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Spontaneous Social Tool Use in Chimpanzees (*Pan troglodytes*)

Manon K. Schweinfurth
University of St Andrews

Sarah E. DeTroy
University of Leipzig

Edwin J. C. van Leeuwen
University of St Andrews and Max Planck Institute for Psycholinguistics, Nijmegen, the Netherlands

Josep Call
University of St Andrews

Daniel B. M. Haun
University of Leipzig

Although there is good evidence that social animals show elaborate cognitive skills to deal with others, there are few reports of animals physically using social agents and their respective responses as means to an end—social tool use. In this case study, we investigated spontaneous and repeated social tool use behavior in chimpanzees (*Pan troglodytes*). We presented a group of chimpanzees with an apparatus, in which pushing two buttons would release juice from a distantly located fountain. Consequently, any one individual could only either push the buttons or drink from the fountain but never push and drink simultaneously. In this scenario, an adult male attempted to retrieve three other individuals and push them toward the buttons that, if pressed, released juice from the fountain. With this strategy, the social tool user increased his juice intake 10-fold. Interestingly, the strategy was stable over time, which was possibly enabled by playing with the social tools. With over 100 instances, we provide the biggest data set on social tool use recorded among nonhuman animals so far. The repeated use of other individuals as social tools may represent a complex social skill linked to Machiavellian intelligence.

Keywords: social tool use, chimpanzee, exploitation, Machiavellian intelligence

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Many animals live, at least during some stage of their lives, in groups, ranging from loose and open aggregations to highly complex and closed societies (Krause & Ruxton, 2002). Although group living is associated with several benefits including increased foraging success (Beauchamp, 1998), predator safety (Lehtonen & Jaatinen, 2016), thermal protection (Gilbert, Robertson, Le Maho, Naito, & Ancel, 2006), and energy savings (Herskin & Steffensen, 1998), it does not come without costs. For instance, group-living animals face increased food (Janson, 1988) and mate competition (Wedell, Gage, & Parker, 2002), risk of disease transmission (Côté & Poulin, 1995), and infanticide (Crockett & Janson, 2000). Complex social environments are characterized by a fine balance of competition and cooperation with multiple individuals interacting repeatedly over time in a variety of contexts, a setting that stands in stark contrast to the conditions operating in anonymous aggregations (Dunbar, 1998; see also Fischer, Farnworth, Sennhenn-Reulen, & Hammerschmidt, 2017). It has been hypothesized that the particular challenges of complex social environments select for advanced sociocognitive skills (Chance & Mead, 1953; Humphrey, 1976; Jolly, 1966).

The Machiavellian intelligence hypothesis (MIH), sometimes referred to as the "social complexity hypothesis," proposes that

Manon K. Schweinfurth, School of Psychology and Neuroscience, Department of Origins of Mind, University of St Andrews; Sarah E. DeTroy, Faculty of Education, Department of Early Child Development and Culture and Leipzig Research Center for Early Child Development, University of Leipzig; Edwin J. C. van Leeuwen, School of Psychology and Neuroscience, Department of Origins of Mind, University of St Andrews and Max Planck Institute for Psycholinguistics, Nijmegen, the Netherlands; Josep Call, School of Psychology and Neuroscience, Department of Origins of Mind, University of St Andrews; Daniel B. M. Haun, Faculty of Education, Department of Early Child Development and Culture and Leipzig Research Center for Early Child Development, University of Leipzig.

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Correspondence concerning this article should be addressed to Manon K. Schweinfurth, School of Psychology and Neuroscience, Department of Origins of Mind, University of St Andrews, Westburn Lane, KY16 9JP St Andrews, United Kingdom. E-mail: ms397@st-andrews.ac.uk

social competition within a social group is one of the main drivers for cognitive skills used to manipulate conspecifics to the benefit of the actor (Byrne & Whiten, 1988). Although in some of their writings Byrne and Whiten (1988) mentioned both cooperation and competition as drivers of social intelligence, the adjective that they chose to describe their hypothesis (Machiavellian) paired with their empirical focus on tactical deception, largely explain why this hypothesis has become associated with social competition, and more specifically with the exploitation of conspecifics.

A far less subtle way to manipulate others than tactical deception, but still within the MIH's purview, involves using conspecifics as social tools. The meaning of social tool use, however, varies considerably across authors. Some researchers have defined "social tool" to denote cases in which one animal interacts with a partner to influence a third party, such as in coalitionary support or agonistic buffering (Johnson & Oswald, 2001). For instance, male Barbary macaques steal unweaned infants and use them as protection shields, for example, agonistic buffers, to avoid aggressive encounters by other males (Deag & Crook, 1971). Other authors have used the term social tool use to refer to the use of physical objects in social contexts, such as using a branch to display (Bard, 1990). We prefer to use the term social tool use in a narrower sense, to denote cases in which social agents physically coerce others to recruit their help (see also Gómez, 1990). This definition is comparable with physical tool use, which might be defined as follows:

> the exertion of control over a freely manipulable external object (the tool) with the goal of (1) altering the physical properties of another object, substance, surface or medium (the target, which may be the tool user or another organism) via a dynamic mechanical interaction, or (2) mediating the flow of information between the tool user and the environment or other organisms in the environment. (St Amant & Horton, 2008 p. 1203)

Our narrower definition of social tool use fits the exploitative dimension of the MIH, and it can take on several forms depending on the level of control between the user and its social tools (Völter, Rossano, & Call, 2015, 2017). Level 1 describes situations in which the social tool is under full control of the user and is treated like a physical object. In Level 2, the social tool user still has power over the social tool, but a response of the social tool is required, which cannot be fully controlled by the user. In Level 3, the user relies on the self-initiated action by the social tool and thus control is further reduced. Finally, in Level 4 the user requests help from the social tool and as such it is mediated by communicative acts (see also Gómez, 1990). Although Level 1 of social tool use is independent of a social tool's response, the other levels demand a coerced response of the social tool, which differs from physical tool use. Therefore, Levels 2–4 are impossible to achieve with static physical tools.

Social tool use has not been often described in the literature, and it is far less common than physical tool use, given the frequent reports of the latter (Shumaker, Walkup, & Beck, 2011). Still, there are some reports of social tool use among nonhuman primates. Sumatran orangutan mothers (*Pongo abelii*) used their immature offspring to retrieve food by actively pushing them toward out-of-reach food, which they eventually steal from their infants in an experimental study (Völter et al., 2015). In the same experimental setting, chimpanzee (*Pan troglodytes*) and bonobo (*Pan paniscus*) mothers allowed their offspring to eat the retrieved food without any harassment or stealing attempts (Völter et al., 2017). A similar case of social tool use was reported in free-ranging Japanese macaques (*Macaca fuscata*): Three females used their infants to climb into a pipe to collect apple slices, which were afterward solely eaten by the mothers (Tokida, Tanaka, Takefushi, & Hagiwara, 1994).

Because the benefits of exploiting others lead to success by gaining resources or mates, they ultimately translate into increased fitness. Therefore, such skills are expected to evolve readily (Gavrilets & Vose, 2006). In addition, if one individual uses a strategy to exploit others, they are expected to develop counter strategies, leading to constant feedback loops as has been detected for some cases of tactical deception (Coussi-Korbel & Fragaszy, 1995; Hirata & Matsuzawa, 2001; Menzel, 1974; see also Byrne & Whiten, 1992). One strategy, which could enable the repeated exploitation of others, is to provide them with some form of benefit, such as grooming or social play, which in turn may reduce counter strategies. Eventually, this spiralling effect may lead to more and more complex skills both during ontogeny and phylogeny (cf. Fisher, 1915). Finally, this process leads to superior sociocognitive skills in species living in complex social environments (as defined earlier) compared with species living in simpler social environments.

In the present study, we report a spontaneously occurring example of social tool use in chimpanzees. By analyzing these spontaneous occurrences of social tool use in chimpanzees, we aimed to shed new light on an aspect of the MIH that has received relatively little attention. Although cases of social tool use in nonhuman animals are witnessed occasionally (Melis, personal communication; Hopkins, personal communication), they are rarely studied systematically. We think that a careful quantification of those data as well as a precise description of the conditions in which they occurred are essential to advancing our knowledge in this area. Thus, we here document the manipulative actions of an adult male chimpanzee toward three group members. In addition, we investigated the success and development of such manipulative acts over time. Furthermore, we investigated whether the social tool user showed a preference for using particular individuals over others and whether the "social tools" differed in their response to the manipulations. Finally, we recorded social play during and shortly after social tool use to test for a possible association between exploiting others and providing them with benefits. We recorded social play because (a) other candidate behaviors, that is, grooming, were rarely seen in this context and (b) social play sometimes transformed into social tool use.

Method

Subjects and Study Site

The study was conducted in 2017 at the Chimfunshi Wildlife Orphanage Trust, which is a chimpanzee sanctuary located in northwestern Zambia. At this time, the sanctuary hosted 119 chimpanzees that lived in several groups composed of wild-born and sanctuary-born individuals. They were housed in enclosures of sizes up to 77 hectares, surrounded by electric fences. During feeding times (2 hr a day), chimpanzees were called into indoor handling facilities with several rooms and were provided with

nshima balls (maze flour cooked with water) and local seasonal fruits and vegetables. Outside of the feeding time, the individuals were able to freely range in their enclosures.

This study made use of a spontaneously occurring behavior by one individual of "Group 4," with which we conducted the fruit juice experiment (see the following text). This group consisted of 11 individuals, housed in a 25-hectare outdoor enclosure (see Table S1 in the online supplemental materials for more information on the group members). The social tool user was a midranking adult male, named Bobby. He was born in the wild, approximately in 1993. In 2000, he was rescued from being a tourist attraction in a restaurant in the Central African Republic, where he daily interacted with many tourists. When he arrived in Chimfunshi he was in good physical condition.

Apparatus

The setup consisted of a drinking fountain, two retractable buttons that were installed in the enclosure, and a tank containing juice placed on top of the feeding house outside of the enclosure (Figure 1). The buttons were connected underground via hosepipes to the fountain. The experimenters could manipulate the buttons from outside the enclosure. The buttons were only present during the testing sessions.

Procedure

Before each session, the experimenter flushed some juice through the fountain to signal the start of the session. Thereafter, the chimpanzees needed to push the two buttons simultaneously to deliver juice to the distant fountain, from which others could drink. The setup created a dilemma because the pushers could not directly drink from the fountain because the flow of juice stopped as soon as the buttons were released. In previous experiments, the chimpanzees had already learned to push a single button that released juice at a juice fountain (van Leeuwen et al., 2018); however, they had never been confronted with a condition in which two buttons needed to be pushed simultaneously to release juice.

Data Coding and Analyses

We conducted 49 sessions lasting between 1 and 2 hr each. We videotaped all sessions with camcorders (JVC-Everio) obtaining a total of 90 hr of video footage. During the sessions, the experimenters, who were present at all times, noted down the social tool use events. The start of each sequence was defined by the first occurrence of any behavior that was involved in increasing the chance for receiving juice through the social tool user. Each sequence was stopped at 5 min after the last social tool use attempt. Afterward these sequences were extracted using the VLC media player. The respective sequences were coded using Solomon Coder (Version 17.03.22). A second coder independently scored 20% of the videos to assess interobserver reliability. We chose the videos randomly, but we ensured that videos from the beginning and end of the testing period were included in the subset. We tested for reliability by calculating the Cohen's κ for count data. Scores given to the social tool user and the social tools by the two observers were highly correlated ($F_{63} = 12.3$, $p < .0001$) with a Cohen's κ of 0.85 and a 95% confidence interval of 0.14.

We scored the behavior of the social tool user and the responses of the social tools. Table 1 provides a detailed description of the behaviors (see also the video included in the online supplemental materials). Additionally, we scored the social tool user's success and his control over the social tools.

Behavior of the social tool user. First, we identified and described the behavior by the social tool user (Bobby [24 years old at the time of data collection]) toward his three social tools (Jack [9 years old], Jewel [4 years old], and Kenny [6 years old]). Because Jack was involved in only one case, we excluded him from further analyses. We recorded the durations of all behaviors, which highly correlated with its frequency (the online supplemental materials) and hence we report statistical analysis on the count data. The first attempt to use one of the social tools was recorded

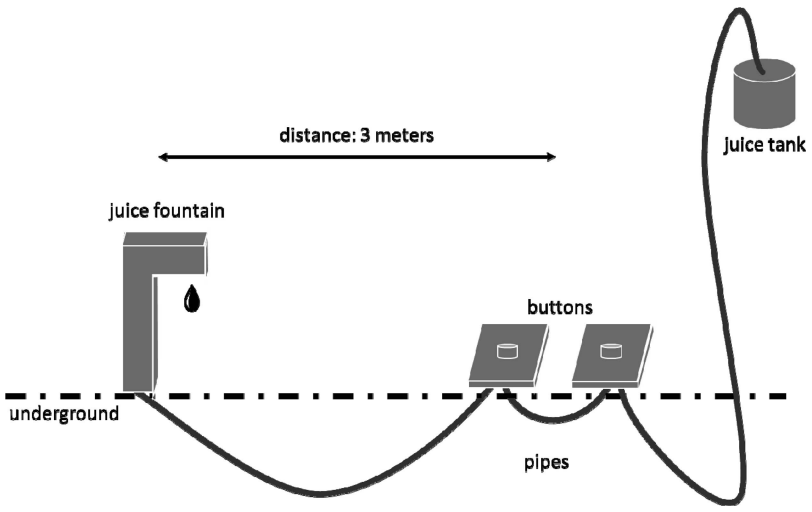

Figure 1. Setting. Juice was stored in a juice tank outside the enclosure. By pushing both buttons simultaneously, the juice was delivered via underground pipes to the distant fountain. Because the buttons and the fountain were 3 m apart, pushers could not drink directly from the fountain.

Table 1
Ethogram of Spontaneous Social Tool Use Behavior

Social tool use behavior	Actor: Social tool user	Social tool use levels
Retrieve (78)	• Herding by closely walking behind the tool and gently touching it • Dragging the tool to the experimental device • Rolling the tool toward the experimental device	Level 1: Complete physical control
Push (146)	• Pushing the tool forcefully into the direction of the buttons and releasing it	Level 2: Partial physical control
Vocalize (1,376)	• Blowing raspberries	Level 4: Soliciting
Reach (30)	• Reaching out hand into the direction of the tool • Shaking wrist while reaching out	Level 4: Soliciting
Response of social tools	**Actor: Social tools**	**Social tool use levels**
Escape (41)	• Going to the direction of the buttons without pushing • Running away from the buttons and the social tool user	Level 3: Self-controlled action without being constrained
Press button (115)	• Pressing the buttons to release juice at the fountain	

Note. Description of behaviors used to manipulate other group members to provide juice to the actor and the responses to this manipulation are indicated. The behaviors are linked to the proposed levels of social tool use by Völter, Rossano, and Call (2015). The numbers correspond to how often the behaviors were recorded.

in Session 12. We analyzed whether the levels of social tool use differed over time using zero-inflated regression models for count data, which account for behavioral data that include zeros. We included the respective social tool use behaviors as response variables (one model for each behavior) and included the session number and social tool identity as explanatory variables. We assumed a negative binomial distribution and only report results from models with a nonsignificant θ value, indicating an appropriate fit of the model (Zuur, Ieno, Walker, Saveliev, & Smith, 2009).

We also recorded any playful behavior between the user and his social tools during the time from the first element of social tool use until 5 min after the last element. Rough and tumble play was defined according to Nishida, Kano, Goodall, McGrew, and Nakamura (1999) as a physical social play that includes the following: tag, wrestle, push, pull, bite, drag, stamp, slap, thrust, and leap. Importantly, all these behaviors occurred in proximity to the experimental device but were not directed to it, as for instance pushing the social tool into the direction of the buttons. We tested whether the two social tools differed in their duration of playing with the social tool user by using a Mann–Whitney *U* test.

Success of the social tool user. We determined the success of the user's strategy by calculating the increase of juice donations by comparing the coerced and uncoerced donations by the two social tools, Kenny and Jewel. We defined a coerced pushing event as Bobby pushing or herding the social tool toward the buttons and all following pressing events without the social tool distancing itself from buttons by more than 3 m. All other pushing events were defined as uncoerced, in which the social tools approached the buttons alone and had not been harassed by Bobby immediately before. In addition, we report the overall drinking rate, standardized by time of observations, before and after Bobby used social tools.

Control over social tool. Social tools could either press the buttons or try to escape by running away or avoiding the buttons after a social tool use attempt. Hence, we recorded in how many trials the social tool user responded to an escape by either retrieving or pushing the social tool back into the direction of the buttons. We consider a behavior to be a response by the actor to an escape attempt, if the user responded within 60 s of the beginning of the escape attempt.

Response of social tools. We recorded the response of the social tools, namely, whether they pressed the buttons and the latency until the behavior was executed. We tested whether the two social tools differed in their response by using a generalized linear mixed model (GLMM) with Poisson error distribution and log link function. We included how often the social tools pressed the buttons as a response variable, the social tool identity (Jewel or Kenny) as an explanatory variable, and the session number as random effect. The model did not show overdispersion, indicating an appropriate fit (Crawley, 2007). Furthermore, we tested whether the social tools differed in their response when being coerced to help by performing a GLMM with a binomial error distribution and logit link function. We included the social tools' response (escape or press the buttons) as a binomial response variable into the model with two random effects, which were the social tool identity and the session number. Finally, we tested whether the time to press the button by the social tools is dependent on the user's gestures by calculating a survival analysis. We included "the time interval between Bobby pushing the social tool until the social tool pressed the buttons" as response variable. We included the information of whether Bobby reached out during the time interval. To correct for the different social tools, we included them as a random factor.

All statistical analyses and graphs were performed in R (Version 3.4.2, http://www.r-project.org; with R studio and packages "lme4," "ggplot2," "cowplot," "pscl," "Hmisc," "irr," and "survival"). Because the data were not normally distributed, we report nonparametric tests throughout the article (see the online supplemental materials).

Ethical Statement

Our study was approved by the ethics committee of the host sanctuary (the Chimfunshi Research Advisory Board). All chimpanzees participated voluntarily in the project. The chimpanzees were never food or water deprived, nor were any chimpanzees separated from their group at any time. In addition, the animals

were constantly monitored during all sessions and if any deviant behavior or unexpected physical reaction had occurred, the experiments could have been stopped immediately, which was not the case. Finally, we adhered to the legal requirements of the Zambia Wildlife Authority and the Ethical Treatment of Nonhuman Primates guidelines by the International Primatological Society's Principles.

Results

Behavior and Success of the Social Tool User

We recorded 146 instances of the tool user (Bobby) actively pushing one of the three social tools into the direction of the buttons that could be used to induce juice flow (Kenny = 118, Jewel = 26, Jack = 2). In 78 cases, Bobby retrieved Kenny (73) and Jewel (5) from a distance of more than 3 m (sometimes from more than 10 m) before directing them to the buttons. While sitting in front of the fountain, Bobby held his hand out to Kenny and Jewel in 19 and 11 times, respectively. Bobby typically blew raspberries while he displayed these behaviors. In all of the cases, retrieving and pushing the social tools occurred before reaching out or blowing raspberries. The juveniles provided juice to Bobby in 115 cases (Kenny = 70, Jewel = 45), which includes cases in which the social tools pressed several times in response to Bobby's actions.

Bobby did not change his behavior over time after he had started using the juveniles as tools (herding: generalized linear model [GLMM]: $\beta = -0.02 \pm 0.03$, $p = .50$; pushing: GLMM: $\beta = -0.05 \pm 0.03$, $p = .15$; reaching out: GLMM: $\beta = 0.01 \pm 0.03$, $p = .70$; blowing raspberries: GLMM: $\beta = 0.01 \pm 0.03$, $p = .83$, Figure 2a–d). Overall, he herded (GLMM: $\beta = 2.71 \pm 1.17$, $p = .020$, Figure 2a) and pushed (GLMM: $\beta = 1.10 \pm 0.44$, $p = .011$, Figure 2b) Kenny more often than Jewel. In contrast, reaching out was directed equally often at both juveniles (GLMM: $\beta = -0.38 \pm 0.41$, $p = .36$, Figure 2c). Bobby's actions were associated with play behavior. Overall, Bobby and Kenny spent more time playing with each other than Jewel and Bobby (Mann–Whitney U test: $W = 274.50$, $p = .002$, Figure S1 in the online supplemental materials).

Kenny pressed the buttons 538 times over all sessions irrespectively for whom and Jewel pressed the buttons 1,154 times. By coercing the juveniles, Bobby's success in obtaining juice increased substantially (Kenny provided juice in 83 cases and Jewel in 54). Furthermore, after he started using the juveniles, his drinking bouts per hour increased from 0.53 to 5.01 (Figure S2 in the online supplemental materials). Bobby got access to juice not only by his social tools. However, he increased his juice intake by 48% through using social tools. If the juveniles tried to escape, Bobby retrieved or pushed them back in 46% of the cases within a median response time of 10.2 s (interquartile range = 20.3).

Response by the Social Tools

In general, Kenny pressed the buttons for Bobby more often than Jewel after being harassed by Bobby (GLMM: $\beta = 0.44 \pm 0.19$, $p = .021$, Figure S3 in the online supplemental materials). We then tested whether one tool was more likely to respond with pressing the buttons than the other and found a nonsignificant trend that Jewel tended to respond more by pressing the buttons for Bobby than Kenny (GLMM: $\beta = 0.68 \pm 0.38$, $p = .075$, Figure 3). The social tools' latency to press the buttons was not influenced by Bobby reaching out to the social tools (proportional hazards regression model: $\beta = 0.10 \pm 0.23$, $p = .66$).

Discussion

We observed an adult male chimpanzee (Bobby) repeatedly using two juveniles (Kenny and Jewel) as social tools to obtain juice (a third, 8-year-old juvenile was used only in one sequence). Bobby displayed several behaviors aimed at enticing the juveniles to press a pair of buttons that activated a juice fountain located 3 m away from them. His behavior varied in the level of control over the juveniles. First, he actively recruited them by rolling or dragging them toward the buttons. In those situations, the juveniles seldom had the chance to escape and were under Bobby's almost full control and in constant contact. Next, Bobby pushed the juveniles in the direction of the buttons. Because the buttons and the fountain were 3 meters apart, he had to release them to drink from the fountain. Hence, his control was limited, and the juveniles could decide whether to press the buttons or to escape. In the case of escaping, however, the social tool user successfully retrieved them in almost half of the cases, suggesting some form of control. Social tool use was accompanied by blowing raspberries and reaching out. The latter was clearly directed toward the juveniles and might have served as begging, although it did not lead to a faster response by them. Blowing raspberries was not apparently directed at the juveniles given that it was sometimes emitted when Bobby was alone, and thus might indicate a general state of arousal.

The benefit for the adult male in using the juveniles was a marked increase in juice intake that persisted over time. In contrast, juveniles received no juice in return for their efforts. In fact, Bobby systematically pushed them away from the fountain when they approached it. Moreover, we observed no reciprocal turn-taking in pressing the buttons by Bobby and any of the juveniles because he never successfully pushed both buttons and released juice from the fountain in this study. This finding is consistent with other cases of social tool use in which a large power differential between mother–offspring dyads or even unrelated pairs of individuals determines the control exerted by the dominant over the subordinate's behavior and the biased distribution of resources (Chalmeau, 1994; Tokida et al., 1994; Völter et al., 2015). However, social tool use does not always require a power asymmetry based on a large discrepancy in terms of age, status, and body size. Chalmeau, Lardeux, Brandibas, and Gallo (1997) reported social tool use between two orangutans of approximately the same age. In addition to work on primates, Tebbich, Taborsky, and Winkler (1996) observed that dominant keas coerced subordinate individuals to sit on a seesaw to open a container with food for the user. This study is particularly interesting because it shows that social tool use also occurs in nonprimates.

One puzzling result is that because the juveniles received no tangible benefit, one would have predicted an overall decrease over time. If social tools started to avoid the user, there should be a decrease in social tool use. This is precisely what Chalmeau (1994) observed in a dyad of chimpanzees, in which the harassed

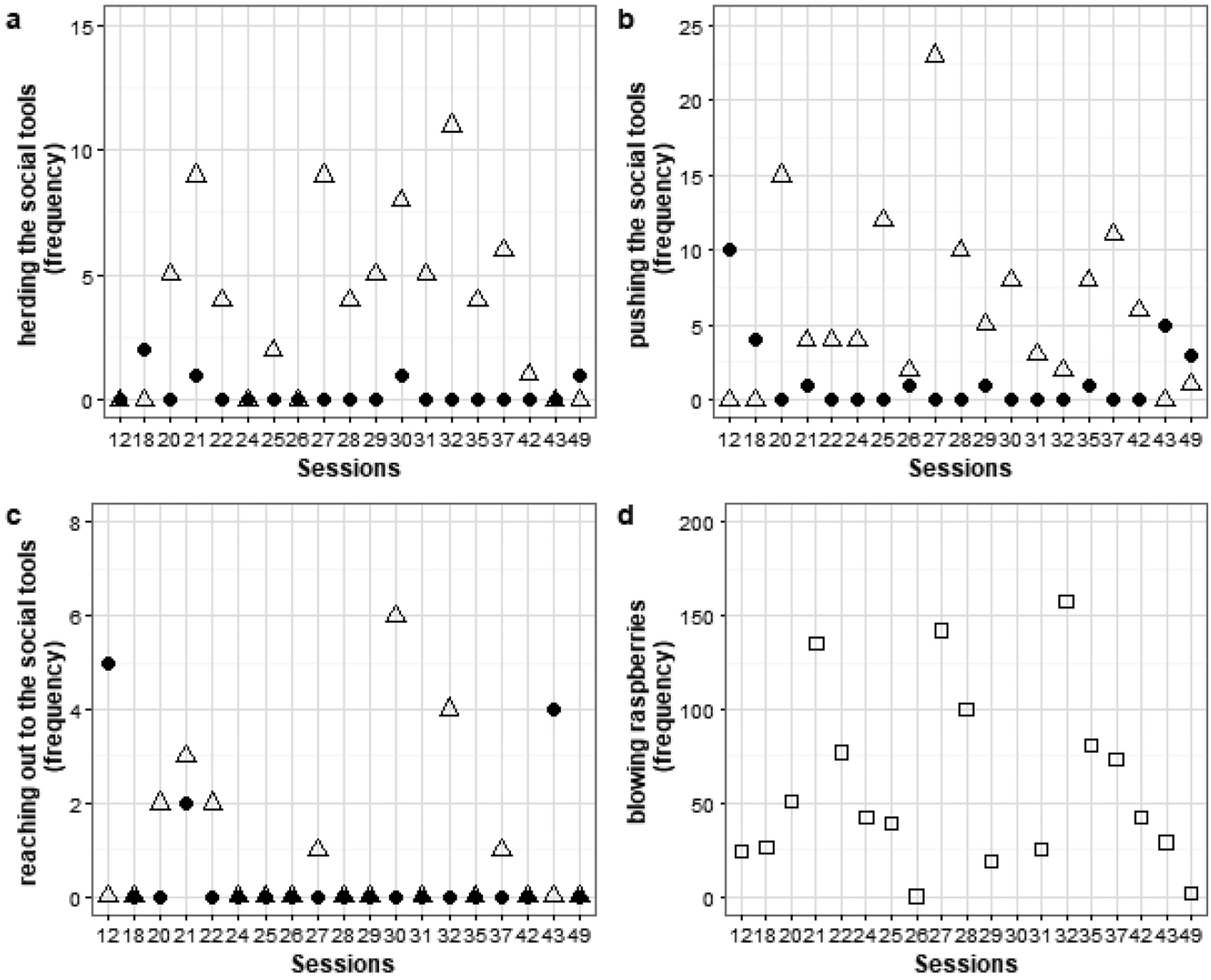

Figure 2. Social tool use behavior over time and across social tools. The social tool user showed four different behaviors to encourage his social tools to provide juice to him. First, he retrieved the social tools (a), then he pushed the respective tool into the direction of the buttons (b), which was sometimes followed by reaching out his hand (c). He blew raspberries throughout the sequences (d). Whereas blowing raspberries was not focused on specific individuals, the first three behaviors were clearly directed to either one of the social tools (depicted in squares [d]). Social tool use was directed more often to Kenny (open triangles [a–c]) than to Jewel (filled points [a–c]) and none of the behaviors varied over time (a–d).

subordinate female escaped in most of the cases, which led the user to use her less often over time. In our case, we found no evidence that the user had to retrieve the social tools more often by the end of the study, which might indicate that social tools started to avoid Bobby. The juveniles' participation is even more puzzling when one considers that the control exerted by Bobby also had its limits. We recorded two aggressive instances after the social tools shortly screamed while the user tried to retrieve them after an escape attempt. In both cases, unrelated adult males rushed over and the tool user was readily displaced. In fact, Völter and colleagues (2017) argued that social tool use between mother–offspring dyads was more prevalent among orangutans compared with chimpanzees and bonobos, because chimpanzee and bonobo infants pro-tested more intensively, thus bringing attention to this situation by other group members. The two cases that we observed, lend some support to this interpretation.

One way to characterize social tool use is in terms of exploitation, that is, one partner benefits and the other does not, despite the social tool's "costly" participation. However, such characterization may overlook that the juveniles may have actually obtained some benefit, such as play, which could explain why they continued to allow themselves to be manipulated. This is of special interest considering the limits to the manipulation that Bobby could exert as indicated by the two aggressive incidents that we observed. To address this issue, we turn our attention to two questions: Why Bobby targeted the

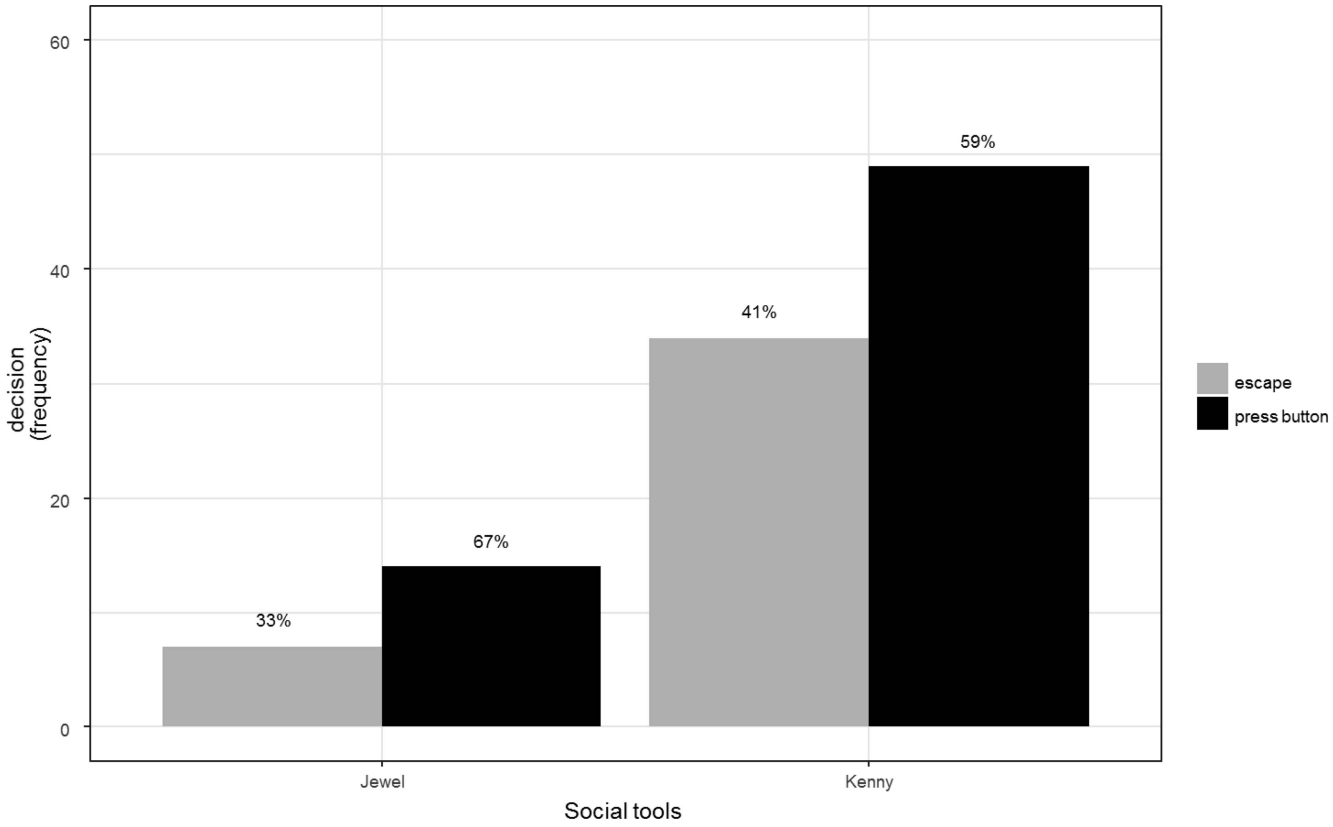

Figure 3. Response of the social tools to harassment. The social tools could either press the buttons (black bars) or escape (gray bars). Overall Kenny was used more often than Jewel. The ratio between escaping and pressing tended to be more biased toward giving in to pressing the buttons by Jewel, but this was nonsignificant.

juveniles in the group and why the juveniles continued to participate in these episodes.

One possibility is that Bobby focused on the juveniles instead of other group members because they were the lowest ranking members of the group, or perhaps the only ones that Bobby clearly outranked in the group. In other words, Bobby may have tried to maximize the power differential between him and his social tools, a factor that is associated with social tool use in most studies. Because the action of pressing the buttons cannot be fully controlled by the user, older group members might not be as easily coerced as younger individuals and might put up a serious fight when being harassed. Another possibility is that Bobby focused on the juveniles because their age made them more suitable for physical and motivational manipulation. Although this explanation partly overlaps with the previous one, it does not do so entirely. Compared with adult individuals, juveniles are more easily pushed and dragged around, and they may offer less resistance to such invasive behavior.

From a motivational point of view, the juveniles may have tolerated the large asymmetry in juice intake better than adults. In other words, adults may have been more likely than juveniles to expect a share of the resources. Male juveniles' interest in associating with adult males (Pusey, 1990) and the prevalence of play among immature individuals (Burghardt, 2005) may have further contributed to making the juveniles particularly effective social tools. Although both juveniles pressed the buttons regularly, Bobby preferred to use the older juvenile (Kenny) from whom he obtained more juice. This preference cannot be explained by a greater success rate when Bobby tried to use Kenny because the less used individual (Jewel) tended to respond more with pressing the buttons than escaping. In other words, 6-year-old Kenny seemed more compliant than 4-year-old Jewel. It is conceivable that a greater motivation to associate with adult males may explain the more frequent interactions between them and, consequently, the more numerous attempts to use Kenny. Furthermore, Kenny and Bobby also played more with each other during or shortly after social tool use. During those play episodes, both Bobby and his social tool displayed a play face. Play is a pleasurable and rewarding behavior (Trezza, Baarendse, & Vanderschuren, 2010). The balance between playing and using the social tools might explain why the juveniles did not avoid Bobby over time. However, this hypothesis needs to be tested in future studies. Moreover, whether play was a byproduct of the increased association between the juveniles and the adult male over time or a tactic deployed by Bobby to secure Kenny's collaboration is also an open question. If the latter were the case, this instrumental use of play would be comparable with the cases of grooming directed to mothers to gain access to their infants that have been labeled as "distraction" in the tactical deception literature (Byrne & Whiten, 1988, 1992; Mitchell, 1988).

Future studies on the development of social tool use could provide important insights into the causal understanding of the social tool user and its actions. In theory, three underlying mechanisms are possible (cf. Seed & Byrne, 2010). First, social tool users could learn from others how to use social tools effectively. Second, social tool users might learn via trial and error that the manipulation of others lead to selfish benefits. Finally, social tool users might causally understand that a social tool is needed to reach a certain goal. We think that in our case social learning is the least likely possibility because Bobby was the only individual showing this behavior during the time of data collection. Whether he found social tool use as a solution to the dilemma by insight or trial and error is difficult to discern without careful experimental manipulations of the context but it could be addressed in further studies.

Although our case study consists of a sample size of only one social tool user and his three social tools, we obtained the largest data set to date, as far as we are aware, in terms of occurrences of this behavior. However, case studies like ours make generalizations difficult. For instance, the adult male was rescued from mistreatment by humans, which may have resulted in an inability to interact appropriately with conspecifics. However, the data available in the literature, particularly the studies focusing on mother–offspring pairs in apes and macaques, weaken this possibility considerably. Alternatively, social tool use might be restricted to fixed groups with no possibility to disperse, as in a sanctuary or laboratory settings. Data from field studies are needed to answer this question.

In sum, we have shown that a chimpanzee spontaneously started using group members as social tools under seminatural conditions. The tool user actively retrieved his social tools and pushed them to buttons that produced juice when pressed. Because pressing the buttons for his own benefit was not possible, Bobby was dependent on others to press the buttons for him. Although the tool user did not have full control over the social tools, he was able to increase his juice intake almost 10-fold. Playing with the social tools might have stabilized Bobby's strategy over time. The balance between using others for the actor's own benefit and preventing the social tools from avoiding the actor might be an example of Machiavellian intelligence. Future studies are needed to understand how widespread social tool use is in chimpanzees and other species, and how the social and ecological settings affect its occurrence. Such data will enable the systematic investigation of its origins and psychological underpinnings.

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