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Direct and Indirect Reputation Formation in Nonhuman Great Apes and Human Children

Esther Herrmann
Max Planck Institute for Evolutionary Anthropology

Stefanie Keupp
Max Planck Institute for Evolutionary Anthropology and
University of Göttingen

Brian Hare
Duke University

Amrisha Vaish and Michael Tomasello
Max Planck Institute for Evolutionary Anthropology

Humans make decisions about when and with whom to cooperate based on their reputations. People either learn about others by direct interaction or by observing third-party interactions or gossip. An important question is whether other animal species, especially our closest living relatives, the nonhuman great apes, also form reputations of others. In Study 1, chimpanzees, bonobos, orangutans, and 2.5-year-old human children experienced a nice experimenter who tried to give food/toys to the subject and a mean experimenter who interrupted the food/toy giving. In studies 2 and 3, nonhuman great apes and human children could only passively observe a similar interaction, in which a nice experimenter and a mean experimenter interacted with a third party. Orangutans and 2.5-year-old human children preferred to approach the nice experimenter rather than the mean one after having directly experienced their respective behaviors. Orangutans, chimpanzees, and 2.5-year-old human children also took into account experimenter actions toward third parties in forming reputations. These studies show that the human ability to form direct and indirect reputation judgment is already present in young children and shared with at least some of the other great apes.

Keywords: direct reputation, indirect reputation, chimpanzees, bonobos, orangutans, human children

Evaluating the behavior of others is an important skill for members of a social group. It is advantageous to know about the good or bad reputation of other individuals to adjust one's own behavior accordingly. Based on this knowledge, individuals can, for instance, choose a cooperative partner for future interactions and decrease the risk of being cheated by noncooperators. The easiest and most precise way to learn about the reputation of others, that is, to gain knowledge about an individual's common behavior in specific situations which is evaluated through experience of the individual's past behavior (Russell, 2007), is by direct interaction (Alexander, 1987; Axelrod, 1984). However, as group size increases and direct encounters are less frequent or when direct assessment might be risky (e.g., when assessing the fighting abilities of others), it becomes more crucial to assess the reputation

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Esther Herrmann, Amrisha Vaish, and Michael Tomasello, Department of Developmental and Comparative Psychology, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany; Stefanie Keupp, Max Planck Institute for Evolutionary Anthropology, and Department of Developmental Psychology, University of Göttingen, Göttingen, Germany; Brian Hare, Department of Evolutionary Anthropology and Center for Cognitive Neuroscience, Duke University, Durham, North Carolina.

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Correspondence concerning this article should be addressed to Esther Herrmann, Max Planck Institute for Evolutionary Anthropology, Deutscher Platz 6, 04103 Leipzig, Germany. E-mail: eherrman@eva.mpg.de

of others through indirect experiences like observing third-party interactions, and in the case of humans, by learning from gossip (Dunbar, 1986; Sommerfeld, Krambeck, Semmann, & Milinski, 2007). In human economic games, the reputation people form about others strongly influences their future cooperative behaviors toward those others (Hammerstein, 2003; Milinski, Semmann, & Krambeck, 2002; Nowak & Sigmund, 1998, 2005; Panchanathan & Boyd, 2003; Tennie, Frith, & Frith, 2010; Wedekind & Milinski, 2000), and people even invest in their own reputation which allows them to be preferably chosen as cooperative partners (Roberts, 2008; Sylwester & Roberts, 2010).

In humans, it has been demonstrated that 3- and 6-month-old infants already evaluate nonhuman agents on the basis of how they behave toward others. They demonstrated their preference for an agent who acted prosocially over one who acted antisocially by either approaching or looking more toward the former (Hamlin, Wynn, & Bloom, 2007, 2010). Eight-month-old infants even preferred a puppet who behaved negatively toward an antisocial character (Hamlin, Wynn, Bloom, & Mahajan, 2011). Furthermore, it has been shown that 3- to 4.5-year-old human children differentially helped or shared resources with other individuals based on their previous moral behavior (Kenward & Dahl, 2011; Olson & Spelke, 2008; Vaish, Carpenter, & Tomasello, 2010).

From research with nonhuman primates, we know that they not only recognize other group members but also understand third-party relationships (e.g., Chapais, 2008; Cheney & Seyfarth, 1980; Dasser, 1988; Silk, Alberts, & Altmann, 2004; Tomasello & Call, 1997). An interesting question remains: do nonhuman primates use the knowledge which they gain from direct interaction or observing interactions indirectly for their own future behavior in similar ways as humans or is this ability uniquely human? Chimpanzees adjust their behavior on the basis of their direct experience with other individuals; for instance, they change their behavior toward an experimenter based on whether he is unwilling or unable to give them food (Call, Hare, Carpenter, & Tomasello, 2004). Furthermore, they choose to recruit the better of two collaborators on the basis of the collaborators' past performance (Melis, Hare, & Tomasello, 2006). Recently, it also has been demonstrated that nonhuman great apes can use knowledge gained by observing third-party interactions for future decisions (Russell, Call, & Dunbar, 2008; Subiaul, Vonk, Okamoto-Barth, & Barth, 2008). In the study of Subiaul et al. (2008) chimpanzees could observe unfamiliar humans being either generous by giving or selfish by refusing to give food to a recipient. Shortly after, chimpanzees could decide from which of the two experimenters to beg for food. In this study the chimpanzees were not just able to learn about the experimenters' reputation indirectly by observation; they also could directly experience the nature of each experimenter over the course of the experiment by receiving food only when begging from the generous experimenter. Chimpanzees initially showed no preference for either experimenter when information could only be gained through observation, but developed a preference for the generous one during the study, even with new experimenter pairs.

A similar question was investigated by Russell et al. (2008). In that study, individuals of all four nonhuman great ape species could gain information about others simply by passively observing them interacting. In one interaction, a nice person gave food to a recipient and in a second interaction the ape could observe a stingy person refusing to share food. After having seen both incidents, the subject was allowed to approach the experimenters. Approach was measured by the proportion of time spent near each experimenter, rather than the subjects' first approach. This study showed that chimpanzees spent significantly more time in proximity to the nice compared with the stingy person, corroborating the findings by Subiaul et al. (2008). However, Russell et al. (2008) did not find a significant effect of a preference for the nice person for any of the other three species but emphasized that the bonobo result looks most similar to the chimpanzee behavior, suggesting a possible cognitive divide between Pan and non-Pan species.

There is also a significant amount of research on various other animal species, especially on fish, birds, and dogs, showing that individuals adjust their behavior based on the information they gain from situations akin to eavesdropping situations (e.g., Amy & Leboucher, 2007; Bshary & Grutter, 2006; Kundey et al., 2011; Peake et al., 2002, 2005; Rooney & Bradshaw, 2006). The most striking example comes from observations of interactions between cleaner fish and client reef fish (Bshary, 2002). Clients more often approach cleaners that they have observed interacting without conflict with another client and avoid cleaners that they observe cheating (eating mucus of the reef fish instead of its parasites). However, in comparison with the studies with nonhuman apes and cleaner fish, most studies on other animal species focus solely on fighting situations, which offer the opportunity to learn mainly about dominance rather than about prosocial behavior. While learning about dominance is undoubtedly important for calculating the outcome for future fighting encounters with conspecifics, learning how prosocial others are provides information that is useful across a variety of different contexts, such as sharing resources and providing and receiving support (Amy & Leboucher, 2007; McGregor, 2005; Valone, 2007; but see Kundey et al., 2011).

In general, it is still the case that very little experimental work has been done evaluating the four nonhuman great ape species' abilities to form reputations (direct and indirect) about others, and how their abilities might compare with those of humans. In the two previous nonhuman ape studies (Subiaul et al., 2008; Russell et al., 2008), positive findings were only found for chimpanzees, though the bonobo behavior looked similar to the chimpanzee behavior. This could be a result of having only chimpanzees participate (Subiaul et al., 2008) or including rather small sample sizes of the other three nonhuman ape species (Russell et al., 2008). However, Russell et al. (2008) suggested a possible cognitive divide between *Pan* and *non-Pan* species. To further examine this issue, we investigated reputation-formation in our two closest living relatives, the chimpanzees and bonobos, who live in large complex social groups with constant cooperative and competitive interactions among group members, as well as in orangutans, a more distantly related ape with a more solitary way of life, for whom reputation formation might not be as important. Another limitation of previous research is that chimpanzees received either extensive training and were directly reinforced when begging from the generous experimenter, or a rather indirect response measure (proportion of time spent near each experimenter) was used. Our investigation thus involved testing a large number of each species and using a direct response measure (first approach to an experimenter). Furthermore, we were interested in whether the nonhuman great apes' use of direct and indirect reputation as knowledge sources on which to shape their future behavior is similar to that of human children. We compared the abilities of chimpanzees, bonobos, orangutans and 2.5-year-old human children to assess the distinct social behaviors of two human experimenters. In Study 1, the individuals could evaluate two experimenters by directly interacting with them, whereas Studies 2 and 3 only allowed the subject to gain some knowledge about the human experimenters by observing third-party interactions.

Study 1: Direct Interaction

In this study, we assessed whether chimpanzees, bonobos, orangutans, and 2.5-year-old human children form different expectations about receiving food/toys in the future from two experimenters based on their prior direct experience with those experimenters. First, the subject experienced a nice experimenter who tried to give food/toys to the subject and a mean experimenter who interrupted the food/toy giving process. After witnessing this incident, the subject could approach one of the two experimenters, both of whom offered food/toys to the subjects.

Method

Participants

One hundred three chimpanzees (53 males and 50 females; 3 to 21 years of age), 33 bonobos (21 males and 12 females; 5 to 22 years of age), and 26 orangutans (16 males and 10 females; 3 to 10 years of age) participated in this study. Three additional chimpanzees, one bonobo, and six orangutans were excluded from the final sample because they made no choice in any of the trials or had to be excluded because of experimenter mistakes. The chimpanzees lived either at the Ngamba Island chimpanzee sanctuary, Lake Victoria, Uganda, or at the Tchimpounga chimpanzee sanctuary, Republic of Congo. The bonobos lived at Lola ya Bonobo sanctuary, Democratic Republic of Congo. All orangutans lived at the Orangutan Care Center and Quarantine in Pasir Panjang, Kalimantan, Indonesia. All apes came to the sanctuaries as orphans as a result of the illegal bushmeat trade, were raised by humans together with peers, and at the time of testing all apes lived in social groups with the exception of five chimpanzees, who lived in pairs (see Wobber & Hare, (2011) for details on social organization and rearing history). Subjects were never food-deprived for any reason, and their diet (i.e., the food which was available in their enclosures) was supplemented two to four times daily with a combination of additional fruits, vegetables, and other species' appropriate foods. Animal husbandry and research complied with the *PASA Primate Veterinary Healthcare Manual* and the policies of Chimpanzee Sanctuary & Wildlife Conservation Trust, Uganda, Tchimpounga Chimpanzee Sanctuary, Republic of Congo, Lola ya Bonobo Sanctuary, Democratic Republic of Congo, and the Orangutan Care Center and Quarantine in Pasir Panjang, Kalimantan, Indonesia.

Furthermore, 88 30-month-old human children (± 2 months; 47 males, 41 females) participated in this study. Seventeen additional children were excluded from the final sample because they made no choice in any of the trials. All children were tested in the Developmental and Comparative Psychology Department at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. The children were recruited by telephone from an existing database, comprising mostly middle-class families. Children received a small gift for their participation.

For all apes and human children the study was administered as part of a larger set of social and physical cognitive tasks.

Materials

Apes. Grapes, almonds, or peanuts were used as food items. Food types were chosen to maximize individuals' motivation to participate. The majority of chimpanzees and bonobos were tested with almonds; the small minority who did not like almonds (i.e., they did not eat almonds when they were handed to them before testing) were tested with peanuts instead. All orangutans were tested with grapes. Each individual was tested during the study with only one food type.

The locations where the experimenters had to position their hands during presentation were marked with a pen on the floor (~20 cm away from the mesh).

Children. The child, who sat on the lap of the parent, and the experimenters sat at a 130 × 70 cm table. Three red bouncy balls were used as toys for the observed interaction and one additional colorful bouncy ball for the intermediate play phase. The locations where the experimenters had to position their hands during presentation were marked with a pencil on the table (30 cm away from the child's end of the table).

Procedure and Design

Each child was accompanied by a parent throughout the study. Parents were blind to the hypotheses of the study. The procedure of the study was explained to the parents. They were told not to influence or help their children in any way to make their choice, except the one time they were instructed to. Two experimenters participated in this task and one caretaker in the case of apes and an assistant experimenter for the children. The two experimenters (E1 and E2) acted out the nice and mean roles and the caretaker distracted the ape and centered the ape before each choice phase. E1 and E2 were either two female researchers with similar familiarity histories with the subject (human children, bonobos, and majority of chimpanzees), two male caregivers (for nine chimpanzees), or a female researcher and a male caregiver (all orangutans). The familiarity of the researchers for the majority of the subjects (human children, bonobos, and chimpanzees) was very similar before the start of the experiment, as researchers began interacting with the apes only a few days before the study took place.[1]

The role of the experimenters E1 and E2 was counterbalanced across subjects; for example, for half of the participants E1 played the role of the nice person and for the other half the role of the

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[1] To ensure that the differences in experimenters did not have an influence on the subjects' behavior, we compared the results from the 34 Ngamba chimpanzees, nine of whom were tested by male caregivers and the remaining 25 by female researchers. The two samples did not differ in their responses: $t(32) = 1.268$, $p = 0.214$. The same was true for Experiment 2: $t(31) = 0.655$, $p = 0.512$ (note that in Experiment 2, one additional chimpanzee was excluded from the Ngamba sample, leaving a total of 33 chimpanzees).

mean person. The position (left vs. right) of each experimenter during the choice phase was counterbalanced across trials. Apes participated in four identical trials and human children in two identical trials. The difference in the amount of given trials across species was a result the fact that human children were not able to pay attention for more than two trials. Each trial consisted of an experience phase and a choice phase.

In each ***experience phase*** E1 was nice by attempting to give 10 food items (ape) or play three times (child) with the subject while E2 behaved badly by interrupting the food giving or the game. After witnessing this incident, the subject participated in a ***choice phase***, in which she or he could choose between E1 and E2, who offered food/toys in their outstretched hands, by approaching one of them.

Experience Phase

Apes. Experimenter E1 and E2 entered the testing area and crouched next to the mesh wall of the holding facility. E1 (nice experimenter) held 10 food items in her hand, and once the subject paid attention E1 attempted to give the food items one after another to the subject. E2 (mean experimenter) crouched next to E1 and prevented the food transfer to the subject by stealing the food and either accidently dropping it on the floor or simulating or actually eating it while making noises indicative of satisfaction (by imitating food grunts) in the case of chimpanzees and bonobos. This incident was repeated until all 10 food items were stolen by E2. In response to the stealing event, E1 showed her frustration by hitting and pushing E2. In addition, E1 vocalized at E2 by either saying "hey" in the case of the orangutans or by making a threat grunt in the case of bonobos and chimpanzees. Then both experimenters left the testing area (see Figure 1a for the experimental set-up).

Children. E1 and E2 approached the table at which the child was already sitting on her parent's lap. E1 (nice experimenter) sat down opposite the child and E2 (mean experimenter) sat to the child's right (see Figure 1b for the experimental set-up). E1 held

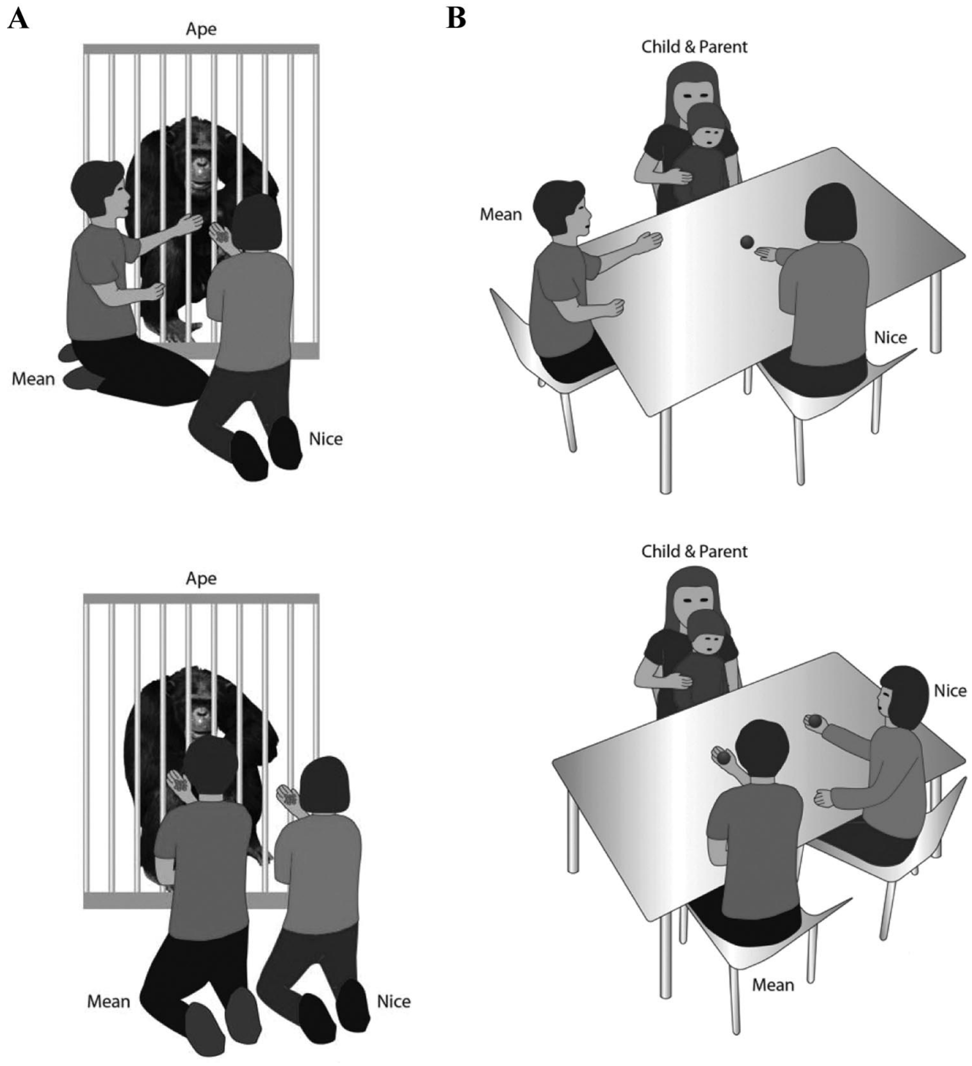

Figure 1. Experimental setup for (A) nonhuman apes in Study 1 and (B) human children in Study 1.

three bouncy balls in a cup under the table and E2 had one empty cup on her lap. Then E1 played with one ball on the table while calling the subject's name, and then attempted to roll the ball to the child. E2 interrupted this game by stealing the ball and putting it in her cup under the table while smirking. This incident was repeated until E2 had stolen all three balls. In response to each stealing event, E1 looked at E2 with a puzzled gaze and vocalized mild protest (e.g., "Mmh, and "Hey") while mildly hitting and pushing E2. Then both experimenters stood up and turned around.

Choice Phase

Apes. E1 and E2 returned to the testing area, each with 10 food items in their hands. They stood with their backs to the ape, while the caretaker centered the ape between both experimenters by giving a piece of food to the subject. E1 and E2 then turned around, crouched (ca. 2 m from each other) and outstretched their arms toward the subject while offering the 10 food items. This presentation lasted for 20 seconds. During this time period the subject could approach one or both experimenters but did not receive food from either experimenter and therefore was not positively reinforced during the study (see Figure 1a for the experimental set-up).

Children. E1 and E2 turned around, hiding an identical bouncy ball in their hands, and sat down next to each other at the table (see Figure 1b for the experimental set-up). Then E1 counted up to three with her foot to indicate the start of the presentation. Both experimenters outstretched their arms up to two designated points that were equidistant to the child, and opened their hands and offered their ball to the child. As soon as the child reached toward one experimenter, both closed and withdrew their hands and left the table. In case the child did not make a choice within 10 seconds, an assistant experimenter who sat in a corner directed the parent to say the name of the child, followed by "Nimm dir einen" ("Go on, get one"). The trial then continued for up to 10 more seconds during which the child could make a choice. If the child still did not make a choice, the trial was ended. In case of a choice the child never received the ball from the chosen experimenter. Immediately after the child made a choice or the trial was ended after no choice, the assistant experimenter or the parent offered a different ball to the child to avoid any kind of frustration. This procedure was designed to make sure that no direct reinforcement took place by the experimenters during the experiment.

Scoring and Analysis

All trials were videotaped. Subjects' responses were initially coded live. The first approach to one of the two experimenters by touching the mesh panel in front of her (ape) or reaching toward one of the experimenters' hands (child) was considered as the subject's choice. To be conservative, a reliability coder then independently scored 100% of the trials for human children and chimpanzees. After excellent reliability was established for these first two species, a second coder then scored the standard 20% of the orangutan and bonobo trials. We compared the coding of the main observer with the second observer by calculating a Spearman correlation for the percentage of choices for all trials and Cohen's kappa for the first trial data for each species separately. The interobserver agreement was excellent. All correlations were significant (human children: $r\text{s} = 1, p < .01$; bonobos: $r\text{s} = 1, p < .01$; chimpanzees: $r\text{s} = 0.99, p < .01$; and orangutans: $r\text{s} = 1, p < .01$) and Cohen's $\kappa = 1$ for all four species.

For the statistical analyses we calculated the percentage of choices of the nice versus mean experimenter, because not all subjects made a choice in each given trial. First, we investigated, by using one-sample t tests, whether the percentage of trials in which participants chose the nice person differed significantly from chance (50%) for each species. Second, we analyzed the choice behavior of the first valid trial of each subject for each species using a binomial test. Third, a univariate analysis (ANOVA) with species as a between-subjects factor and the percentage of choices of nice person as a dependent variable was carried out. Post hoc tests (using the Bonferroni correction) were conducted in case a significant effect was detected. All statistical tests were two-tailed.

Results

Figure 2 presents the mean percent of choices for the nice and mean person for each species separately. A preference for the nice person was detected for orangutans, $t(25) = 2.04, p = .05, d = .40$ and human children, $t(87) = 2.83, p = .01, d = .30$, whereas the two *Pan* species did not show a significant preference for either person (chimpanzees: $t(102) = 1.33, p = .19, d = .13$; bonobos: $t(32) = -.05, p = .96, d = -.01$). The human children already showed a preference for the nice experimenter on the first trial (binominal test: $p = .05, g = -0.22$) with 61% of them choosing the nice person first. However, the three nonhuman ape species did not show a preference for either the nice or mean experimenter on the first trial. When comparing the choice behavior across all four species, no significant differences between species were found ($F_{3,246} = 1.49, p = .22$).

Discussion

Orangutans and 2.5-year-old human children preferred to approach the nice experimenter rather than the mean one after having directly experienced their respective behaviors. The human children even showed a significant preference for the nice experimenter on the very first trial. These results show that both human children and at least one species of nonhuman apes make reputa-

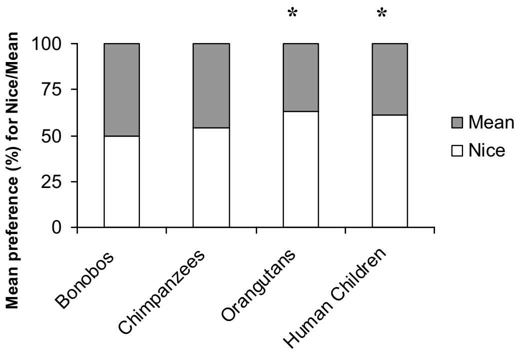

Figure 2. Mean percentage of approach to the nice and mean experimenter in Study 1 for bonobos, chimpanzees, orangutans, and human children ($^{*}p = 0.05$).

tion judgments based on direct interactions and use this information for future interactions. In contrast to human children and orangutans, neither chimpanzees nor bonobos differentiated between the two experimenters. In the case of orangutans, it might be possible that differences in familiarity of the experimenters could have had an effect on the choice behavior. However, this explanation is unlikely because the role of the experimenters E1 and E2 was counterbalanced across subjects. Furthermore, the chimpanzee results are consistent with a previous study in which chimpanzees did not prefer a generous experimenter even after being rewarded for choosing the generous experimenter (Subiaul et al., 2008; Experiment 1). Only after extensive training did they develop a preference for the generous experimenter. However, it is unclear why one nonhuman great ape species, the orangutans, differentiated between the experimenters whereas two others, which live in larger social groups and are even more closely related to humans, did not. One explanation could be that the two Pan species perceived the situation differently. We do know from previous research that chimpanzees distinguish between an unable and unwilling person (Call et al., 2004), but one possibility is that in this study bonobos and chimpanzees did not perceive the nice person to be unable to hand over food. Thus, the two species may not have distinguished this person from an unwilling or mean person. Furthermore, it could be that this specific situation, in which one person is stealing and eating the food that was supposed to be for the subject, who is not receiving food herself, is more frustrating for bonobos and chimpanzees than for orangutans, who are more solitary and usually encounter less direct food competition in the wild (Wich, Atmoko, Setia, & van Schaik, 2009). In general, further studies are needed to explain these observed species differences.

Although we know that various animal species do consider whether they are observed by others or not and although direct interactions are probably the most accurate source for determining reputation, very little is known about the importance of reputation assessment in animals (Andreoni & Bernheim, 2009; Bshary & Grutter, 2006; Evans & Marler, 1991). However, life in large groups of social animals and especially of humans involves an increase in interacting with more individuals and strangers and thus a decrease in the opportunities for direct encounters. Therefore, one important source for gaining useful knowledge and determining others' reputation is through indirect experiences, by observing third-party interactions. Thus, in the following two studies, we investigated whether nonhuman apes and 2.5-year-old human children form reputations about two experimenters based on observations of those experimenters in third-party interactions.

Study 2: Third-Party Interaction

In this study, we assessed whether chimpanzees, bonobos, orangutans, and 2.5-year-old human children have different expectations about receiving food/toys in the future from two experimenters based on observing prior third-party interactions. First, the subject observed a nice experimenter who tried to give food/toys to a recipient and a mean experimenter who interrupted the attempts of the nice experimenter when trying to give the food/toy. After witnessing this incident, the subject could approach either the nice or the mean experimenter, both of whom offered food/toys to the subjects.

Method

Participants

The subjects were the same as in Study 1. However, in this study, five chimpanzees, one bonobo, eight orangutans, and 30 30-month-old human children had to be excluded from the sample because they made no choice in any of the trials or had to be excluded because of experimenter mistakes. Therefore, the final sample consisted of 101 chimpanzees (51 males and 50 females; 3 to 21 years of age), 33 bonobos (21 males and 12 females; 5 to 22 years of age), 24 orangutans (15 males and 9 females; 3 to 10 years of age), and 75 30-month-old human children (±2 months; 40 males, 35 females).

Materials

The same materials as in Study 1 were used.

Procedure and Design

The procedure was very similar to the one in Study 1 except that the food or toy transfer was not directed to the subject but instead to a third experimenter. Hence, in Study 2 the subject was not engaged in the interaction and only played the role of an observer.

Three experimenters participated in this study. Two of the three experimenters (E1 and E2) acted out the nice and mean roles, and E3 played the role of the recipient. In the case of the apes, E3 also distracted the ape and centered the ape before each choice phase. In the case of the children, E3 also played the role of the assistant experimenter from Study 1. The role of the experimenters E1 and E2 was counterbalanced across subjects, for example, for half of the Participants E1 played the role of the nice person and for the other half the role of the mean person, but the roles remained the same for each subject across Study 1 and 2. The position (left vs. right) of the experimenters during the observation phase (E1 and E3) and choice phase (E1 and E2) was counterbalanced across trials. Apes participated in four identical trials and human children in two identical trials. Each trial consisted of an observation phase and a choice phase.

In each ***observation phase*** E1 was nice by attempting to give 10 food items (ape) or play three times (child) with E3 (the recipient) while E2 behaved meanly by interrupting the food giving or the game. After witnessing this incident, the subject participated in a ***choice phase***, the same as in Study 1, in which she or he could choose between E1 and E2, who offered food/toys in their outstretched hands, by approaching one of them.

Observation Phase

Apes. All three experimenters entered the testing area and crouched next to the mesh wall of the holding facility. E1 (nice experimenter) held 10 food items in her hand, and once the subject paid attention E1 attempted to give the food items one after another to E3, who was begging to get some. E2 (mean experimenter) crouched next to E1 and E3 and prevented the food transfer to E3 by stealing the food (as in Study 1) while making noises indicating satisfaction (by imitating food grunts) in the case of chimpanzees and bonobos. This incident was repeated until all 10 food items were stolen by E2. In response to the stealing event, E1 showed her frustration by hitting and pushing E2. In addition, E1 vocalized at E2 by either saying “hey” in the case of the orangutans or by making threat grunts in the case of bonobos and chimpanzees. Then all three experimenters left the testing area (see Figure 3a for the experimental set-up).

Children. All three experimenters approached the table at which the child was already sitting on her parent’s lap. E2 (mean experimenter) sat opposite the child, and E1 (nice experimenter) and E3 (recipient) sat opposite each other, on the left side and the right side of the table (see Figure 3b for the experimental set-up). E1 held three bouncy balls in a cup under the table, and E2 had one empty cup on her lap. Then E1 played with one ball on the table while calling E3’s name, and then attempted to roll the ball to E3. E2 interrupted this game by stealing the ball and putting it in her cup under the table, while smiling spitefully. This incident was repeated until all three balls were stolen by E2. In response to each stealing event, E1 looked at E2 with a puzzled gaze and vocalized mild protest (e.g., “Mmh,” and “Hey”) while mildly hitting and pushing E2. E3 looked disappointed. Then all experimenters stood up, and E1 and E2 turned around while E3 walked away from the table and waited in one corner of the room.

Choice Phase

The procedure was the same for all species as in Study 1.

Scoring and Analysis

Coding was carried out as in Study 1. The interobserver agreement was excellent. All correlations were significant (human children: $r\text{s} = .99$, $p < .01$; bonobos: $r\text{s} = 1$, $p < .01$; chimpanzees: $r\text{s} = .95$, $p < .01$; and orangutans: $r\text{s} = .95$, $p < .01$) and Cohen’s $\kappa = 1$ (for all three nonhuman ape species) and Cohen’s $\kappa = .97$ for human children.

For the statistical analyses we calculated the percentage of choices of the nice versus mean experimenter. Analyses were conducted as in Study 1.

Results

Figure 4 presents the mean percent of choices for the nice and mean person for each species separately. A preference for the nice person was detected for chimpanzees, $t(100) = 2.37$, $p = .02$, $d =$

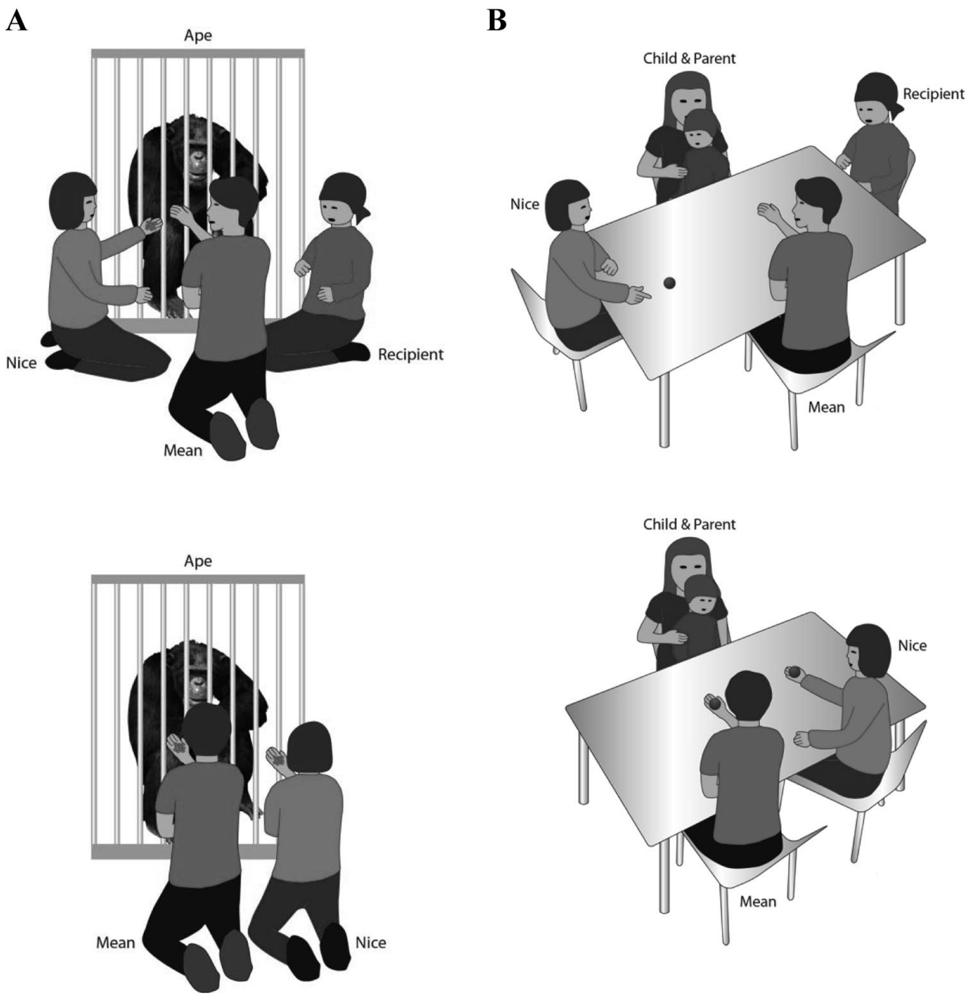

Figure 3. Experimental setup for (A) nonhuman apes in Study 2 and (B) human children in Study 2.

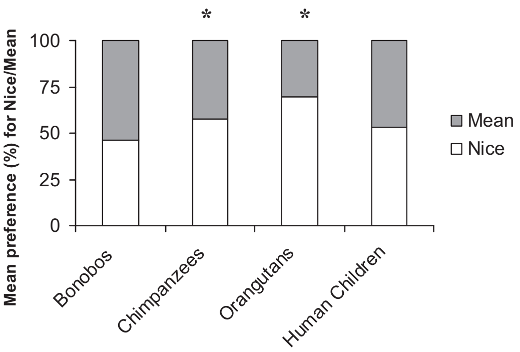

Figure 4. Mean percentage of approach to the nice and mean experimenter in Study 2 for bonobos, chimpanzees, orangutans, and human children (* $p < 0.05$).

.24 and orangutans, $t(23) = 3.33$, $p < .01$, $d = .68$, whereas the bonobos and human children did not show a significant preference for either person (bonobos: $t(32) = -.08$, $p = .45$, $d = -.13$; human children: $t(74) = 0.82$, $p = .42$, $d = .38$). The orangutans already showed a preference for the nice experimenter on the first trial (binominal test: $p = .01$, $g = -0.56$) with 78% of them choosing the nice person first. However, the other three species did not show a preference for either the nice or mean experimenter on the first trial. When comparing the choices across species, a significant difference was found ($F_{3,229} = 2.75$, $p = .04$). Post hoc tests (Bonferroni corrected) revealed that orangutans chose the nice person significantly more often than did the bonobos ($p = .04$), with no differences between the other species in their preferences.

Discussion

Orangutans and chimpanzees preferred to approach the nice rather than the mean experimenter after observing only one third-party interaction, showing that nonhuman apes have the ability to attribute reputation to humans based not only on direct experience but also on indirect observations. The chimpanzee results extend the findings of Subiaul et al. (2008) who have shown that chimpanzees, at least after extensive training and direct reinforcement, and in later experiments with new experimenters with whom they had no direct experience, prefer to beg for food from a generous experimenter (Subiaul et al., 2008), and the results of Russell et al. (2008) showing that chimpanzees spent significantly more time in proximity to a nice experimenter as opposed to a nasty one after indirect observations. However, the orangutan results in the present study do not corroborate previous findings by Russell et al. (2008), in which, except for the chimpanzees, no other nonhuman ape species showed a preference for either experimenter, which led the authors to suggest a possible cognitive divide between *Pan* and *non-Pan* species. Our findings do not provide support for such a divide, as we found that orangutans and chimpanzees showed the same preference.

Furthermore, the procedure and especially the behavior measure of this study differed from previous work that either directly reinforced the subjects after choosing the generous experimenter (Subiaul et al., 2008) or used the proportion of time that subjects spent near each person as the measure of preference (Russell et al., 2008). In comparison with Russell et al. (2008), we used a more direct response by analyzing the first approach to one of the two experimenters made by the subjects touching the mesh panel in front of her or reaching toward one of the experimenters' hands. Furthermore, in both previous studies the subjects observed two incidents, one nice interaction and one mean interaction in which the experimenter refused to give food, whereas in this study both mean and nice characters interacted with each other in one incident and the mean experimenter stole food. This adjustment could explain some of the differences in the results.

However, why bonobos and children, in contrast to chimpanzees and orangutans, did not show a preference for the nice experimenter in this study as well as in Study 1 remains unclear. Like chimpanzees, bonobos live in complex social groups, in which it is advantageous to evaluate the behaviors of others to make the best decisions for one's own behavior for future interactions. Nevertheless, based on previous research, one hypothesis could be that bonobos need more experience relative to chimpanzees to show such preferences. Wobber, Wrangham, and Hare (2010) investigated the social reversal learning abilities of the two species and showed that not only did chimpanzees perform better than bonobos in the first half of the experiment, but also that bonobos exhibited a developmental delay relative to chimpanzees. In addition, it is possible that bonobos (and children) were more confused by the scenarios presented in Study 2 than were chimpanzees or orangutans. For instance, seeing the nice experimenter, who was first nice and intended to share food, subsequently reacting aggressively toward (by hitting and pushing) the mean experimenter may have been a bit confusing for all apes and in particular for bonobos. Even if the aggressive behavior was never directed toward the subject, it might be that the bonobos perceived the initially nice experimenter as not so nice and did not differentiate her from the mean experimenter who stole the food.

It is also possible that subjects perceived the two experimenters not in terms of their "niceness" or "meanness" but rather perceived them as dominant and subordinate individuals. At the beginning of a trial, the nice experimenter could be seen as a subordinate who was interrupted by the dominant experimenter and not permitted to carry out her intended action. However, the hitting/pushing behavior which followed the stealing event could have provided confusing and conflicting information about the dominance relationships of the two experimenters and hence made it difficult for the subjects, in particular the bonobos and maybe the chimpanzees in Study 1, to form a preference for one individual. In addition, during the choice phase, subjects were offered food by both experimenters (though note that they were not rewarded for making a choice). It might be possible that a previously mean experimenter subsequently offering food proved to be confusing for some subjects. However, this probably did not apply to chimpanzees and orangutans, who did show a preference for the nice experimenter. Further studies using different methods are needed to understand these observed species differences.

The most unexpected result in this study was that human children did not show the same preference as their closest relatives. We know from previous research that 3- and 6-month-old infants already prefer a helpful agent to a hindering agent (Hamlin et al., 2007; 2010), and 8-month-old infants even preferred a puppet who behaved negatively toward an antisocial character to one who behaved positively (Hamlin et al., 2011). Furthermore, by the age of 3 years, children differentially help individuals based on their previous moral behavior (Vaish et al., 2010). There are several possible explanations for our results that 2.5-year-old human children showed no preference for the nice experimenter. First, it might be that in this study children did not receive enough trials to be able to make reputation judgments based on indirect observations. In comparison with the nonhuman apes and previous studies in which subjects saw the respective nature of both agents at least four times (Vaish et al., 2010), human children only observed two trials in which they could learn about the reputation of the experimenters. Furthermore, each trial only included three events in which a ball was stolen in the case of human children in comparison with 10 events in which food was taken away for nonhuman apes. This methodological difference was chosen because in this setup human children found it difficult to pay attention for a longer period. Second, both the nice and the mean experimenter were presented to the subject at the same time instead of in two separate incidents, one with a nice experimenter and a second with a mean experimenter. The chosen number of trials for each species (four trials, each including 10 stealing events for nonhuman apes, and two trials, each including only three stealing events for human children) and the procedure of this study might have put the human children at a disadvantage and might explain the differences across species and to previous research. A further explanation might be that in trying to use a similar method with human children and nonhuman apes to be able to compare their behaviors, perhaps our method was too unnatural or otherwise not well-suited to human children. For example, perhaps the chosen ball game with the pushing/hitting reaction of the nice experimenter was too harsh and the experimenters' reactions toward the approach of nonhuman apes and human children—leaving after 20 seconds without reinforcement for the apes and withdrawing the hands as soon as the child approached—and the experience of not getting rewarded for an approach could be more disturbing for human children. The combination of the above-mentioned issues might explain why, in contrast to the vast majority of nonhuman apes who approached an experimenter on most trials, 29% of the human children did not feel comfortable approaching either of the experimenters in any of the trials, even after parents prompted them.

Because of these concerns, a follow-up study investigated the ability of human children to form reputation judgments based on third-party observations. In Study 3, we used a method generally similar to Study 2, but we changed the observed interaction by having two separate incidents for the mean and the nice experimenter, used different games, and increased the number of trials.

Study 3: Third-Party Interaction Follow-Up With Children

In this study, we assessed whether 2.5- to 3-year-old human children have different expectations about receiving toys in the future from two experimenters based on observing prior third-party interactions. In comparison to Study 2, we used four different games during each of which the subject observed two incidents, a nice and a mean interaction. During the nice interaction an experimenter shared toys, whereas in the mean interaction an experimenter took toys away from a second experimenter. After witnessing both incidents, the subject could approach either the nice or the mean experimenter, both of whom offered toys to the subject.

Method

Participants

Thirty-three 30- to 36-month-old human children (*M* = 33,6; 17 males, 16 females) participated in this study. Eleven additional children were excluded from the final sample because they made no choice in any of the trials, did not want to participate, or had to be excluded because of experimenter mistakes. All children were tested in the Developmental and Comparative Psychology Department at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. The children were recruited by telephone from an existing database, comprising mostly middle-class families. Children received a small gift for their participation.

Materials

The experimenters and the child, who sat on the lap of the parent, were sitting opposite a 120 × 70 cm table. The child observed four different games being played by the experimenters. Every game could only be played with some crucial components and ended as soon as each of the available four crucial components was used once.

Jumping frogs. Four colorful plastic frogs which jump when pressed and a small blue bucket were used. The aim of the game was to let the frogs jump into "the lake" (bucket). During the choice phase each experimenter held a red and a blue frog in her outstretched hand.

Marble run. A marble run was built with a green plastic tube which ends in a yellow box. Four marbles were used. When running through the tube, the marbles produce a nice sound when falling into the yellow box. During the choice phase each experimenter held two marbles in her outstretched hand.

Magic board. A magnetic magic paint board and four magnetic stamps, which differ in shape, were used. The aim of the game was to stamp the stamps into the corresponding shape which was drawn on the paint board. During the choice phase each experimenter held a blue and a green stamp in her outstretched hand.

Loop. A car course with a loop which ends in a yellow box ("garage") and four small toy racing cars were used. The aim of the game was to let the cars do the loop and end up in the garage. During the choice phase each experimenter held a red and a black car in her outstretched hand.

In addition, a blue adhesive tape marked the critical line for the coding of the child's reaching behavior and was positioned 20 cm away from the child. The locations where the experimenters had to position their hands during presentation were marked with two small pieces of transparent adhesive tape on the table.

Procedure and Design

Each participant was accompanied by a parent throughout the study. The procedure was explained to the parents who were told not to influence or help their children in any way to make their choice, except the one time they were instructed to. There were four experimenters involved in this study. E1 and E3 acted out as nice and mean persons, E2 always had the role of recipient or victim (depending on the interaction), and E4 distracted and guided the child throughout the experiment. The role of E1 and E3 was counterbalanced; that is, for half of the Participants E1 played the role of the nice person and for the other half the role of the mean person. Each subject participated in four trials that differed in terms of the game that was played. The order of the games was the same for all subjects and each game was played twice, once with a nice interaction and once with a mean interaction. After the first observed interaction (either nice or mean) E4 re-setup the same game by placing four toy pieces on the table (e.g., she took the cars out of the "garage" in which they drove after the loop and placed them on the table again) for the second interaction (either mean or nice).

The order of nice and mean interactions was counterbalanced across subjects (i.e., half started with the nice and half with the mean interaction) and alternated between the trials. The position of each experimenter during interaction and presentation was counterbalanced across trials.

Each trial consisted of a nice interaction and a mean interaction followed by a choice phase. Participants observed a ***nice interaction*** during which E1 shared one toy with E2 and a ***mean interaction*** during which E3 took three toys away from E2. After this observation, the child participated in a ***choice phase***, in which she or he could choose between E1 and E3 who offered toys in their outstretched hands, followed by an intermediate play phase with E4.

Nice interaction. E1 approached the table where four crucial parts of the respective game (i.e., frogs, marbles, magnetic stamps, or cars) were placed on her side of the table and began to play. Meanwhile E2 had approached and watched with interest and excitement. After E1 had played twice, E2 asked whether she could try as well, and E1 let her play one round. After E1 played the last round, both expressed their satisfaction and happiness about the finished game and left the table.

Mean interaction. E2 approached the table where four crucial parts of the respective game were placed on her side of the table and began to play. After finishing the first round, E3 approached and took the other three pieces away from E2 while stating that she wanted to play now and therefore E2 could not play anymore. E2 looked irritated at E3, protested mildly and expressed her disappointment. After E3 played the last round both left the table.

Choice phase. E4 removed the game from the table after the second interaction and explained to the child that she would put this on a different table now and the child should get a toy (e.g., car) so they can play the game (e.g., car loop). E1 and E3 returned to the table, sat down, and presented the toy pieces simultaneously in their outstretched hands. E1 and E3 had two identical pieces, for example a blue and a red frog or two marbles of the same kind. To encourage the child to make a choice, the parent told the child "Nimm dir eines" ("Go on, get one"). For the first three trials, as soon as the child reached over the blue line to get the toys from one of the experimenters, both closed and withdrew their hands and left the table. At this point, E4 immediately approached and offered a toy of the same kind that she "had found." On the last trial, the child actually received the toys from E1 or E3 after making a choice and the three of them played with it. This procedure was chosen to make sure that no direct reinforcement took place by the experimenters during the experiment. In case a child had made no choice after 15 seconds, E4 signaled the parent to repeat their prompt. If the child still had not chosen after 10 more seconds, E4 went to the experimenters' side of the table, stood between them, and motivated the child again and suggested that the child could also indicate by pointing to the experimenter from whom she or he wanted to take a toy.

Scoring and Analysis

Subjects' responses were coded live. A choice was considered made when a child reached over the blue line on the table toward one of the experimenters' hands or pointed toward one of the experimenters. All trials were videotaped and a second observer independently scored 20% of the trials; interobserver reliability with the main observer was excellent (Cohen's $\kappa = 1$). For the statistical analyses we calculated the percentage of choices of the nice versus mean experimenter. First, we investigated, by using a one-sample *t* test, whether the percentage of trials in which participants chose the nice person differed significantly from chance (50%). Second, we analyzed the choice behavior of the first valid trials with a binomial test.

Results

Figure 5 presents the mean percent of choices for the nice and mean person for the human children. The children chose the nice person significantly more often than expected by chance, $t(32) = 2.56$, $p = .02$, $d = .45$. However, this preference for the nice experimenter was not evident on the first valid trial (binominal test: $p = .49$), with 58% of children choosing the nice person first.

Discussion

Consistent with previous research (Hamlin et al., 2007, 2010; Olson & Spelke, 2008; Vaish et al., 2010) in this study, human children preferred to approach a nice rather than a mean experimenter based on observing third-party interactions. Several possible reasons can account for a significant preference for the nice

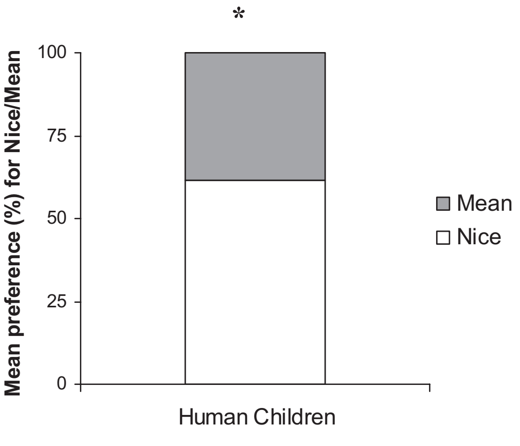

Figure 5. Mean percentage of approach to the nice and mean experimenter in Study 3 for human children ($^{*}p < 0.05$).

experimenter in this study in contrast to Study 2. First, it might be that the games were less harsh and more interesting, thus drawing more of the child's attention toward the interactions. This engagement might also explain the increased participation rate of the children (83%, as compared to 71% in Study 2). Second, the change from one interaction that presented both a nice and a mean experimenter, to separate nice and mean interactions might have clarified the different experimenters' characters. Furthermore, in Study 3, human children participated in four trials, in comparison with the previous study in which they only received two trials. One possible factor in explaining the preference for the nice experimenter in this study is that human children need more opportunities to learn about others' reputation when the only source of information comes from indirect observations.

General Discussion

The present studies examined the abilities of nonhuman apes (chimpanzees, bonobos, and orangutans) and human children to form a reputation about others when the source of information is based on direct or indirect experience (i.e., observation from an uninvolved bystander's perspective) with a nice and a mean person. In Study 1, orangutans and 2.5-year-old human children predicted individuals' future behaviors on the basis of their directly experienced behavior by preferring to approach a previously nice and generous experimenter rather than a mean one. In Study 2, chimpanzees and orangutans, and in Study 3, human children also took into account experimenter actions toward others in forming reputations, which led them to choose a previously nice experimenter over a mean one in their own subsequent interactions with the experimenters. In sum, these studies demonstrate that at least some of our closest living relatives as well as human children have the ability to form direct and indirect reputation judgments, extending the findings with chimpanzees by Subiaul et al. (2008) and Russell et al. (2008) to orangutans. The reasons for the observed species differences are not entirely clear and should be subject to future research. Furthermore, it would be important to explore how nonhuman apes evaluate the behavior not just of humans but also of conspecifics in similar scenarios.

Another open question concerns the basis of reputation formation and partner choice behavior in nonhuman apes and human children. Do human children and nonhuman apes focus on the same information, that is, evaluating both individuals based on the nice nature of one experimenter, the mean nature of the other experimenter, or both, to show this preference? We know from previous research that human children not only prefer or help a more prosocial individual to one who is hindering or harming another, but they also prefer a helping individual to a neutral individual, and prefer or help a neutral individual more than a hindering or harming one (Hamlin et al., 2007; Vaish et al., 2010). However, it has been shown that antisocial behavior has a stronger impact on children's behavior than prosocial behavior (Hamlin et al., 2010; Vaish et al., 2010). This negativity bias has been documented for a variety of social assessments for human children and adults (e.g., Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Kanouse & Hanson, 1972; Vaish, Grossmann, & Woodward, 2008). Future studies assessing social interactions should explore whether this phenomenon is also present in nonhuman apes (although one pilot study with nonhuman apes did not find evidence for this bias; Keupp et al., unpublished data).

In humans, reputation formation and management play a crucial role on a daily basis. We frequently decide how to react to somebody or whom we choose for future interactions based on what we know about that individual. Furthermore, we often help individuals who helped us before (Trivers, 1971), but also choose to help individuals who act prosocially toward others (Alexander, 1987) and punish noncooperators (Fehr & Gächter, 2002). Experimental studies have confirmed that humans make their decisions about whom to cooperate with and help based on the other individual's reputation (Milinski et al., 2001, 2002; Seinen & Schram, 2001; Wedekind & Milinski, 2000) and also invest in their own reputation to be preferably chosen as a cooperative partner (Sylwester & Roberts, 2010).

The present studies, together with previous work (Russell et al., 2008; Subiaul et al., 2008), suggest that nonhuman apes also have the ability to form direct and indirect reputations about others. However, it remains unclear whether reputation judgment plays a similarly important role in their life when interacting with other individuals, as has been shown in humans and to some extent in fish (Bshary, 2002; Bshary & Grutter, 2006). Chimpanzees choose their partners based on previous direct experiences with them: being a bad collaborator can result in not being chosen for future interactions (Melis et al., 2006, 2008), and chimpanzees retaliate against conspecifics for stealing food directly from them (Jensen, Call, & Tomasello, 2007). But would nonhuman apes choose the most collaborative partner or punish individuals with bad reputations if their sole source of reputation were indirect experience by observing third-party interactions as an uninvolved bystander? So far the evidence suggests that chimpanzees do not punish third parties (Riedl, Jensen, Call, & Tomasello, submitted). Furthermore, humans constantly adjust their behavior to follow social norms and to present themselves as a good and collaborative member of the group (e.g., Goffman, 1967). Are nonhuman apes also concerned about being evaluated by others and hence about their own reputation, and do they have similar reputation management mechanisms as humans?

This study together with previous work provides better insight into the role of reputation formation in our closest living relatives, but future research on nonhuman apes and human children is necessary to shed more light on the ontogeny and phylogeny of this very important topic.

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