Rehabilitation

	Predictor	*B*	*SEB*	*p*	*sr^2*	*N*
Total Orientation	Duration[1]	0.00	0.01	0.99	0.00	8
	Entry Age	-0.02	0.09	0.80	0.01	
	Duration*E.A.[2]	0.00	0.01	0.83	0.01	
Promoting Behaviors	Duration	0.01	0.00	0.20	0.02	8
	Entry Age	-0.02	0.02	0.32	0.00	
	Duration*E.A.	-0.01	0.01	0.06	0.09	
Inhibiting Behaviors	Duration	0.01	0.00	0.30	0.13	8
	Entry Age	0.03	0.02	0.11	0.42	
	Duration*E.A.	0.00	0.01	0.87	0.00	
No Response	Duration	0.00	0.00	0.05	0.42	9
	Entry Age	-0.01	0.01	0.35	0.06	
	Duration*E.A.	0.00	0.00	0.54	0.03	

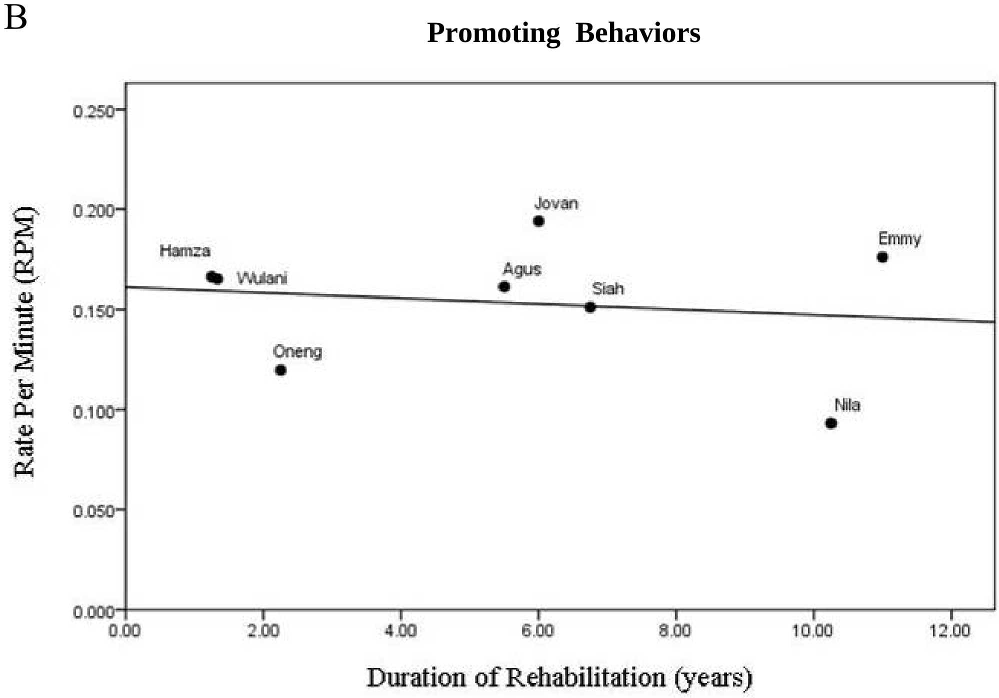
1. Duration (years) of rehabilitation
2. Interaction between duration of rehabilitation and entry age

Figure 5. Regression scatterplots for duration of rehabilitation and orientation behaviors, controlled for age at entry to rehabilitation.

A

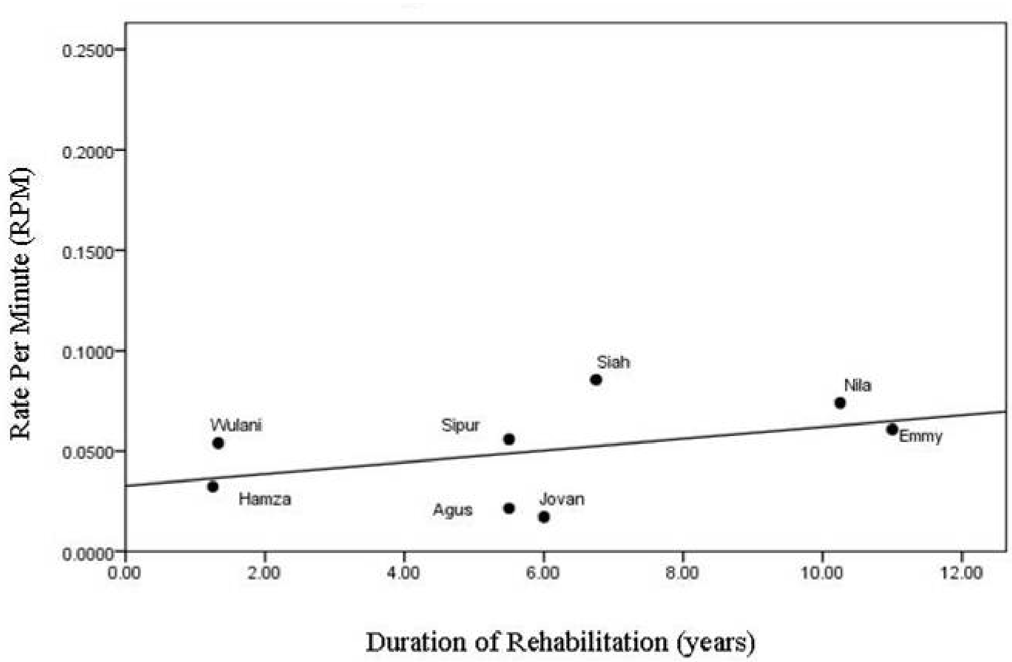


B



C

Inhibiting Behaviors



D

No Response

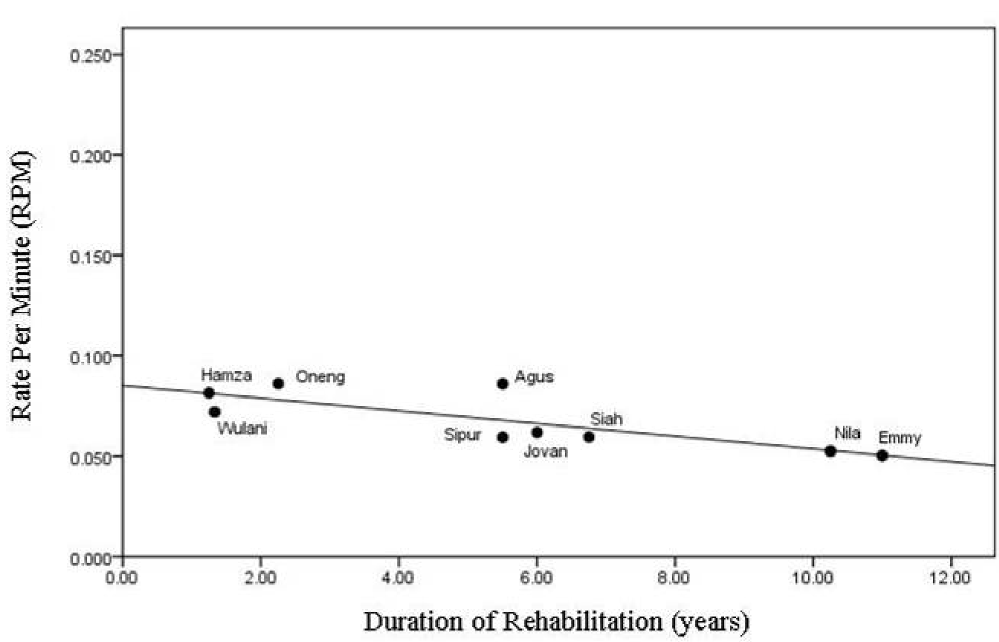
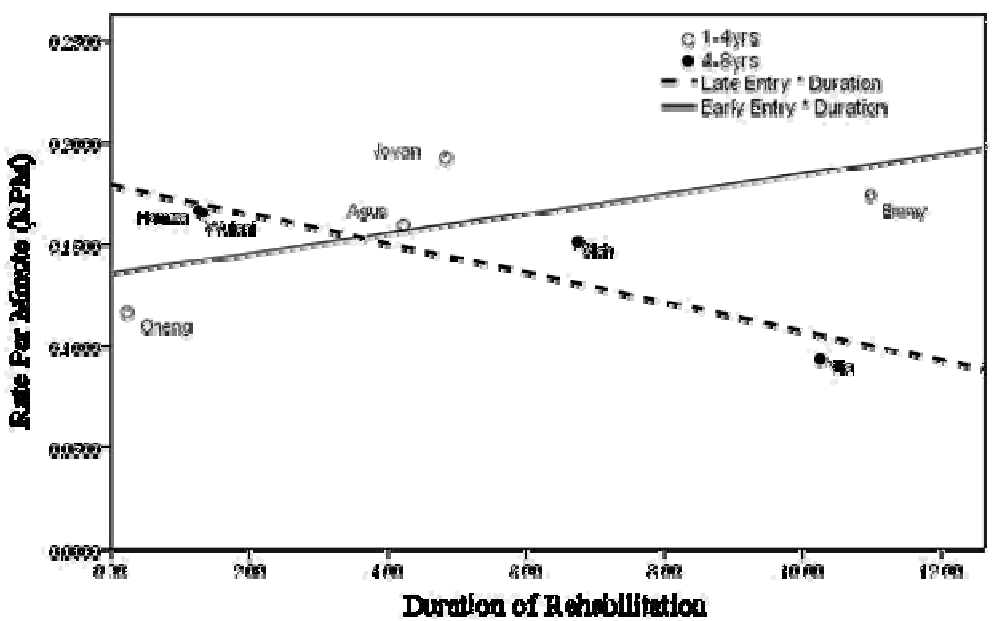


Figure 6. Interaction between duration of rehabilitation and entry age for promoting behaviors.

Promoting Behaviors: Duration of Rehabilitation * Entry Age



Prediction Seven: Human Contact in Rehabilitation

Differential human orientation was predicted as a function of the intensity (i.e., closeness) of human contact experienced during rehabilitation, with more/less intense human contact being associated, respectively with higher/lower rates of human orientation. I initially planned to assess intensity of human contact using intensity scores based on the duration of each housing condition experienced. However, housing data from project records were insufficient for this assessment. Housing records were not available prior to 2004 and, from 2004-2008, contained many instances of missing data (i.e., no record of housing condition). Therefore, the relationship between human contact intensity in rehabilitation and human-directed behaviors was assessed using data on maximal exposure only (i.e., minimal, moderate, or intense human contact). A series of one way ANOVAs was carried out to determine whether differences in rehabilitants' maximal exposure were associated with differences in human orientation. Because no rehabilitants' maximal contact was recorded as moderate, comparisons were limited to intense vs. minimal human contact. Significant effects of maximal exposure were found for promoting and inhibiting behaviors, but not for total orientation or no response (see Table 9, Figure 7). Rehabilitants who experienced intense human contact during rehabilitation displayed significantly higher and lower rates of promoting and inhibiting behaviors, respectively, than rehabilitants who had experienced minimal human contact during rehabilitation. Rehabilitants who experienced intense human contact averaged 13 promoting behaviors and 2 inhibiting behaviors per hour, compared to an average of 9 promoting behaviors and 4 inhibiting behaviors per hour for rehabilitants who experienced minimal human contact during rehabilitation.

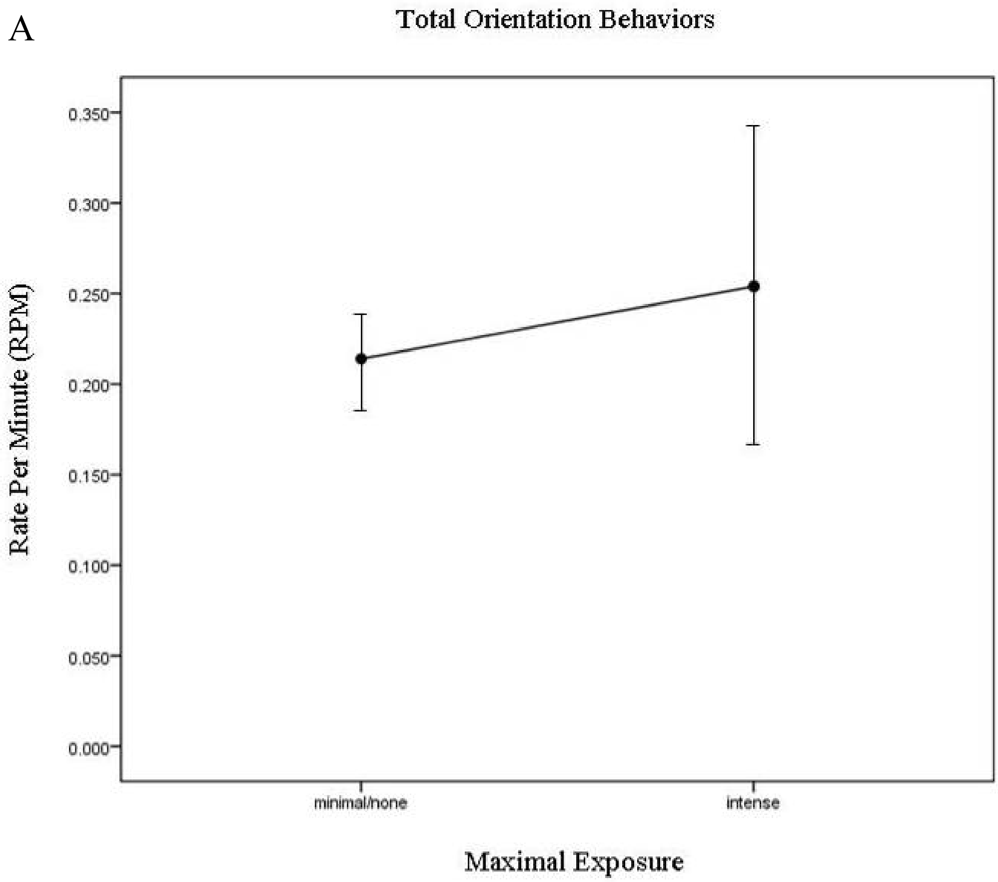
Table 9

One Way ANOVAs: Orientation Behaviors and Maximal Exposure

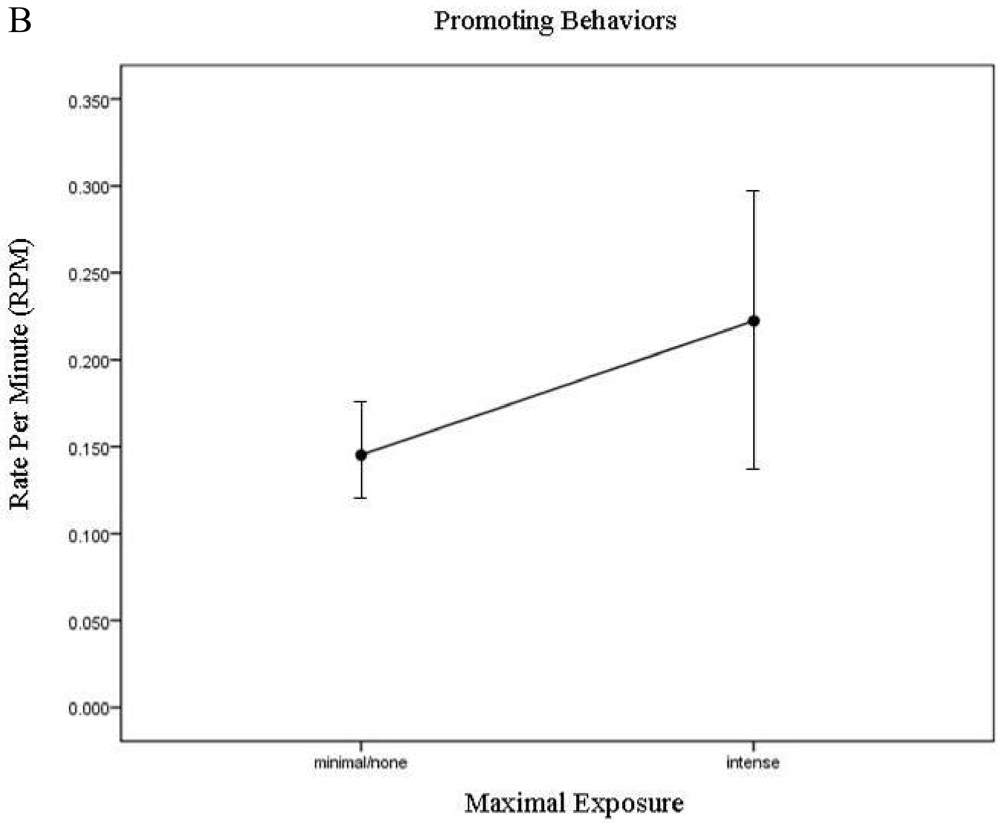
Maximal Exposure[1]	*F*	*Df*	*p*	ω^2	*M*	*SD*	*N*
Total Orientation	0.95	(1,7)	0.36	0.00	0.23	0.06	9
minimal					0.21	0.03	6
intense					0.25	0.10	3
Promoting Behaviors	4.69	(1,7)	0.07	0.29	0.17	0.06	9
minimal					0.15	0.03	6
intense					0.22	0.08	3
Inhibiting Behaviors	4.60	(1,7)	0.07	0.23	0.06	0.03	9
minimal					0.07	0.03	6
intense					0.03	0.02	3
No Response	0.04	(1,7)	0.86	0.00	0.07	0.01	9
minimal					0.07	0.02	6
intense					0.07	0.02	3

Figure 7. Orientation behaviors (RPM) as a function of maximal exposure.

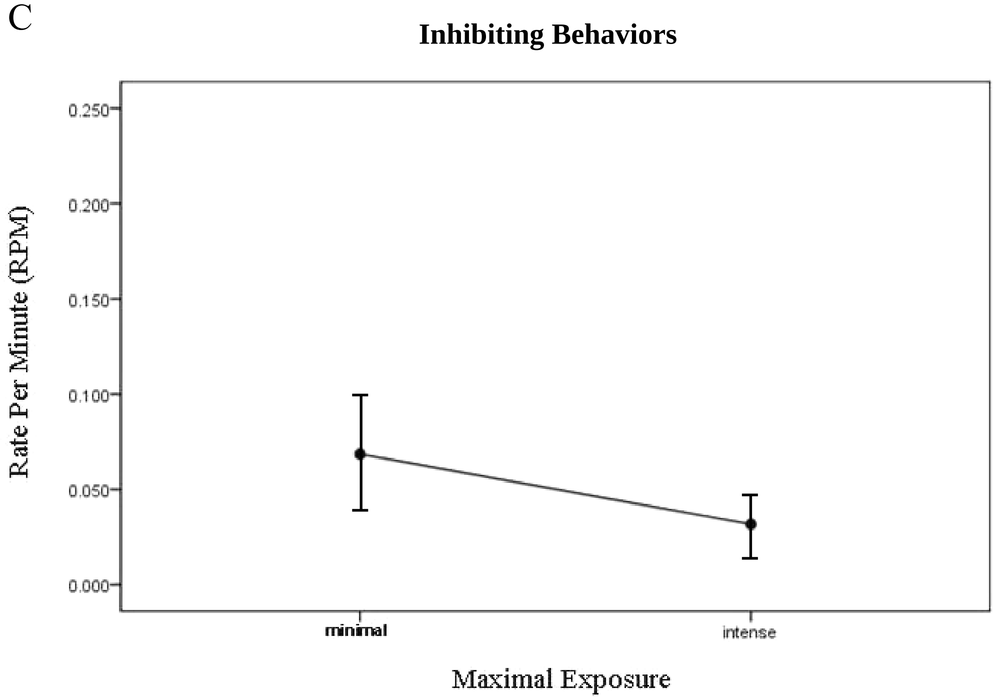
A



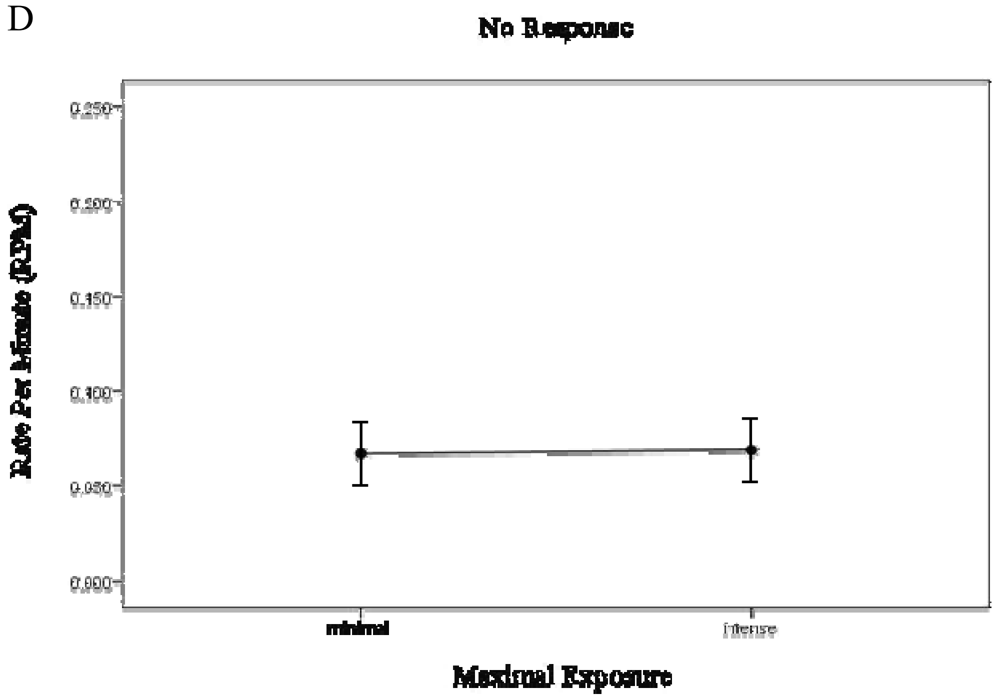
B


Promoting Behaviors
Rate Per Minute (RPM)
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
minimal/none
intense
Maximal Exposure

C


Inhibiting Behaviors
Rate Per Minute (RPM)
0.250
0.200
0.150
0.100
0.050
0.000
minimal
intense
Maximal Exposure

D


No Response
Rate Per Minute (RPM)
0.250
0.200
0.150
0.100
0.050
0.000
minimal
intense
Maximal Exposure

Additional Analyses

Sex/Island Differences in Human Orientation

The predictions of this study were based on developmental variables, including individual history, i.e., age at different points in the rehabilitation process, conditions and duration of captivity, and type and duration of rehabilitation procedures. However, a number of these variables were confounded, especially with sex and island. In conducting observations for this study, I4/male and I6/female ex-captives appeared to behave differently toward humans. Although not considered in the original predictions for this study, differences in orangutan orientation to humans could be a function of sex. Male and female orangutans' social interactions with conspecifics differ (Galdikas, 1984, 1985a, 1985b, 1985c; Russon, 2002a, 2003a; Watts & Pusey, 2002). It stands to reason that these differences would not be limited to social interactions with conspecifics. Therefore, to explore possible sex effects, I assessed whether I4/male and I6/female rehabilitants differed in the rate and type of behaviors they directed to humans.

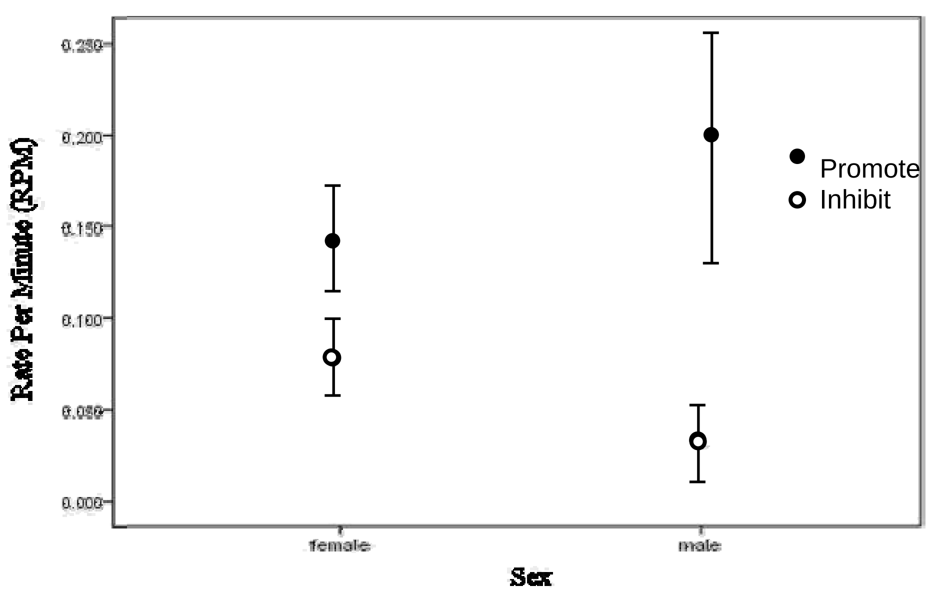
A series of one way ANOVAs was carried out to determine whether I4/males and I6/females differed on measures of total orientation, promoting and inhibiting behaviors, and no response. Sex/island differences were found for promoting and inhibiting behaviors but not for total orientation or no response. I4/males had significantly higher rates of promoting behaviors and lower rates of inhibiting behaviors than I6/females (see Table 10, Figure 8). I4/males engaged, on average, in 12 promoting and 2 inhibiting behaviors per hour, compared to an average of 8 promoting and 5 inhibiting behaviors per hour for I6/females.

Table 10

One Way ANOVAs: Sex/Island Differences in Orientation Behaviors (RPM)

	F	*Df*	*p*	ω^2	*M*	*SD*	*N*
Total Orientation	0.33	(1,7)	0.59	0.00	0.23	0.06	9
I6/Female					0.22	0.03	5
I4/Male					0.24	0.09	4
Promoting Behaviors	3.61	(1,7)	0.10	0.23	0.17	0.06	9
I6/Female					0.14	0.03	5
I4/Male					0.21	0.07	4
Inhibiting Behaviors	11.80	(1,7)	0.01	0.55	0.06	0.03	9
I6/Female					0.08	0.02	5
I4/Male					0.03	0.02	4
No Response	0.71	(1,7)	0.43	0.00	0.07	0.01	9
I6/Female					0.06	0.02	5
I4/Male					0.07	0.01	4

Figure 8. Sex/island differences in promoting and inhibiting behaviors.



I4/male and I6/female rehabilitants also appeared to differ in the types of promoting and inhibiting behaviors they directed to humans. Promoting behaviors were therefore broken down into active (e.g., locomote, approach) behaviors and passive (e.g., visual, reposition toward) behaviors and inhibiting behaviors into aggressive (e.g., display, throw, splash, aggressive vocalization) behaviors and avoidance (e.g., withdrawal, hide, position away) behaviors (see Table 11).

Table 11

Types of Promoting and Inhibiting Behaviors by Sex/Island

	I6/Female			I4/Male		
	M	*SD*	*N*	*M*	*SD*	*N*
Promoting Behaviors						
Active	0.11	0.02	5	0.15	0.05	4
Passive	0.03	0.06	5	0.06	0.03	4
Inhibiting Behaviors						
Aggressive	0.002	0.003	5	0.01	0.02	4
Avoidance	0.07	0.02	5	0.02	0.01	4

A doubly 2x2 between-within MANOVA was carried out to examine sex/island differences in active/passive promoting and aggressive/avoidance inhibiting behaviors (see Table 12). Main effects for sex/island on promoting and inhibiting behaviors match those found above (see Table 10). For promoting behaviors no sex/island by behavior type interaction was found, but there was a significant main effect of behavior type. Overall, rates of active promoting behaviors were significantly higher than rates of passive promoting behaviors for both I4/males and I6/females (see Figure 9A). I4/males averaged 9 active and 3 passive promoting behaviors per hour, and I6/females averaged 6 active and 2 passive promoting behaviors per hour. For inhibiting behaviors, a significant island/sex by behavior type interaction was found as well a main effect of inhibiting behavior type. While rates of avoidance behaviors were significantly higher than rates of aggressive behaviors overall for both I6/females and I4/males, I6/females had significantly higher rates of avoidance behaviors and lower rates of aggressive behaviors than I4/males (see Figure 9B). I6/females averaged four avoidance behaviors per hour while I4/males averaged one avoidance behavior per hour. Also, although both I4/males and I6/females averaged less than one aggressive behavior per hour, the average hourly rate of aggressive behaviors for I4/males was more than five times that of I6/females (0.60/hr vs. 0.11/hr respectively).

Table 12

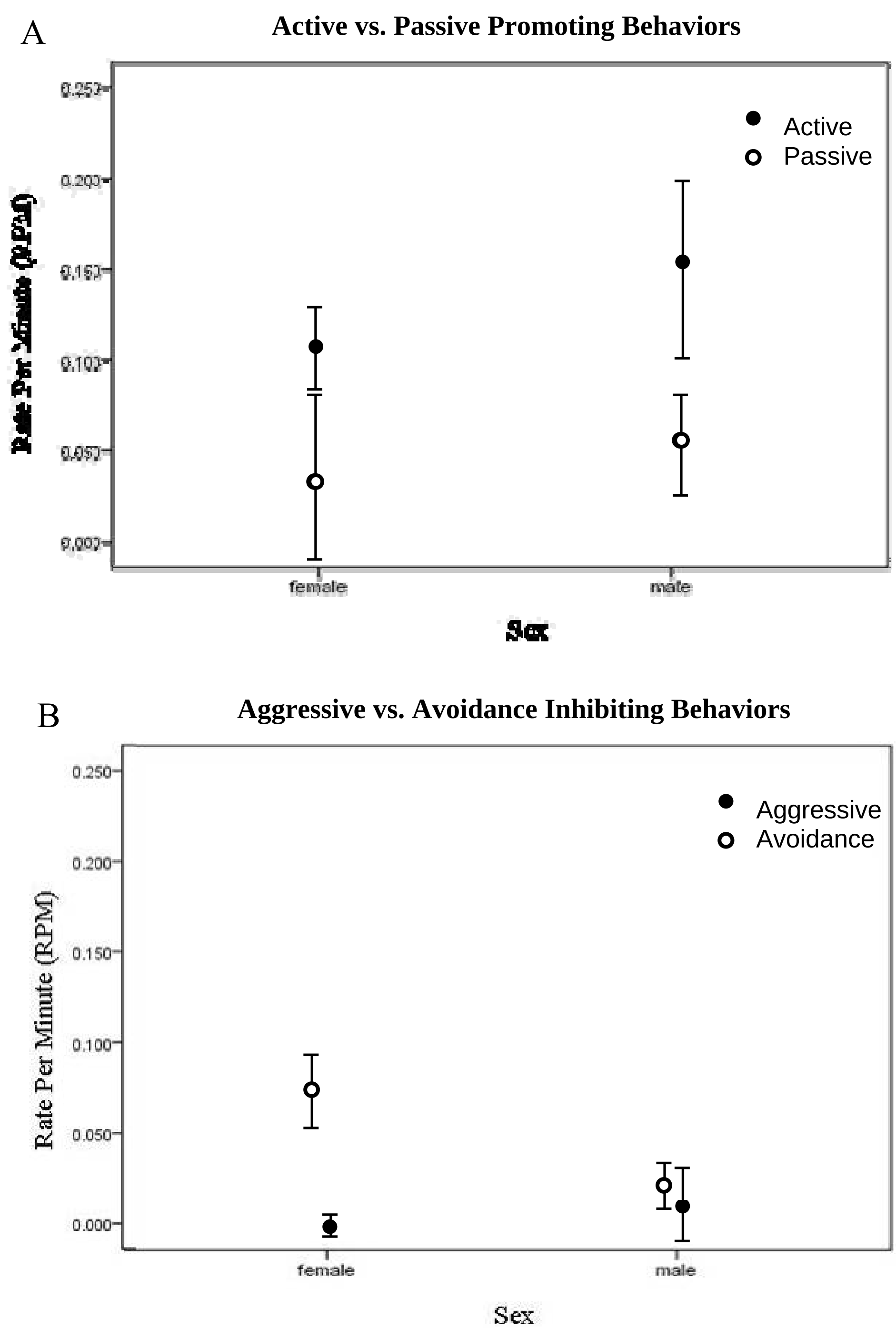
MANOVA: Sex/Island Differences in Types of Promoting and Inhibiting Behaviors

	F	*df*	*p*	ω^2
Wilk's Lambda = 0.146[1]	5.87	(4,4)	0.06	0.82
Promoting Behaviors				
Active vs. Passive[2]	115.00	(1,7)	<0.01	0.91
Sex/Island	3.55	(1,7)	0.10	0.22
Interaction[3]	1.84	(1,7)	0.22	0.01
Inhibiting Behaviors				
Aggressive vs. Avoidance[4]	56.20	(1,7)	<0.01	0.59
Sex/Island	11.90	(1,7)	0.01	0.55
Interaction[5]	29.50	(1,7)	<0.01	0.30

1. Wilk's Lambda value.
2. Main effect of behavior type for promoting behaviors (i.e., difference between active and passive behaviors)
3. Interaction between type of promoting behavior (active vs. passive) and sex/island
4. Main effect of behavior type for inhibiting behaviors (i.e., difference between aggressive and avoidance behaviors)
5. Interaction between type of inhibiting behavior (aggressive vs. avoidance) and sex/island

Note: omega squared values (ω^2) may sum to more than one here because between and within subject effects were calculated separately.

Figure 9. Sex/Island differences in types of promoting and inhibiting behaviors.



DISCUSSION

The aim of this study was to determine which, if any, developmental factors predict rehabilitant orangutans' orientation towards humans and orangutan-initiated interactions with humans. To date this is the only study of which I am aware that focuses on orangutan-initiated, human-directed behaviors and orangutans' contributions to orangutan-human interaction. Current age, duration of rehabilitation, and the degree of human contact experienced during rehabilitation all appeared to be associated with differences in the degree of orientation and types of behavior directed to humans. Rehabilitants' human-directed behaviors also differed by sex/island. However, because of confounds and correlations between study variables, it was not possible to isolate the effects of each individual factor. Therefore, the conclusions drawn here should be considered as indications of areas/factors deserving closer study.

Increasing age was associated with an overall decline in rates of orientation to humans but increasing rates of inhibiting behaviors and lower rates of no response. This pattern suggests that as rehabilitants age, their orientation behaviors may serve to inhibit rather than promote interaction with humans. While older rehabilitants (i.e., from mid-late adolescence on) appeared more likely to avoid humans, younger rehabilitants (i.e., between late infancy and early adolescence) appeared more likely to initiate interactions with humans. Although younger rehabilitants responded to humans at lower rates than older ones, their human-directed behaviors were typically those that promoted interaction. This suggests that age-related differences in human-directed behaviors cannot be explained solely by differential rates of response. Instead, patterns suggest that the types of behavior directed to humans (i.e., promoting vs. inhibiting) may better account for these differences.

The sample for this study did not allow assessment of human-directed behaviors using standard age classes. However, even with the small sample size employed here, findings on current age parallel findings from previous research on orangutan-orangutan interaction, which indicated that juvenile rehabilitants were more social than older rehabilitants (Snaith, 1999) and that wild immatures were more likely than wild adults to initiate social interactions (Galdikas, 1985b). Current findings are also consistent with findings that juvenile rehabilitants initiated more interactions with humans than do adults (Snaith, 1999). Therefore, current findings appear consistent with developmental changes found elsewhere in orangutans' initiation of social interactions.

However, deviations from predicted patterns based on current age, as seen in Pur and Oneng, suggest that individual differences also likely influence the type of behaviors directed to humans. For instance, Oneng's behavior departed from the developmental pattern found in this study for currently younger vs. older rehabilitants. Her behavior resembled that of the older female rehabilitant's on I6 (i.e., higher rates of inhibiting behaviors and lower rates of promoting behaviors). Oneng spent a great deal of her time in association with Nila (the oldest and most dominant female on I6), who had the highest rate of inhibiting behaviors (specifically withdrawal and hiding from humans). Nila may also have acted as a surrogate mother figure for Oneng, and thus Oneng may have taken behavioral cues, including human-directed behaviors, from Nila. It seems likely then that

Oneng's association with Nila probably accounted for at least some her deviation from predicted patterns based on current age.

Pur's deviation, on the other hand, was not so much in kind as in degree. Like the other I4/males, Pur's rate of promoting and inhibiting behaviors was higher and lower, respectively, than those of I6/females. However, Pur's promoting behaviors were much higher than the other I4/males. In addition, Pur had the highest rate of inhibiting behaviors among I4/males. This pattern suggests that Pur's behavior may, in part, be explained by high overall reactivity. In fact, technicians and other researchers familiar with Pur indicated that he has always been highly active compared to his peers.

Analyses of entry age did not yield significant results, possibly because the current sample was not large enough to verify a contribution of entry age to human orientation. In addition, correlations between entry age and other predictor variables may have prevented identification of significant effects for entry age. However, effect size measures and visual examination of behavioral trends suggested that younger entry age (i.e., 1-4yrs of age) was associated with greater human orientation, particularly higher rates of promoting behaviors, than older entry age (i.e., 4-8yrs of age). This suggests that entry age may be a valuable predictor of human orientation. The value of entry age in predicting human orientation may be supported by its correlations with other predictor variables. The positive correlation between entry age and human contact intensity (i.e., earlier entry ages were associated with higher maximal exposure) and the interaction between entry age and duration of rehabilitation (for predicting promoting behaviors), indicate that entry age is associated with other factors that appear to influence human orientation and orangutan-initiated interaction. Thus, it is possible that the effect of entry age on human-directed behaviors may be indirect. For example, early entry to rehabilitation requires rehabilitation procedures associated with intense human contact (e.g., human rearing), which serves to establish strong human orientation. Further, prolonged rehabilitation combined with intense human contact from an early age may promote continued orientation to and interaction with humans.

In addition to the interaction between entry age and rehabilitation duration, longer duration of rehabilitation was associated with higher rates of response to humans. These findings suggest that early entry to and long duration of rehabilitation have the potential to produce rehabilitants that may be particularly likely to initiate interactions with humans. In the current study, rehabilitants whose experiences during rehabilitation fit this pattern responded to humans at higher rates than older entrants who experienced shorter duration of rehabilitation and responded in a manner that promoted more than inhibited interaction. This does not, however, mean that these orangutan-initiated interactions will be prosocial (i.e., friendly), just that early entry age and longer duration rehabilitation are likely to produce rehabilitants more prone to seek interactions with humans.

Difference in the maximal intensity of human contact was associated with differences in the rate of rehabilitants' orientation to humans as predicted. . Rehabilitants who experienced intense contact with humans during rehabilitation had higher rates of promoting behaviors and lower rates of inhibiting behaviors than rehabilitants who had experienced minimal human contact; no differences were found in overall response rates. However, maximal exposure provides only a partial picture of human contact during rehabilitation, and was also significantly correlated with entry age and closely related to sex/island.

Thus, although confounds exist and the contributions of individual factors cannot be verified, there appears to be an identifiable suite of developmental factors associated with orangutan-initiated, human-directed behaviors. In summary, the rehabilitants that appear to be at the greatest risk for human orientation, and potential conflict, are probably those who entered rehabilitation at an early age, experienced longer duration rehabilitation, and experienced more intense contact with humans during rehabilitants.

In addition, although not formally predicted, differences in human-directed behaviors were also found between sexes/islands. Again, however, conclusions regarding sex/island differences in human-directed behaviors must be considered in light of study variable confounds. For example, sex was entirely confounded with Hepatitis B status (i.e., I6/females were Hep B positive and I4/males were Hep B negative) and island, and was related to differential exposure to human events (i.e., I6/females were exposed to visitor observation while I4/males generally were not). Thus, island/sex-based differences in human-directed behaviors cannot be completely divorced from differences linked with other factors.

I4/males had higher rates of promoting behaviors and lower rates of inhibiting behaviors than I6/females. I4/males had higher rates of active promoting behaviors than I6/females. In addition, I6/females had lower rates of aggressive behaviors and higher rates of avoidance behaviors than I4/males. These findings parallel previous findings in rehabilitant orangutans that suggested that males were more interested in social interactions than females and females were more frequently alone than males (Commitante, 2005). These findings are similar to previous findings for wild, rehabilitant, and captive orangutans that suggest that across settings, males consistently show higher levels of aggressive behavior than females. In the wild, males are much more aggressive than females (Galdikas, 1984, 1985a, 1985b, 1985c). Wild males are also more likely than females to interact aggressively with humans and have been known to chase human observers (Cant, 1987). Rehabilitants' behavioral responses to stress suggest that even infant males engage in aggressive behaviors more frequently than females (Commitante, 2005). Current findings are also consistent with findings from studies of captive orangutans, that males are more aggressive than females and that females are more likely than males to engage in behaviors that serve to minimize or avoid social interactions (Edwards, 1982; Edwards & Snowdon, 1980). Captive orangutan females have also been shown to monitor conspecifics and humans more frequently than males and it has been suggested that this monitoring may allow females to avoid unwanted social contact within the restricted confines of a zoo enclosure (Edwards, 1982; Edwards & Snowdon, 1980). It is possible that the significantly higher rates of avoidance behaviors exhibited by rehabilitant I6/females in the current study, compared to I4/males, may serve a similar function, allowing them to avoid unwanted social encounters with humans. Similarly, as with captive orangutans, I4/males may engage in less monitoring or avoidance behavior than I6/females because they are stronger and rely more on aggression to resolve unwanted social interactions with humans than I6/female rehabilitants do.

Limitations

The two most important limitations of this study are confounded study variables and limited sample size. First, as noted above, sex/island differences are confounded with differences in age, rehabilitation procedures experienced, and human events experienced. These factors may have contributed to the observed greater human orientation in I4/males vs. I6/females in this study. As a group, I4/males were generally younger and experienced more human contact-intensive rehabilitation procedures than I6/females. As such, sex/island differences cannot be completely separated from the effects of age and human contact. Additionally, because I6/females were observed more often under fair versus rainy weather conditions than I4/males, weather may have played a role in the observed sex/island differences if I4/males chose to seek shelter from the rain rather than to respond and orient to humans. However, this seems unlikely, given that both I4/males and I6/females were observed to go about their normal activities in all but the worst weather (i.e., rain that also drove the observer and ORP staff to seek shelter). In addition, although not analyzed statistically, I4/males' human-directed behaviors did not appear to be affected by the rain. One example from Pur illustrates this well. Pur had climbed a pole to observe veterinary and technician staff on adjacent island 5 (I5). The weather had been overcast, but after approximately 15 minutes turned to steady rain. Rather than seek shelter, however, Pur continued to observe the events on I5 for 67 minutes.

Small sample size likely affected statistical results. Visual examination of scatterplots suggested that as rehabilitants aged and experienced longer duration rehabilitation, their human-directed behaviors became more variable. A larger sample size could have allowed for analyses based on standard age classes for Bornean orangutans, which would have improved comparisons between the current and previous studies, and would have helped to determine whether these patterns are true reflections of behavioral variation with age groups or are artifacts of small sample size. Therefore, generalizations to other orangutans and even to other rehabilitants must be made with caution and the findings here should be replicated with larger sample sizes under conditions where variables can be assessed free of confounds before accepting them.

Additionally, the layout of the study site and the procedures promoted at ORP may have biased the behaviors observed. Visual behaviors accounted for the largest number of human-directed behaviors (62%). This number may be artificially high given the layout of the orangutan islands and the limited potential for direct contact/interaction with humans. Water barriers prevented approach within ten meters and contact (with the rare exception of veterinary and technician procedures on the islands). This constraint limited the majority of my observations to human-directed behaviors likely to promote or inhibit orangutan-initiated interactions and interactions that did not require physical contact. In addition, with the exception of aggressive human-directed behaviors, it was generally not possible to assess whether ensuing interactions were likely to be positive or negative (i.e., friendly or antagonistic). Rehabilitant orangutans probably direct different behaviors to humans in areas where they are not physically separated, e.g., increased approach and contact, as occurs in other rehabilitation and tourism facilities (Rijksen, 1997; Russell, 1995; Yeager, 1997). Therefore behavior rates and interpretations from this study may be applicable only to rehabilitants that are physically separated from humans.

Implications

The current findings have important implications for orangutan rehabilitation and the mediation of orangutan-human conflict. Current findings identify a combination of factors that may predispose ex-captive orangutans to orient to and initiate interactions with humans in the rehabilitation context. Younger rehabilitants who enter rehabilitation at young ages and undergo longer duration rehabilitation associated with close human contact procedures appear to be the most likely to orient to and initiate interactions with humans. Entry age may be a key component in this combination, because ex-captives who enter rehabilitation at early ages are more likely to require intensive physical, social, and emotional support from humans, more likely to take longer to acquire the expertise they need to return to the forest, and more likely to develop or continue social attachments to humans. These individuals are probably at the greatest risk for potential future conflict with humans. This may be especially true of male rehabilitants, as I4/males appeared more likely to initiate interactions with humans and directed more aggressive behaviors to humans than I6/females. This combination of behaviors creates an especially dangerous and potentially disastrous conflict potential.

Rehabilitation projects should design age-specific methods to distance early entrants from humans in order to prevent continued reliance on and orientation to humans. This seems especially important in light of the connection between early entry and intense human contact and their effect on human orientation. Projects would likely benefit from age-graded procedures designed to wean rehabilitants from human support and promote peer interactions in a way that closely simulates the gradual withdrawal of maternal support in the wild.

One way to accomplish this may be through the use of age-graded forest schools which simulate normal orangutan development (including developing social relationships with conspecifics), are staffed by a small and dedicated team, and are strictly off limits to nonessential personnel and visitors. Under these conditions, orientation and attachment to humans may be limited to a specific small number of human surrogates rather than extending to humans generally. As rehabilitants age, human support and tolerance can be gradually withdrawn and peer social relationships encouraged in a manner that simulates the weaning process in the wild. Additionally, rehabilitants' human-directed behaviors should be assessed regularly as an indication of how well such methods are working and allow for adjustment in procedures to ensure effective dehumanization prior to releasing rehabilitants to free forest life. Findings from studies of ex-captives reintroduced following rehabilitation suggest that rehabilitants may remain oriented to humans and thus are at risk for orangutan-human conflict following release (Peters, 1995; Riedler, 2007; Russon, 1996).

The current findings also have implications for the larger issue of orangutan-human conflict as a whole. By examining orangutan-initiatives in orangutan-human interaction in rehabilitation I found that rehabilitants with different developmental histories differed in the degree of human orientation and the types of behaviors they directed to humans. This suggests that no single rehabilitation method is likely to successfully dehumanize rehabilitant orangutans and that projects would benefit from considering ex-captives' individual developmental histories and orangutan agendas when designing and implementing rehabilitation procedures. Similar methods to assess orangutan initiatives would probably be beneficial in examining other aspects of orangutan-human conflict. For example, crop raiding conflicts are not likely to be resolved without understanding orangutans' motivational factors. As an example, both free-ranging rehabilitants and wild orangutans raid crops to obtain foods, but their motivations may differ. Work with wild orangutans has suggested that insufficient wild foods due to habitat destruction, and increased proximity to humans and human crops, contribute to wild orangutans' crop raiding (Brown & Jacobson, 2005; Campbell-Smith, 2006; Marchal & Hill, 2009). Similar work with free-ranging rehabilitants has not been undertaken. However, it is possible that they may engage in crop raiding because they are familiar with humans and human foods and may not fear humans. Free-ranging rehabilitants have been known to identify humans as sources of foods and to steal from humans to obtain human foods (Dellatore, 2007; Russon, 1996). In addition, human-oriented free ranging rehabilitants are known to seek proximity to humans (Riedler, 2007; Russon, 1996). Thus, it seems possible that willingness to approach humans and interest in human foods may be associated with crop raiding. As such, methods to mitigate free-ranging rehabilitants' crop raiding may not equally mitigate crop raiding by wild orangutans and vice versa. Only by examining the agendas and motivation of all parties (orangutan and human) within a given conflict can we work toward conflict resolution.

Future Directions

This study focused on the developmental factors associated with orangutan-initiated human-directed behaviors in a rehabilitation context and under conditions where direct orangutan-human contact was not possible. Further study under different conditions would extend the current findings and determine whether orangutan-initiated behaviors directed toward humans differ in facilities that use different procedures, especially concerning orangutan-human contact. Studying rehabilitants under conditions where contact with humans is possible is especially important, because direct contact probably has strong implications for with dangerous aggressive conflicts. Similar studies with free-ranging rehabilitants would also be beneficial to assess whether these orangutans remain oriented to humans and at risk for orangutan-human conflict.

Additionally, human factors such as sex, age, identity (e.g., staff vs. visitor) and relationships (e.g., familiar/trusted caregiver vs. stranger) probably influence which behaviors orangutans direct to humans. Age, sex, and individual relationships are important factors in how well wild orangutans tolerate one another (Russon, 2002a, 2003a; Russon & Galdikas, 1995). Rehabilitant orangutans' human-directed behaviors may follow similar patterns. For example, during the observations for this study, I4/male orangutans appeared to direct aggressive behaviors more selectively to male staff and appeared to direct their behavior to specific staff members. Rehabilitant orangutans seem to recognize humans they encounter on a regular basis, and may be able to distinguish between project staff and visitors. In addition, rehabilitants' probably develop different relationships with humans depending on their experience with them (e.g., caring vs. abusing, familiar vs. strangers).

Future studies could examine whether orangutan-initiated human-directed behaviors differ based on the age/sex of target humans, whether target human(s) are project staff or project visitors, and the relationships (or lack thereof) between rehabilitants and target humans. Studies of this nature may be especially beneficial in identifying particular humans to which ex-captive orangutans are more likely to orient. This is important throughout rehabilitation. Early in rehabilitation it is important for projects to capitalize on rehabilitants' orientation to and relationships with humans while also preventing generalized orientation to all humans. In later stages it is important to use procedures that promote independence and dehumanization and prevent orangutan-initiated interactions. Because developmental factors, orangutans agendas, and human factors are likely transactional rather than independently acting, future studies would benefit from developing methods that the joint action of these factors and their bidirectional influences.

Another area that would probably benefit from further investigation is the relationship between types of human events orangutans experience and the types of behaviors that they direct toward humans. For example, project staff and visitors not only have different relationships with the orangutans, but the behaviors they direct to the orangutans and the activities they engage in while observing orangutans also differ; indeed, the former is probably a product of the latter. While ORP staff were familiar to rehabilitants and typically limited their visits to their assigned duties and engaged rehabilitants only to the degree necessitated by the task, visitors were unfamiliar and more likely to attempt to engage orangutans and to behave in ways that attract rehabilitants' attention. During my study period, visitors were also more likely than staff to be loud, to stare, and to prolong visits, even in the face of orangutans' displeasure (e.g., branch breaking, kiss squeaks). It seems quite likely that the types of human events that rehabilitants are exposed to will influence the behaviors that they direct toward humans.

A final area for future exploration concerns orangutan tourism, both within rehabilitation and beyond. Similar to the factors discussed for staff, human factors are also likely to be important in orangutan-initiated interactions with tourists. In addition, tourism presents its own unique factors. For example, the orangutans observed in this study appeared to direct different behaviors toward project visitors (i.e., tourists) based on the duration of their visit. Specifically, rehabilitants appeared to engage in behaviors that inhibited interaction, including aggression, at a higher rate as the duration of visits increased. Thus it may be beneficial, especially to mitigate orangutan-tourist conflicts, to identify appropriate viewing limits that do not trigger potentially dangerous orangutan behaviors. Group size and behavior may also be important factors for future studies to examine. Although rare in this study, aggressive behaviors directed toward project visitors were observed only in response to larger visitor groups engaged in typically loud and conspicuous behaviors (e.g., more than 6-8 people, prolonged staring and pointing), in conjunction with longer duration visits. As such, assessing orangutan-initiated human-directed behaviors in orangutan tourism may prove beneficial for developing tourism guidelines to prevent potential conflicts.

Conclusions

This study identified a suite of developmental factors that appear to be associated with human orientation in rehabilitant orangutans and the likelihood of orangutan-initiated interactions with humans. This study indicates that there is not a single factor, but rather a combination of factors, associated with human orientation. Moreover, this study identified particular ex-captive orangutans that may be at greater risk for future conflicts with humans and that may be in need of special rehabilitation methods to reduce human orientation. Most importantly, this study indicates that orangutan-initiated human-directed behaviors differ in relation to age and past experience during rehabilitation. Findings indicate that rehabilitation projects would benefit from considering orangutan agendas and initiatives in the design of rehabilitation procedures in order to successfully dehumanize ex-captive orangutans and prevent future orangutan-human conflicts. While certainly not conclusive, this study provides impetus for future studies, particularly studies that consider both orangutan and human factors and the interaction between these factors, to improve our understanding of orangutan-human interaction and conflict. By understanding the factors that underlie human-directed behaviors and orangutan-initiated interactions, we may gain insight into what motivates these behaviors which may prove invaluable in mitigating orangutan-human conflict in rehabilitation and beyond.

REFERENCES

Adams, L. C. (2005). *Social learning opportunities in orangutans.* Unpublished Master's Thesis, York University, Toronto. Retrieved December 8 2009. York University Library Dissertations and Theses database.

Agoramoorthy, G. (2002). Exhibiting orang-utans on a natural island in Malaysia. *International Zoo News (IZN), 49*(5), 260-266.

Agoramoorthy, G., & Hsu, M. J. (2005). Use of nonhuman primates in entertainment in Southeast Asia. *JOURNAL OF APPLIED ANIMAL WELFARE SCIENCE, 8*(2), 141-149.

Altmann, J. (1974). Observational study of behaviour: Sampling methods. *Behaviour, 49*, 227-267.

Ancrenaz, M., Dabek, L., & O'Neil, S. (2007). The costs of exclusion: recognizing a role for local communities in biodiversity conservation. . *PLoS Biol (doi:10.1371/journal.pbio.0050289) www.plosbiology.org, 5*(11), e289.

Aveling, R., & Mitchell, A. (1982). Is rehabilitating orang utans worth while? *ORYX, 16*, 263-271.

Beck, B., Walkup, K., Rodrigues, M., Unwin, S., Travis, D., & Stoinski, T. (2007). *Best Practice Guidelines for the Re-Introduction of Great Apes*. Gland, Switzerland: SSC Primate Specialist Group, World Conservation Union (IUCN).

Bowden, E. (1980). *Evaluation of the orangutan rehabilitation process at Sepilok Rehabilitation Center in Malaysia.* Unpublished Thesis, Colorado College.

Brown, E., & Jacobson, M. F. (2005). *Cruel Oil: How Palm Oiol Harms Health, Rainforest, and Wildlife*. Washington, DC: Center for Science in the Public Interest.

Buckland, H. (2005). *The oil for ape scandal: How palm oil is threatening orang-utan survival.*: Friends of the Earth Trust.

Byrne, R. W., & Russon, A. E. (1998). Learning by imitation: A hierarchical approach. *Behavioral and Brain Sciences, 21*(5), 667-721.

Campbell-Smith, G. (2006). *Bittersweet knowledge: Can Farmers And Orangutans Live In Harmony?* Unpublished Doctoral Dissertation, The University of Kent, Canterbury.

Cant, J. G. H. (1987). Positional behavior of female Bornean orangutans (*Pongo pygmaeus*). *American Journal of Primatology, 12*, 71-90.

CITES/GRASP (2006). *CITES/GRASP Orang-Utan Technical Mission: Indonesia, 8-12 May 2006*. Geneva: CITES Secretariat.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). Quantitative scales, curvilinear relationships, and transformations. In J. Cohen, P. Cohen, S. G. West & L. S. Aiken (Eds.), *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences*. Mahawah, New Jersey: Lawrence Erlbaum Associates.

Commitante, R. (2005). *Orang-Utan Stress: Behaviour and Cortisol Responses in Rehabilitation.* Unpublished PhD Thesis, University of Cambridge, Cambridge, UK.

Dellatore, D. F. (2007). Behavioural health of reintroduced orangutans (*Pongo abelii*) in Bukit Lawang, Sumatra Indonesia. *Unpublished MSc Thesis, Primate Conservation, Oxford Brookes University*.

Donaghy, K. (2002). Up close with orang utans at Sepilok, Sabah Retrieved Feb. 28, 2008, from http://www.wildasia.net/main.cfm?page=article&articleID=18

Edwards, S. D. (1982). Social potential expressed in captive, group-living orangutans. In L. E. M. de Boer (Ed.), *The Orang utan. Its Biology and Conservation* (pp. 249-255). The Hague: Dr. W. Junk Publishers.

Edwards, S. D., & Snowdon, C. T. (1980). Social behavior of captive, group-living orang-utans. *International Journal of Primatology, 1*(1), 39-62.

EIA (1999). The final cut: Illegal logging in Indonesia's orangutan parks. Retrieved November 28, 2007, from http://www.eia-international.org/old-reports/Forests/Indonesia/FinalCut/

Felton, A. M., Engstrom, L. M., Felton, A., & Knott, C. D. (2003). Orangutan population density, forest structure and fruit availability in hand-logged and unlogged peat swamp forests in West Kalimantan, Indonesia. *Biological Conservation 114*, 91-101.

Fernando, R. (2001). Rehabilitating orphaned orang-utans in North Borneo. *Asian Primates 7*(3-4), 20-21.

Fooden, J., & Izor, R. J. (1983). Growth curves, dental emergence norms, and supplementary morphological observationsin known-age captive orangutans. *American Journal of Primatology, 5*, 285-301.

Fox, E. A., Sitompul, A. F., & van Schaik, C. P. (1999). Intelligent tool use in wild Sumatran orangutans. In S. T. Parker, R. W. Mitchell & H. L. W. Miles (Eds.), *The Mentalities of Gorillas and Orangutans: Comparative Perspectives* (pp. 99-116). Cambridge: Cambridge University Press.

Galdikas, B. M. F. (1984). Adult female sociality among wild orangutans at Tanjung Puting Reserve. In M. F. Small (Ed.), *Female Primates* (pp. 217-235). New York: Alan R. Liss.

Galdikas, B. M. F. (1985a). Adult male sociality and reproductive tactics amon orangutans at Tanjung Puting *Folia Primatologica, 45*, 9-24.

Galdikas, B. M. F. (1985b). Orangutan sociality at Tanjung Puting. *American Journal of Primatology, 9*, 101-119.

Galdikas, B. M. F. (1985c). Subadult male orangutan sociality and reproductive behavior at Tanjung Puting National Park. *American Journal of Primatology, 8*, 87-99.

Grundmann, E. (2005). Will re-introduction and rehabilitation help the long-term conservation of orangutans in Indonesia? *Re-Introduction News, 24*, 25-27.

Hardus, M. E., Lameira, A. R., Singleton, I., Morrogh-Bernard, H. C., Knott, C. D., Ancrenaz, M., et al. (2009). A description of the orangutan's vocal and sound repetoire, with a focus on geographic variation. In S. A. Wich, S. S. Utami Atmoko, T. Mitra Setia & C. P. van Schaik (Eds.), *Orangutans: Geographic Variation in Behavioral Ecology and Conservation* (pp. 49-64). Oxford: Oxford University Press.

Harlow, H. F., Dodsworth, R. O., & Harlow, M. K. (1965). Total social isolation in monkeys. *Proceedings of the National Academy of Sciences of the United States of America, 54*(1), 90-97.

Harrisson, B. (1960). A study of orang-utan behaviour in the semi-wild state, 1959-1960. *Sarawak Museum Journal, 9*(15-16).

Hockings, K., & Humble, T. (2009). *Best Practice Guidelines for the Prevention and Mitigation of Conflict Between Humans and Great Apes*. Gland, Switzerland: IUCN/SSC Primate Specialist Group (PSG).

Hoyle, R. H. (1999). *Statistical Strategies for Small Sample Research*. Thousand Oaks, CA: Sage Publications, Inc.

Kaplan, G., & Rogers, L. (1994). *Orang-Utans in Borneo.* Armidale, Australia: University of New England Press.

Lackman-Ancrenaz, I., Ancrenaz, M., & Saburi, R. (2001). The Kinabatangan Orangutan Conservation Project (KOCP). In B. Zoo (Ed.), *The Apes: Challenges for the 21st Century* (pp. 262-265). Chicago: Brookfield Zoo.

Lardeux-Gilloux, I. (1995). Rehabilitation centers: Their struggle, their future. In R. D. Nadler, B. M. F. Galdikas, L. K. Sheeran & N. Rosen (Eds.), *The Neglected Ape* (pp. 61-68). New York: Plenum Press.

Leavens, D. A. (2004). Manual deixis in apes and humans. *Interaction Studies, 5*(3), 387-408.

Leavens, D. A., & Hopkins, W. D. (1998). Intentional communication by chimpanzees: A cross-sectional study of the use of referential gestures. *Developmental Psychology, 34*(5), 813-822.

Leavens, D. A., Hopkins, W. D., & Thomas, R. K. (2004). Referential communication by chimpanzees (*Pan troglodytes*). *Journal of Comparative Psychology, 118*(1), 48-57.

Leiman, A., & Ghaffar, N. (1996). Use, misuse and abuse of the orang utan: Exploitation as a threat or the only real salvation? *The Exploitation of Mammal Populations* (pp. 345-357). London: Chapman & Hall.

Marchal, V., & Hill, C. (2009). Primate crop-raiding: A study of local perceptions in four villages in North Sumatra, Indonesia. *Primate Conservation, 24*, 8-17.

Martin, P., & Bateson, P. (2007). *Measuring Behavior: An Introductory Guide* (3rd ed.). Cambridge: Cambridge University Press.

Morrogh-Bernard, H., Husson, S., & McLardy, C. (2002). *Orang-utan data collection standardisation.* . San Anselmo, USA: Orang-utan Culture Workshop; http://www.aim.uzh.ch/orangutannetwork/FieldGuidelines.html.

Nelleman, C., & Newton, A. (2002). *The Great Apes: The Road Ahead*. Gland, Switzerland: UNEP.

Peters, H. (1995). *Orangutan reintroduction? Development, use, and evaluation of a new method: Reintroduction.* Unpublished MSc Thesis, University of Groningen, The Netherlands.

Riedler, B. (2007). *Activity patterns, habitat use and foraging strategies of juvenile orang utans (Pongo abelii) during the adaptation process to forest life.* Unpublished Thesis, University of Vienna.

Rijksen, H. D. (1978). *A field study on Sumatran orang utans (Pongo pygmaeus abelii Lesson 1827): Ecology, behavior, and conservation.* Wageningen, The Netherlands: H. Veenman and Zonen B.V.
Rijksen, H. D. (1982). How to save the mysterious 'man of the rain forest'? In L. E. M. de Boer (Ed.), *The Orang utan: Its Biology and Conservation* (pp. 317-341). The Hague: Dr. W. Junk Publishers.
Rijksen, H. D. (1995). The neglected ape? NATO and the imminent extinction of our close relative. In R. D. Nadler, B. M. F. Galdikas, L. K. Sheeran & N. Rosen (Eds.), *The Neglected Ape* (pp. 13-21). New York: Plenum Press.
Rijksen, H. D. (1997). *Evaluation of Ex Orangutan Rehabilitation Stations: Bohorok and Tanjung Puting*. Balikpapan, Indonesia: International Ministry of Forestry Tropenbos Project.
Rijksen, H. D. (2001). The orangutan and the conservation battle in Indonesia. In B. B. Beck, T. S. Stoinski, M. Hutchins, T. L. Maple, B. Norton, A. Rowan, E. F. Stevens & A. Arluke (Eds.), *Great Apes & Humans: The Ethics of Coexistence* (pp. 57-70). Washington: Smithsonian Institution Press.
Rijksen, H. D., & Meijaard, E. (1999). *Our Vanishing Relative: The Status of Wild Orang-Utans at the Close of the Twentieth Century.* Dordrecht: Kluwer Academic Publishing.
Rijksen, H. D., & Rijksen-Graatsma, A. G. (1975). Orang Utan rescue work in North Sumatra. *Oryx, 13*, 65-73.
Russell, C. L. (1995). The social construction of orangutans: An ecotourist experience. *Society and Animals 3*(2), 151-170.
Russell, C. L. (2001). Primate-focused ecotourism: Proceed with caution. *Laboratory Primate Newsletter 40*(4), 7-8.
Russell, C. L. (2004). Establishing guidelines for primate-focused ecotourism: lessons from whalewatching. *Folia Primatologica, 75*(S1), 45.
Russon, A. E. (1996). *Report on Observations of Release Group VI* (Unpublished Report to the Wanariset Orangutan Reintroduction Project). East Kalimantan, Indonesia: Borneo Orangutan Suvival Foundation, Wanariset.
Russon, A. E. (1998). The nature and evolution of intelligence in orangutans (*Pongo pygmaeus*). *Primates, 39*(4), 485-503.
Russon, A. E. (2000). *Orangutans: Wizards of the Rainforest*. Buffalo, NY: Firefly Books Ltd.
Russon, A. E. (2001). *Rehabilitating orangutans (Pongo pygmaeus): Behavioral competence.* Paper presented at the International Primatological Society Symposium: Critical Issues in Captive Care, Adelaide, Australia.
Russon, A. E. (2002a). Comparative developmental perspectives on culture: The great apes. In H. Keller, Y. H. Poortinga & A. Schoelmerich (Eds.), *Between Culture and Biology: Perspectives on Ontogenetic Development* (pp. 30-56). Cambridge: Cambridge University Press.
Russon, A. E. (2002b). Return of the native: Cognition and site-specific expertise in orangutan rehabilitation. *International Journal of Primatology 23*(3), 461-478.

Russon, A. E. (2003a). Developmental perspectives on great ape traditions. In D. M. Fragaszy & S. Perry (Eds.), *The Biology of Traditions: Models and Evidence* (pp. 329-364). Cambridge: Cambridge University Press.

Russon, A. E. (2003b). Innovation and creativity in forest-living rehabilitant orang-utans. In S. Reader & L. Laland (Eds.), *Animal innovation* (pp. 279-306). Oxford: Oxford University Press.

Russon, A. E. (2006). Acquisition of complex foraging skills in juvenile and adolescent orangutans (*Pongo pygmaeus*): Developmental Influences. *Aquatic Mammals, 32*(4), 500-510.

Russon, A. E. (2007). Orangutan Rehabilitation and Reintroduction: Successes, failures, and role in conservation. In S. A. Wich (Ed.), *Orangutans Compared*: Oxford University Press.

Russon, A. E. (2009). Orangutan Rehabilitation and reintroduction: Successes, failures, and role in conservation. In S. A. Wich, S. S. Utami Atmoko, T. Mitra Setia & v. S. C.P. (Eds.), *Orangutans: Geographic Variation in Behavioral Ecology and Conservation* (pp. 327-350). Oxford: Oxford University Press.

Russon, A. E., & Galdikas, B. M. F. (1993). Imitation in free-ranging rehabilitant orangutans. . *Journal of Comparative Psychology, 107*(2), 147-161.

Russon, A. E., & Galdikas, B. M. F. (1995). Constraints on great apes' imitation: Model and action selectivity in rehabilitant orangutan (Pongo pygmaeus) imitation. *Journal of Comparative Psychology, 109*(1), 5-17.

Russon, A. E., & Russell, C. L. (2005). Orangutan tourism. In J. Caldecott & L. Miles (Eds.), *Worla Atlas of Great Apes and Their Conservation* (pp. 264-265). Berkeley: University of California Press/UNEP World Conservation Monitoring Centre.

Russon, A. E., Susilo, A., & Russell, C. L. (2005). Orangutan-focused tourism: 30 years of experience in conservation perspective *Unpublished Manuscript*.

Salafsky, N. (1993). Mammalian use of a buffer zone agroforestry system bordering Gunung Palung National Park, West Kalimantan, Indonesia. *Conservation Biology, 7*(4), 928-933.

Sandbrook, C., & Semple, S. (2006). The rules and the reality of mountain gorilla (*Gorilla beringei beringei*) tracking: How close do tourists get? *Oryx, 40*(4), 428-433.

Smits, W. T. M., Heriyanto, & Ramono, W. S. (1995). A new method for rehabilitation of orangutans in Indonesia: A first overview. In R. D. Nadler, B. M. F. Galdikas, L. K. Sheeran & N. Rosen (Eds.), *The Neglected Ape* (pp. 69-77). New York: Plenum Press.

Snaith, T. (1999). *The behavior of free-ranging ex-captives in Tanjung Puting National Park, Indonesia.* Unpublished Master's Thesis, University of Calgary, Calgary.

Sowards, S. K. (2006). Identification through orangutan: Destabilizing the nature/culture dualism. *Ethics & the Environment, 11*(2), 45-61.

Swan, R. A., & Warren, K. S. (2001). Health, management, and disease factors affecting orangutans in a reintroduction centre in Indonesia *The Apes: Challenges for the 21st Century* (pp. 364). Chicago: Brookfield Zoo.

UNEP-WCMC (2009). UNEP-WCMC Species Database: CITES-Listed Species Retrieved January 28, 2009, from www.cites.org/eng/resources/species.html

van Adrichem, G. G. J., Utami, S. S., Wich, S. A., van Hooff, J. A. R. A. M., & Sterck, E. H. M. (2006). The development of wild immature Sumatran orangutans (*Pongo abelii*) at Ketambe. *Primates, 47*, 300-309.

van Noordwijk, M. A., Sauren, S. E. B., Nuzuar, Abulani, A., Morrogh-Bernard, H., Utami Atmoko, S. S., et al. (2009). Development of independence: Sumatran and Bornean orangutans compared. In S. A. Wich, S. S. Utami Atmoko, T. Mitra Setia & v. S. C.P. (Eds.), *Orangutans: Geographic Variation in Behavioral Ecology and Conservation* (pp. 189-209). Oxford: Oxford University Press.

van Noordwijk, M. A., & van Schaik, C. P. (2005). Development of ecological competence in Sumatran orangutans. *American Journal of Physical Anthropology 127*, 79-94.

van Schaik, C. P., & Gisi, M. (2008). Orangutan Call Repetoires Retrieved February 1, 2008, from http://www.aim.uzh.ch/orangutannetwork/orangutancallrepertoires.html#135

Watts, D., & Pusey, A. E. (2002). Behavior of juvenile and adolescent great apes. In M. A. Pereira & L. A. Fairbanks (Eds.), *Juvenile Primates* (pp. 148-167). Chicago: University of Chicago Press.

Whitten, A. J., & Ranger, J. (1986). Logging at Bohorok. *Oryx, 20*(4), 246-248.

Wich, S. A., Meijaard, E., Marshall, A. J., Husson, S., Ancrenaz, M., Lacy, R. C., et al. (2008). Distribution and conservation status of the orang-utan (*Pongo* spp.) on Borneo and Sumatra: How many remain? *Oryx, 42*(3), 329-339.

Winkler, L. A., Schwartz, J. H., & Swindler, D. R. (1991). Aspects of dental development in the orangutan prior to eruption of the permanent dentition. *American Journal of Physical Anthropology, 86*, 255-271.

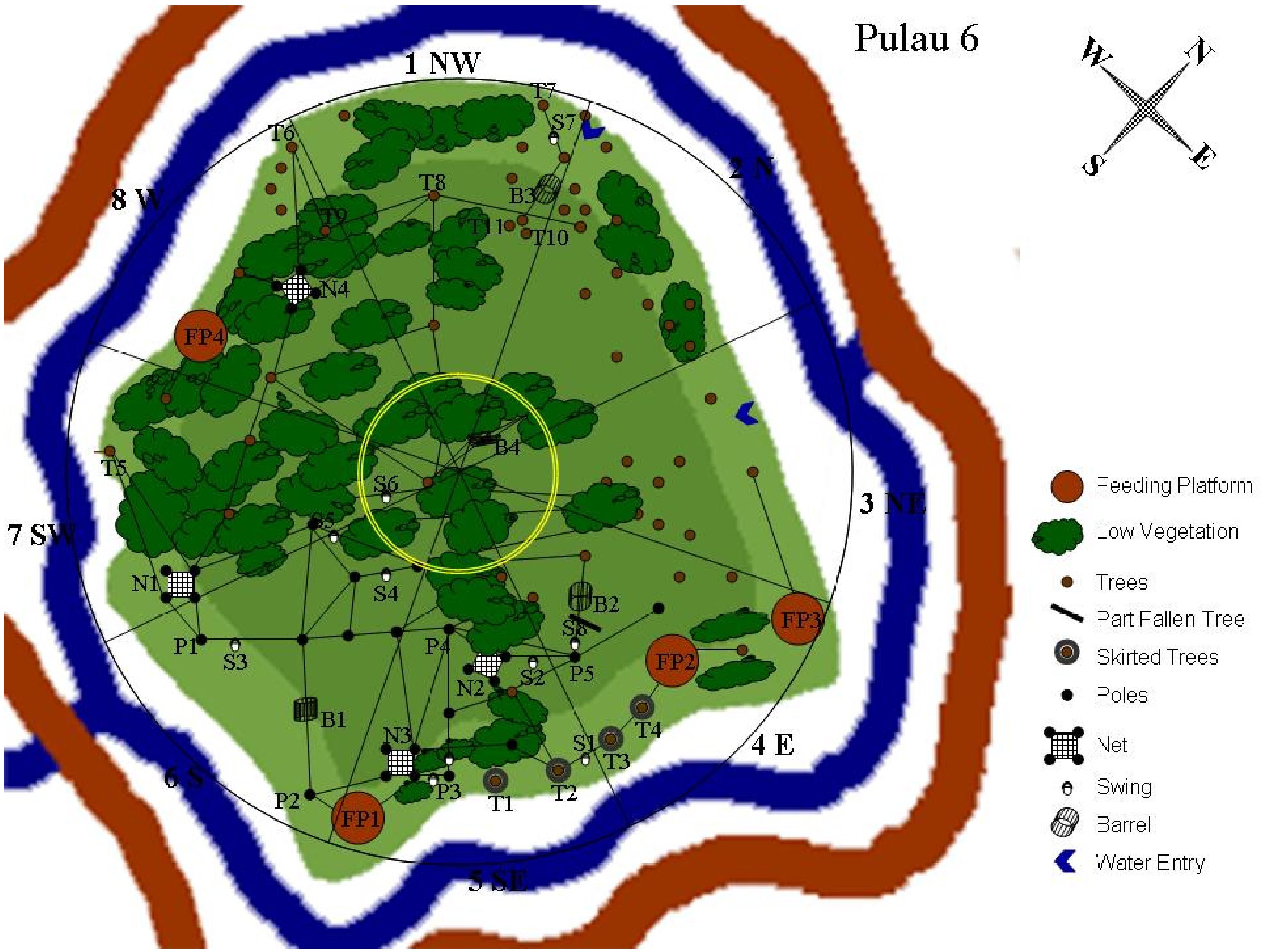
Woodford, M. H., Butynski, T. M., & Karesh, W. B. (2002). Habituating the great apes: the disease risks. *Oryx, 36*(2), 153-160.

Woodroffe, R., Thirgood, S., & Rabinowitz, A. (Eds.). (2005). *People and Wildlife: Conflict of Coexistence?* Cambridge: Cambridge University Press.

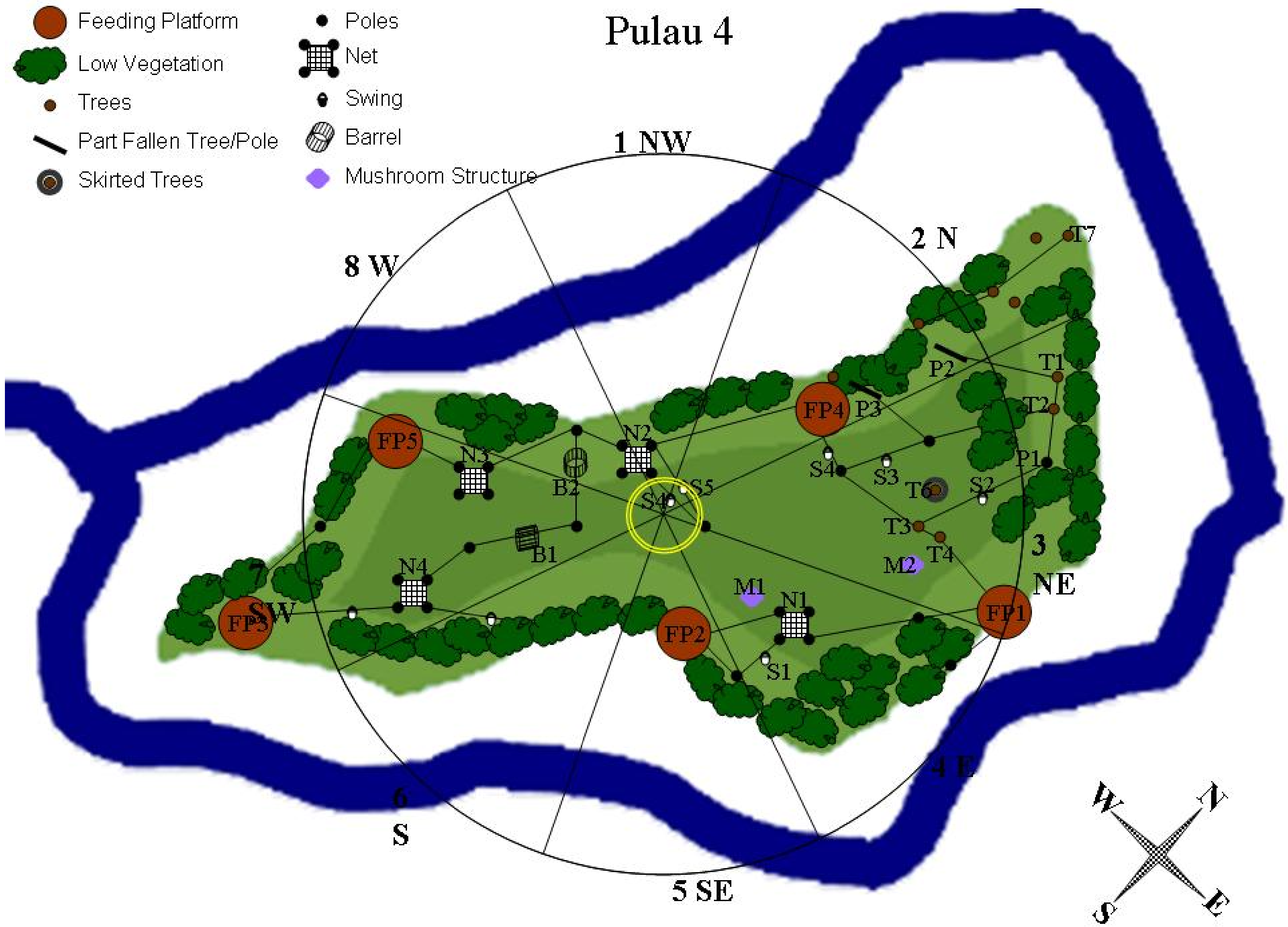
Yeager, C. P. (1997). Orangutan rehabilitation in Tanjung Puting National Park, Indonesia. *Conservation Biology, 11*(3), 802-805.

Yuwono, E. H., Susanto, P., Saleh, C., Andayani, N. P., D. , & Utami Atmoko, S. S. (2007). *Guidelines for Better Management Practices on Avoidance, Mitigation and Management of Human-Orangutan Conflict in and around Oil Palm Plantations.*: WWF Indonesia.

Appendix A(i): Island 6 Diagram



Appendix A(ii): Island 4 Diagram



Appendix B (i). Focal observation sheet: General orangutan behavior and proximity[1]

ORANGUTANS																
											Proximity Scans (5 minutes)*					
Focal	Date	Island	Start	End	HT	Activity	Location	Island Area	OU Social	With Who	Nila	Oneng	Emmy	Wulani	Siah	PROX Code

[1] Sample focal sheet shown for Island 6 females. For Island 4 males, names under proximity scans are changed.

Appendix B (ii). Orangutan Activities Ethogram[1]

Height Ranges	
1	0 meters
2	< 2m
3	2-5m
4	5-10m
5	10m+

General Activity	
MT	Eat Provisions
MF	Eat/Forage
MO	Old Provisions
D	Drink
L	Locomote
R	Rest (sit, lay down)
H	Hang
P	Play
OOS	Out of Sight

Location/Substrate	
N	Nest
G	Ground
P#	Pole
T#	Tree
R	Rope
B	Barrel
S	Swing
FP#	Feeding Platform #

Self-Directed/Alone	
DMS	Play alone
DMO	Play with object
DBP	Make rain/sun hat
DBS	Make Nest
DKS	Self Groom

Affiliation - non-sexual	
SDE	Sit Near
SPE	Embrace
SJS	Walk Together
SKT	Social Grooming
SGU	Play Wrestle
SMB	Co-feed
SME	Tease

Social Learning	
SPE	Watch/Attend
SPC	Peer/watch close
SBG	Share Something
SBE	Scrounge remains
SMI	Ask/Request/Beg

Aggression	
SGS	Wrestle/Fight
SKE	Pursue/Chase
SLA	Flee/Escape
SPI	Displace
SHI	Avoid
SCU	Steal

Proximity Scans	
PROX Code	
1	Prox Scan
Blank	Prox at start of new behavior or event

Proximity Categories	
1	0m (contact)
2	0-2m
3	2-5m
4	5+
5	OOS
Blank	Current Focal

Island Location (2-digits)	
First Digit	
1	Exterior
2	Interior
Second Digit	
1	North West
2	North
3	North East
4	East
5	South East
6	South
7	South West
8	West

[1] Adapted from the Orangutan Cultures and Social Learning Project (OCSLP) ethogram for ex-captives in forest schools at the Wanariset Orangutan Reintroduction Program

Appendix B (iii). Focal observation sheet: Human Events

HUMANS						HUMAN-DIRECTED ORANGUTAN BEHAVIORS						
Description	ID Notes	Age	Type	Human Behavior	Guide Pos.	Visual	Vocal	Gesture	Position	Locomote	No Resp.	Comments

Appendix B (iv). Human-directed orangutan behaviors

Visual		
VG	Glance/Peek	Singular glance < 30 second
VR	Repeated Glances	Multiple glances no single glance >30 second duration
VT	Visual Tracking	maintain visual contact & follow moving humans with gaze
VA	Look away	position head/gaze to move line of sight away from humans
VI	Ignore	No visual response to humans
Vocal		
KS	Kiss squeak	
R	Raspberry	
G	Grunt	
P	Pig Squeal	
M	Squeak (mip-mip)	
Gestural		
GR	Reach out (H/F)	Extend arm and hand palm up
GP	Point	Motion toward – pointing hand out palm down
GTA	Throw at	Throw any item in direction of another (human or OU)
GTD	Throw down	Throw item down (e.g. not specifically in direction of other)
GO	Offer	Hold item out toward another
GS	Splash at	Splash water (hand, foot, stick, etc.)
Locomotor		
LA	Approach	Move toward humans (from still or change direction)
LW	Withdraw	Move away from humans (from still or change direction)
LF	Follow/Parallel	Move in same direction as humans
LU	Move Up	Move vertically up (context = view/escape)
LD	Move Down	Move vertically down (context = toward/escape)
Positional		
PT	Reposition toward	Change body position toward
PA	Reposition away	Change body position away (e.g. turn back on humans)
PH	Hide	partially/fully behind object or individual – not OOS
Contact		
C	Note any contact, type, duration, human identity, location, etc.	
No Response		
X	No change in orangutan activity, position, locomotion, etc.	
Multiple Actions		
XX	multiple actions – see comments column for description of actions and sequence	

Appendix C(i). Frequency of Promoting Behaviors

	Visual [1]			Gestural			Position		Locomotor			
Name	G	RG	VT	Reach	Point	Offer	Toward	App	Parallel	Up (view)	Down (toward)	Total Promoting
Nila	11	4	11	0	0	0	3	6	0	4	0	39
Siah	6	25	36	0	0	0	4	19	4	5	0	99
Emmy	10	17	29	0	0	0	7	12	4	3	2	84
Wulani	6	20	33	0	0	0	6	23	3	6	4	101
Oneng	6	15	13	0	0	0	1	10	2	1	2	50
Female Total	39	81	122	0	0	0	21	70	13	19	8	373
Agus	10	8	19	0	0	0	2	10	5	5	1	60
Jovan	11	13	47	1	0	0	4	11	5	15	6	113
Pur	16	13	67	0	0	0	2	23	11	22	19	173
Hamza	8	21	35	0	0	0	1	22	4	3	4	98
Male Total	45	55	168	1	0	0	9	66	25	45	30	444
TOTALS	84	136	290	1	0	0	30	136	38	64	38	817

1. Visual Behaviors: glance (G), repeated glances (RG), visual tracking (VT)

Appendix C(ii). Frequency of Inhibiting Behaviors

	Visual[1]	Gestural			Position	Vocal	Locomotor				
Name	Look/Pos Away	Display [2]	Throw object	Splash	Hide	All [3]	Withdraw	Up (escape)	Down (escape)	Total Inhibiting	NR
Nila	11	0	0	0	10	0	5	4	1	31	22
Siah	14	0	0	0	9	0	28	3	2	56	39
Emmy	13	0	0	0	2	0	11	2	1	29	24
Wulani	9	0	1	0	4	0	18	1	0	33	44
Oneng	12	1	0	0	7	2	16	3	3	44	36
Female Total	59	1	1	0	32	2	78	13	7	193	165
Agus	2	0	0	0	1	1	3	1	0	8	32
Jovan	1	0	0	0	0	0	8	0	1	10	36
Pur	0	11	4	4	2	0	9	1	0	31	33
Hamza	3	0	0	0	0	2	13	1	0	19	48
Male Total	6	11	4	4	3	3	33	3	1	68	149
TOTALS	65	12	5	4	35	5	111	16	8	261	314

1. Look and position away combined (deliberate ignoring).
2. Displays: Oneng (1 vegetation displays, Pur (9 vegetation displays, 2 object displays)
3. Vocalizations: Oneng (2 kiss squeaks), Agua (1 grunt), Hamza (2 kiss squeaks)