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From exploitation to cooperation: social tool use in orang-utan mother–offspring dyads

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Social manipulation represents an important aspect of human social interactions, including cooperative ones. Yet, little is known about social manipulation of conspecifics in nonhuman great apes. We investigated how orang-utan, *Pongo abelii*, mothers used their offspring as a means to access food in competitive and cooperative test situations. In the competitive situations, only the offspring could retrieve high-value food rewards. Here, orang-utan mothers often stole the food from their offspring and even coerced them into retrieving it to begin with, by moving the offspring to the test site, guiding their arms and bodies towards the food, and even reorienting their hands so that they would grab the food. However, modifying the task constraints so that mothers were now required to cooperate with their offspring to obtain the food changed the mothers' behaviour completely. Suddenly, mothers cooperated with their offspring by handing them tools that only their offspring could use to activate a mechanism delivering food for both of them. We conclude that orang-utans, like humans, are able to flexibly use conspecifics as a social tool and that this kind of social tool use supports their ability to cooperate.

In recent years, the psychological processes underlying cooperation have received considerable research attention from a comparative perspective. Experimental studies have shown that several group-living primate species including chimpanzees, *Pan troglodytes* (Chalmeau, 1994; Crawford, 1937; Hirata & Fuwa, 2007; Melis, Hare, & Tomasello, 2006a, 2006b; Melis & Tomasello, 2013), bonobos, *Pan paniscus* (Hare, Melis, Woods, Hastings, & Wrangham, 2007), capuchin monkeys, *Sapajus apella* (Brosnan, Freeman, & De Waal, 2006; Chalmeau, Visalberghi, & Gallo, 1997; Hattori, Kuroshima, & Fujita, 2005; Mendres & de Waal, 2000; Visalberghi, Quarantotti, & Tranchida, 2000; de Waal & Berger, 2000; de Waal & Davis, 2003) and cottontop tamarins, *Saguinus oedipus* (Cronin, Kurian, & Snowdon, 2005; Cronin & Snowdon, 2008) are able to coordinate their actions flexibly in cooperative problem-solving tasks. For instance, chimpanzees can coordinate with their partners by either carrying out identical (Chalmeau, 1994; Crawford, 1937; Hirata & Fuwa, 2007; Melis et al., 2006a, 2006b) or complementary actions (Melis & Tomasello, 2013) to achieve their objectives.

Temporal coordination is often crucial and chimpanzees can wait until their partners are ready to jointly engage in the task (Hirata & Fuwa, 2007). Furthermore, chimpanzees know who the best cooperators are and actively select them to work together (Melis et al., 2006a). However, given a choice between working with others and working alone, chimpanzees prefer the latter (Bullinger, Burkart, Melis, & Tomasello, 2013; Bullinger, Melis, & Tomasello, 2011; Melis et al., 2006b; Rekers, Haun, & Tomasello, 2011). Also, although some studies found that chimpanzees may help others even if they do not directly benefit (Melis et al., 2011; Warneken, Hare, Melis, Hanus, & Tomasello, 2007; Yamamoto, Humle, & Tanaka, 2009, 2012), other studies did not find such prosocial tendencies (Jensen, Hare, Call, & Tomasello, 2006), and most studies reporting sustained cooperation elicited it in situations in which both individuals would benefit (mutual cooperation). It has therefore been suggested that chimpanzees conceive their cooperators as social tools and that they are, in contrast to humans, not intrinsically motivated to cooperate (Bullinger et al., 2011; Warneken, Gräfenhain, & Tomasello, 2012).

The considerable research effort devoted to investigate the motivational basis of cooperation contrasts with how little is known about how individuals manipulate others as tools. We

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define social tool use as the physical and psychological manipulations of animate beings towards some goal. Social tool use has an instrumental and a motivational dimension. The motivational dimension involves the motives (self- or other-regarding) underlying these manipulations whereas the instrumental dimension involves the actual means-end manipulations of animate beings. We can subdivide the instrumental dimension of social tool use into four levels depending on the degree of direct physical influence that the tool user exerts over the social tool. Level 1 represents the highest degree of physical influence since it involves the physical manipulation of others' bodies analogous to the manipulation of inanimate objects. Here, the social tool is treated as an object (not an agent) and the tool user completely controls it (e.g. pulling the arm of a conspecific to access the food that she is holding in her hand). Level 2 combines the physical control of the social tool with the opportunistic exploitation of self-initiated and self-controlled actions by the social tool that are not under direct control of the tool user (e.g. guiding the arm of the conspecific towards a target object and pulling it back but only after the social tool has grabbed the target object).

Level 3 relies entirely on the social tool's self-initiated and self-controlled actions and involves no direct physical control by the tool user. Here, the tool user treats the social tool as a self-propelled agent (e.g. passing a tool over to the social tool who will then act independently of the tool user but in line with the goals of the latter). This level of tool use depends on the social tool's willingness to cooperate (either because of their aligned goals or her prosocial tendencies). In the cooperation literature, social tool use is commonly used in this latter sense (level 3). Finally, level 4 represents the lowest level of direct physical influence on the social tool and involves communication and the psychological effects derived from it (manipulating the social tool by communicating with it without any direct physical interaction; e.g. Bard, 1990). In the current study, we focused on levels 1 and 2 (coercive) and level 3 (cooperative) instances of social tool use.

Clear-cut cases of social tool use involve physical manipulations of the tool (i.e. level 1 and 2). For this type of social tool use to occur (especially when it only results in food for the tool user), there has to be a power differential between partners. However, power differential is often associated with low social tolerance, which has been identified as a major factor limiting cooperation in chimpanzees (Melis et al., 2006b), macaques (Petit, Desportes, & Thierry, 1992) and capuchin monkeys (Brosnan et al., 2006; Chalmeau, Visalberghi, et al., 1997; de Waal & Davis, 2003). It is therefore not surprising that direct evidence for goal-directed and selective manipulations of others as if they were tools has rarely been documented in cooperative problem-solving tasks. If the power differential between partners is large, social tolerance is low and, conversely, if tolerance is high, the power differential may not be large enough to create the conditions for social tool use to appear. There are some exceptions, however. In an instrumental cooperation task with keas, *Nestor notabilis,* in which one kea needed to operate a lever so that another conspecific could retrieve food from a box, three dominant individuals aggressively approached their subordinate cooperators until the subordinates pushed down the lever (Tebbich, Taborsky, & Winkler, 1996). Thus, dominant individuals were enforcing cooperation by means of social manipulations. There is some evidence for social tool use in primates. In a tool use task that required throwing stones into a pipe to retrieve a food reward, one Japanese macaque, *Macaca fuscata,* repeatedly used her infants to retrieve the food by actively pushing them into the pipe and pulling them back as soon as they had grabbed the food (Tokida, Tanaka, Takefushi, & Hagiwara, 1994). When this kind of social tool use was unsuccessful, the female macaque used a stick or a stone as a tool instead, suggesting that she considered her infants as a tool in this problem-solving situation. In another cooperation study, a pair of subadult male orang-utans, *Pongo pygmaeus,* simultaneously pulled a handle to retrieve food (Chalmeau, Lardeux, Brandibas, & Gallo, 1997). Interestingly, in some instances one of the two individuals pushed the other orang-utan towards one of the handles, thereby soliciting cooperation, something suggestive of social tool use. Moreover, two adult orang-utans, *Pongo abelii,* have been found to exchange tokens reciprocally when each individual possessed only tokens that were useless for themselves but that the other individual could exchange for food (Dufour, Pelé, Neumann, Thierry, & Call, 2009). In fact, orang-utans were much more likely to donate tokens to conspecifics, which the recipient could exchange for food with the experimenter, than chimpanzees, gorillas and bonobos (Pelé, Dufour, Thierry, & Call, 2009).

Thus, orang-utans seem to be a promising species to explore various levels of social tool use. Mother–offspring dyads in particular might offer the ideal scenario (as suggested by Tokida et al. 1994) because they combine a marked power differential with high levels of tolerance between partners. Mothers' physical strength allows them to steal food resources from their offspring at very low direct costs as they do not have to fear aggressive retribution (which might be the case among adults). Moreover, mothers show high levels of tolerance towards their offspring, who depend on their mothers for an extended period of time (van Noordwijk & van Schaik, 2005). The balance of power between mother and offspring, however, may be shifted by changing the experimental set-up. In particular, creating a situation in which mothers have no direct physical control over their offspring (level 3 social tool use) may transform the mother's social tool use from an exploitative to a cooperative activity.

The aim of the current study was to investigate whether and how three Sumatran orang-utan mothers, *P. abelii,* manipulated their dependent offspring as social tools to achieve their goals. We varied the extent to which mothers could physically control their offspring's actions across different experimental situations. We were interested in how flexibly mothers would adjust their manipulations to changing test situations and task constraints. Therefore, we provided the offspring with privileged access to high-value food (competitive situations) or with the exclusive opportunity to activate a mechanism delivering food either to both mother and offspring or only to the offspring (cooperative situation). We examined mothers' responses towards their offspring across these situations. In experiment 1, we investigated whether mothers stole high-quality food from their offspring when only the offspring was able to reach it. Crucially, we investigated whether they would manipulate their offspring before the latter had retrieved the food, to accelerate this process (level 1 and 2 social tool use). In experiments 2 and 3, we examined whether mothers would also manipulate their offspring to obtain an out-of-reach stick tool that mothers, in turn, could use to retrieve a high-value reward. Finally, in experiment 4, we presented a cooperative situation in which mothers had initial control over the stick tool but this time only infants could use it to operate the apparatus and obtain the food rewards. Thus, mothers could only retrieve the food by giving the tool to their offspring to use (level 3 social tool use).

EXPERIMENT 1

Methods

Subjects

Three orang-utan mother–offspring dyads participated in this study. All orang-utans were mother-reared. Two of the juveniles were males. The ages of the juveniles ranged from 3 years, 7