# Supporting Information

## Clay and de Waal 10.1073/pnas.1316449110

### SI Methods

**Subjects and Housing.** Observations were conducted at the Lola ya Bonobo Sanctuary, Kinshasa, Democratic Republic of the Congo from May to August 2012. Most individuals arrive to the sanctuary as wild-caught juvenile orphans, typically victims of the illegal bush-meat and pet trades. Their histories are not generally known in detail, but most have typically spent several weeks or months living with human captors, typically in adverse conditions, before their seizure by the authorities. Most arrive severely malnourished and with injuries/health problems resulting from maltreatment. Upon arrival, each orphan is assigned a substitute human mother and reared within a nursery "cohort group" before integration into large mixed-age social groups. Some offspring have been born (to former orphans) and mother-reared at the Sanctuary within the large mixed enclosures. Individuals spent their days ranging outdoors in one of three naturalistic forest enclosures (15–20 ha), composed of rainforest, lake, swamp, streams, and open grassland areas. Individuals slept together inside dormitories at night (approximately 75 $m^2$). The bonobos were provisioned three to four times per day by caregivers with a variety of fruits and vegetables, as well as enriched soya milk supplements once per day. Their daily routines remained the same throughout the observation period.

We observed at enclosure 1 (group 1, $n = 22$ individuals) and enclosure 2 (group 2, $n = 20$ individuals) (more information in Table S1). Because exact birth dates for orphaned apes were unknown, we used age estimates made by veterinarians made upon arrival, which were adjusted on the basis of measurements of weight and patterns of dental emergence according to known patterns of ape development (1, 2). This method was validated by the known exact ages of all individuals born at the sanctuary (Table S2).

**Definitions.** ***Agonistic interactions.*** We conducted all-occurrence observations of agonistic interactions, which were defined as including at least one of the following behavioral elements: recipient fleeing and/or screaming in reaction to aggression, and aggressor threat barks/ grunts, directed display charge, threat arm wave, chase, hit, trample, slap, shove, poke, or bite. For each agonistic interaction, we recorded the identities of the initial recipient of the aggression, which we will call the "victim," and the aggressor, as well as the identities of all visible bystanders.

***Tantrums.*** We also recorded instances of spontaneous tantrums involving a single focal individual. Tantrums were defined as spontaneous distress responses involving screaming (including noisy broad-band tantrum screaming), in which there was no clear opponent. Tantrums could also be accompanied by: whimpering, pouting, self-embrace, beating the ground with hands/feet or body, twirling, rolling on the ground, front-rolls, crouching, head shaking, nipple-tweaking.

***Conflict intensity.*** We defined conflict intensity at three levels, Low, Medium and High. Low = Threat (hand shake, bipedal swagger threat/whistle bark, lunge); Directed display/charge without physical contact; Medium = chase pursuits or quick poke/shove; single grab/hit/slap without biting; High = severe/multiple grab/hit or biting; and Injurious physical attack or biting.

***Affiliative bystander contacts.***

*Embrace*: Individual places one/both arms around the recipient's body while facing the partner or in lateral position

*Genito-genital contact:* Individuals embrace ventro-ventrally and swing their hips laterally, while keeping their vulvae in contact

*Mount*: Individual makes lateral contact of their genitals behind the recipient and thrusts their pelvis onto the recipient's behind/back area.

*Genital touch:* Touching the genitals of the recipient using any body part other than the genitals (i.e., using hand/foot to touch recipient's penis/genitals)

*Copulation:* Penile intromission and hip thrusting with male or female partner

*Touching:* Any instantaneous soft touch to the recipients body, other than to their genitals, using any body part other than the actor's genitals.

*Grooming:* Directed cleaning/touching/visual inspection of the recipient's hair/skin

*Contact sitting:* Sit in physical contact with the recipient

*Play:* Individuals wrestle/run/jump/chase/tickle accompanied by play face and/or laughing

*Hold*: Grasp/hold onto recipient's body with one or both hands. Generally when recipient is walking or standing.

*Pat:* Pronounced tapping/patting contact onto recipients body using flat hand

*Inspect:* Visual and contact inspection of the recipient's wound or injured body part, after a conflict

***Immediate bystander responses.*** We coded the immediate responses, within 10 s, of all bystanders within 3 min of the onset of the postdistress (PD) period. The response of each proximate bystander was coded as positive, negative, neutral, or agonistic. Positive responses included approaching or walking toward the victim and/or offering positive affiliative contact. Negative responses included moving/walking away from the victim, fleeing, and screaming. Neutral responses included no response/visible reaction, without repositioning. Agonistic responses included receiving or initiating an agonistic act with the victim or another individual. Any bystanders or actions that were not clearly classifiable were excluded.

***Victim anxiety responses.*** We recorded victim recovery time, as measured by the latency to cease showing any unprovoked anxiety response behaviors taken from the last occurrence of one of these behaviors. Anxiety responses included any of the following: bared teeth, whimper, pout, whine, scream, pout-moan, spontaneous jump-back/avoidance, self-nipple tweak, ground roll, face-down on ground, self-hit, self-embrace, self-slap. Responses to redirected or renewed aggression during any focal sample were excluded.

**Juvenile Sociality Focals.** We collected 15-min focals samples on the juveniles ($n = 6$ mother-reared, $n = 6$ orphans; Table S2) during daily observation hours (501 focals, balanced across individuals: mean 42 ± 4 focals per individual). Focal times were assigned randomly using a random order matrix, and only one focal sample was taken per study session (morning/afternoon) per individual. We only collected focals when the individual was in a relaxed state and had not been involved in an agonistic interaction for more than 1 h. Focals that included an agonistic interaction during the focal were excluded.

## SI Results

**Victim Responses With/Without Consolation.** To control for the effects of receiving consolation on the probability of restarting screaming and time to cease anxiety responses, we conducted separate analyses of individual's mean scores for consolation and nonconsolation PD periods. Results showed that the effect was significant in the same direction in all analyses [i.e., compared with orphans ($n = 6$), mother-reared juveniles ($n = 6$) were less likely to restart screaming and recovered sooner, regardless of whether consolation occurred] (probability of restarting screaming after consolation: Mann-Whitney $U = 5.5$, $P = 0.041$, without consolation: $U = 4.5$, $P = 0.027$; latency to relaxed behavior with consolation: $U = 3, P = 0.016$, without consolation: $U = 0, P = 0.004$).

**Sociality Measures for Composite Sociality Index.** We extracted four sociality measures used in the Composite Sociality Index: three sociality measures from the sociality focals and one measure from the affinity scans. From the sociality focals, we extracted (*i*) mean rate of initiating playful interactions per hour, (*ii*) mean rate of play per observation hour, and (*iii*) the proportion of focals in which the individual engaged in an affiliative interaction. Play duration was the number of minutes spent in social play, per hour of observation. The proportion of focals with contact affiliation were the number of focals in which the juvenile engaged in at least one contact affiliation with a nonmother, divided by the total number of focals conducted per individual. From the affinity scans, we calculated degree of dyadic affiliation using a combined measure of five affiliation behaviors (grooming, contact sitting, sitting within arms' reach, play, or sexual contact) that occurred between a given dyad, divided by the number of scans in which both individuals were present. From these, we calculated each individual's mean level of affiliative tendency by averaging across their affiliative scores with each available partner.

1. Wobber V, Wrangham R, Hare B (2010) Bonobos exhibit delayed development of social behavior and cognition relative to chimpanzees. *Curr Biol* 20(3):226–230.

2. Rosati AG, Hare B (2012) Chimpanzees and bonobos exhibit divergent spatial memory development. *Dev Sci* 15(6):840–853.

**Table S1. Composition of study groups, housed at Lola ya Bonobo Sanctuary, Democratic Republic of the Congo**

| Group 1 | | | | | Group 2 | | |
|---|---|---|---|---|---|---|---|
| Name | Code | Age, y | Age class | Name | Code | Age | Age, y |
| Females | | | | | | | |
| Opala | OP | 17 | A | Maya$^{+Mayele\ (m)}$ | MY | 19 | A |
| Semendwa$^{+Makasi\ (m)}$ | SW | 15 | A | Kalina$^{+Bolingo\ (m)}$ | KL | 14 | A |
| Bandundu | BD | 15 | A | Kisantu$^{+Liyaka\ (f)}$ | KS | 13 | A |
| Salonga | SL | 14 | A | Likasi$^{+Elonga}$ | LI | 11 | AD |
| Lisala$^{+Nyota}$ | LS | 11 | AD | Muanda | MU | 8 | AD |
| Katako | KT | 8 | J | Sake | SK | 7 | J |
| Elikia*$^{(SW)}$ | EK | 7 | J | Malaika*$^{(KL)}$ | ML | 5 | J |
| Waka | WK | 6 | J | Masisi | MS | 6 | J |
| Kimia*$^{(SL)}$ | KM | 3 | J | | | | |
| Males | | | | | | | |
| Manono | MN | 18 | A | Keza | KZ | 20+ | A |
| Kikwit | KW | 14 | A | Max | MX | 26 | A |
| Fizi | FZ | 13 | A | Mbandaka | MB | 10 | AD |
| Lomami | LM | 13 | A | Bili | BL | 11 | AD |
| Api | AP | 12 | AD | Ilebo | IB | 10 | AD |
| Matadi | MA | 12 | AD | Yolo | YL | 8 | AD |
| Dilolo | DL | 11 | AD | Bisengo*$^{(MY)}$ | BS | 7 | J |
| Kasongo | KG | 10 | AD | Eleke | EL | 7 | J |
| Mabali | MB | 9 | AD | | | | |
| Pole*$^{(OP)}$ | PO | 7 | J | | | | |
| Wongolo*$^{(BD)}$ | WO | 4 | J | | | | |

Age classes: A, adult; AD, adolescent; J, juvenile.
*Mother-reared individuals born at the sanctuary, with the identity of their mother in superscript. $^{+}$, Female's young infant offspring.

**Table S2. Information on juvenile subjects, including sex (male/female), rearing type (M, mother-reared, O, orphan), and age in years**

| Group | Code | Sex | Rearing | Age | Group | Code | Sex | Rearing | Age |
|---|---|---|---|---|---|---|---|---|---|
| 1 | PO | M | M | 7 | 2 | BS | M | M | 7 |
| 1 | EK | F | M | 7 | 2 | ML | F | M | 5 |
| 1 | WO | M | M | 4 | 2 | YL | M | O | 8 |
| 1 | KM | F | M | 3 | 2 | EL | M | O | 7 |
| 1 | KT | F | O | 8 | 2 | SK | F | O | 7 |
| 1 | WK | F | O | 7 | 2 | MS | F | O | 6 |

F, female; M, male.

**Table S3. Spearman rank correlations showing the relationship between the four sociality measures used in the Composite Sociality Index for $n = 12$ juvenile bonobos**

| Measure A | Measure B | Spearman's ρ | *P* |
|---|---|---|---|
| Duration of play | Affinity score | 0.69 | 0.013 |
| | Frequency initiate play | 0.82 | 0.001 |
| | Proportion of social contact rocals | 0.70 | 0.011 |
| Affinity score | Frequency initiate play | 0.65 | 0.022 |
| | Proportion of social contact focals | 0.63 | 0.003 |
| Frequency initiate play | Proportion of social contact focals | 0.78 | 0.003 |

## Other Supporting Information Files

Movie S1