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# Preschool children and chimpanzees incur costs to watch punishment of antisocial others

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# Supplemental Information

## Supplementary Tables

| Chimpanzee Group | Subjects  | Age (years, months) | Sex | Rearing history | Study           |
|------------------|-----------|---------------------|-----|-----------------|-----------------|
| B                | Alex      | (10,9)              | M   | Hand reared     | Studies 1 and 3 |
|                  | Alexandra | (12,4)              | F   | Hand reared     | Study 1         |
|                  | Annette   | (12,4)              | F   | Hand reared     | Study 1         |
|                  | Fifi      | (18,7)              | F   | Mother          | Study 1         |
|                  | Jahaga    | (18,11)             | F   | Mother          | Studies 1 and 3 |
|                  | Trudy     | (18,7)              | F   | Mother          | Study 1         |
|                  | Frederike | (42)                | F   | Unknown         | Study 3         |
|                  | Daza      | (30)                | F   | Unknown         | Study 3         |
| A                | Corrie    | (12,4)              | F   | Hand reared     | Studies 1 and 3 |
|                  | Fraukje   | (37,1)              | F   | Hand reared     | Studies 1 and 3 |
|                  | Kofi      | (8,4)               | M   | Mother          | Studies 1 and 3 |
|                  | Lobo      | (9,1)               | M   | Mother          | Studies 1 and 3 |
|                  | Lome      | (12,5)              | M   | Mother          | Study 1 and 3   |
|                  | Natascha  | (33,0)              | F   | Hand reared     | Studies 1 and 3 |
|                  | Sandra    | (20,3)              | F   | Mother          | Studies 1 and 3 |
|                  | Kara      | (8,3)               | F   | Mother          | Study 1         |
|                  | Riet      | (36,8)              | F   | Hand reared     | Studies 1 and 3 |

|               |               |          |                    |                        |
|---------------|---------------|----------|--------------------|------------------------|
| <b>Robert</b> | <b>(38,9)</b> | <b>M</b> | <b>Hand reared</b> | <b>Studies 1 and 3</b> |
| <b>Tai</b>    | <b>(15,6)</b> | <b>F</b> | <b>Mother</b>      | <b>Study 3</b>         |
| <b>Ulla</b>   | <b>(36,3)</b> | <b>F</b> | <b>Hand reared</b> | <b>Study 1</b>         |

Table S1. Age, sex, and rearing history of the subjects that participated in which of the studies.  
Note. Study 1, Watching punishment following directly experienced pro- and antisocial behavior;  
Study 3, Watching punishment following indirectly experienced pro- and antisocial behavior

## Supplementary Figures

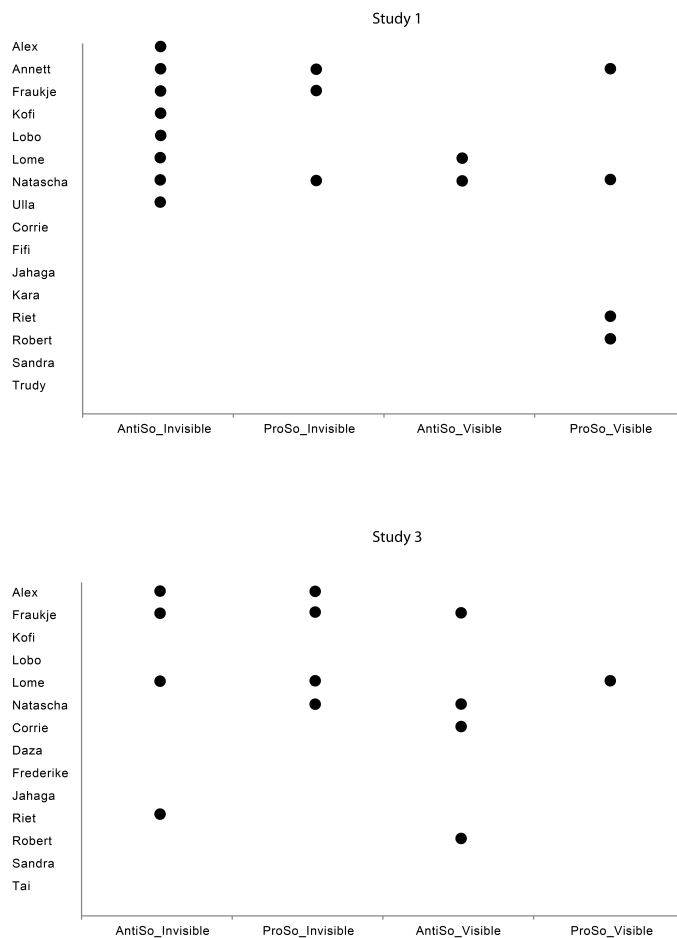


Figure S1. Individual data points across all four conditions in Studies 1 and 3.

## Supplementary Methods

### Experimental Procedure: Studies 1 and 3

#### Participants

See Table S1 for an overview of the subjects that participated in Studies 1 and 3.

#### Procedure

*Training phase.* Comprised of 5 different consecutive stages. The mesh sliding door was positioned in between two rooms (start and destination rooms) of the chimpanzees. To encourage subjects to open the door, slices of bananas (and sometimes pellets, grapes or slices of onions, depending on individual preferences) were placed in the destination room. Subjects could witness the baiting process and the food was visible to them all the time as the wall in between the rooms was made out of mesh. In case subjects did not attempt to open the door within 5 min., the respective trial was re-started. Subjects from chimpanzee group A (see Table S1) had already received a training to open the sliding door in a previous experiment [50] and therefore only received refreshment trials (stage III) two years after the initial training.

Stage I. The sliding door was left 1/3 open. Subjects had to slightly push the door to the side in order to get into the destination room and retrieve the food. The criterion for advancing a subject to the next training stage consisted of passing through the door without showing signs of fear. It took subjects from group B an average of 2 trials (range, 1–4 trials) to reach the criterion for this stage. One subject (Alexandra) never reached the criterion (showed signs of fear in crossing the door), even after 50 trials.

Stage II. The door was completely closed but not locked. That is, subjects had to pull the door to the side but did not have to unlock it. As in stage I, the criterion for advancing a subject to the next stage consisted of opening the door and passing through it without showing signs of fear. It took subjects from group B an average of 1,6 trials (range, 1–3 trials) to reach the criterion for this stage. One subject (Annett) never reached the criterion (showed signs of fear in crossing the door), even after 25 trials.

Stage III. The door was not only completely closed but also locked with the help of a peg. Initially, a removable plastic peg was used, which was latter stage replaced by a fixed metal peg. The plastic peg blocked the opening of the door, but once it was taken out the door could be pulled to the side just like in the previous stage (stage II). In case subjects did not realize that

the peg had to be removed in order to open the door, the experimenter encouraged the exchange of the peg with food items. This procedure was facilitated by placing similar pegs, to the one blocking the sliding door, on the floor of the room. The chimpanzees are used to exchange objects present in their rooms for food rewards. As soon as the subjects learned how to unlock the door, the plastic peg was replaced by a metal peg that could not be detached from the door. The criterion for advancing a subject to the next phase consisted of opening the sliding door and moving into the destination room within 10 sec. in four consecutive trials. It took subjects from group B an average of 41 trials (range, 9–103 trials) to reach the criterion for this stage. Subjects from group A took an average of 11 trials (range, 6–24 trials) to learn how to open the door.

Stage IV. No food was placed in the destination room and the door was closed and locked with the metal peg. Two of these trials were included in order to eliminate the association between opening the door and receiving food.

*Exposure phase.* In Study 1 (Watching punishment following directly experienced pro- and antisocial behavior) each of the human agents came into the testing room (one at a time) and sat in front of a sliding table attached to the subject's room. The agent placed half a grape on top of the sliding table and moved it towards the subject. As soon as the subject tried to reach for the food, the prosocial agent allowed it to take it, while the antisocial agent brought back the sliding table thus preventing the subject from taking the food. Each subject received three blocks of 12 trials each (6 trials with each of the two experimenters). The exposure to either pro- or antisocial agent in each block was counterbalanced across subjects. This phase took place one day before the Punishment phase. In addition, two refresh trials were administered immediately before the correspondent Punishment trial.

In Study 3 (Watching punishment following indirectly experienced pro- and antisocial behavior), each of the agents (always one at a time in the room) proceeded in the same way as in Study 1 but towards a stooge and not towards the subject. The subject was in an adjacent room and witnessed the interaction between the human agent and the stooge. To ensure that the subject watched the whole interaction a juice dispenser was added to the booth area of the room. The spout of the dispenser was located in such an angle that while drinking subjects directly faced the agent and the stooge. Each of the human agents made sure that every trial was watched by the subject. That is, they looked sideways to the subject and in case he/she stopped drinking, they waited to restart the interaction with the stooge until the subject was again gazing at them.

*Preference phase.* In Study 1, both human agents entered the testing room simultaneously, each carrying a bucket with equal amount of grapes. However neither offered grapes if the subjects begged for it. Both agents sat in front of the subject's room with their backs oriented towards each other. The agents remained in their position for 5 min. from the moment the subject came into the room. The preference phase in Study 3 was very similar to the one in Study 1, except for: Both agents sat side by side, each of them in front of a different mesh panel. This change follows Russell and colleagues (1) who have shown an effective way to discriminate the behavior of the chimpanzees towards social and antisocial agents. For this phase the following vocalizations and other behavioral signs of display, distress and begging gestures were coded from the usb video cards, respectively: 1) spat, bang, throw feces at experimenter, knock/shake window panel, hoots; 2) scratch body/nose, whimper, scream; and 3) loose under-lip, boob-head-body, present bottom at experimenter, poke through the holes in the window panel and/or grab bucket from experimenter. The duration of the calls was analyzed with the sound analysis software Avisoft and Praat.

In Study 3 this phase took place either immediately after the Exposure phase or at the end of the Punishment phase (counterbalanced across subjects). However, in Study 3 (third-party punishment), it always took place at the end of the Punishment phase in order to keep the role of the agents unaffected.

*Punishment phase.* To ensure that the duration of the punishment was equal across conditions, in the visible condition after the fourth hit with the stick, the punisher brought it further back, to achieve an even stronger hit, for 5 sec. In the invisible condition the E used those 5 sec. to move into another part of the room (move from area A to area B, see Figure 1A). Once the E and the punisher had moved in another part of the room, the subject no longer had visual access to the punishment. We assured the restriction of visual access of the subject to the remote area of the room by adding black occluders to the Plexiglas windows in the middle area. Thus, if the subject wanted to continue watching the punishment it had to open the sliding door (learned during the Training phase) and move in front of the Plexiglas window in the new room. For the two subjects that did not learn to operate the sliding door because they were afraid of it (see Training phase, Stages I and II), the sliding door was cracked open. The heavy sliding door is a fundamental aspect in our procedure as we want subjects to incur a cost for opening it.

## **Experimental Procedure: Study 2**

In this experiment we investigated how 4-, 5-, and 6-year-old children perform in a similar task to the one presented to the chimpanzees in a comparable experimental setting. These age groups were selected due to their age-related differences in overcoming inequity aversion [2] and in non-social processes involving self-regulatory mechanisms [3].

### Participants

36 boys and 36 girls were tested. There were three age groups: 24 4-year-olds ( $M = 4.15$ , age range = 4.04–4.35), 24 5-year-olds ( $M = 5.04$ , age range = 4.97–5.4), and 24 6-year-olds ( $M = 6.17$ , age range = 5.98–6.33). In each group there were equal number of boys and girls. In total 7 children had to be removed from the analyses due to procedural error or fussiness. All remaining subjects received all conditions. All children were recruited from a subject database at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, Germany. The ethics committee of the University of Leipzig approved the study. Caregivers provided written consent form to use the acquired data.

### Procedure

*Training phase.* Children saw a short performance of noddy and the princess playing hide and seek. To the right and the left of the theatre was one small box. After 20 sec. of the performance, the curtain closed and the subject was told that if he/she wanted to continue watching the performance he/she would have to place one of the MUs into the box on the right. If he/she did not want to continue watching the performance he/she would have to place one of the MUs into the box on the left. The child was told that all MUs placed into the right were no longer his/hers, whereas all MUs placed into the left could be exchanged against the stickers at the end of the experiment. Depending on what the child did, the curtain re-opened and performance was continued for 10 sec. or not. At the end, children were asked 6 control questions making sure that each aspect of the experimental procedure had been fully understood. Comprehension scores were subsequently calculated.

The control questions were as follows:

1. “If you have  $x$  amount of Mus how many stickers will you receive at the end?” Correct answer is  $x$  amount of stickers.
2. “Here are two coins. Who do these coins belong to?” Correct answer is these coins belong to the child.

3. "What should you do with your coin if you want to continue watching the puppet show?" Correct answer is to put them in Box X.
4. "What should you do with your coin if you do not want to continue watching the puppet show?" Correct answer is to put them in Box Y.
5. "What can you do with all the coins lying in Box X at the end of the show?" Correct answer is nothing, they do not belong to me.
6. "What can you do with the coins lying in Box Y at the end of the show?" Correct answer is I can trade them in for stickers.

*Exposure phase.* Out-of-sight of the child the caregiver gave three of the child's favorite toys to the experimenter, who hid them behind the theater curtain.

When holding one of the favorite toys in front of the child the puppet said „*Hello (name of the child), my name is (name of the puppet). How are you doing? Ooohh, great. I am also very good ... and do you know what? I would like to play with you. Would you also like to play with me? Look, your daddy/mammy brought me three of your toys. Wow, look here (name of the child)! It is your (name of the toy). It is very nice and I know that you like (name of the object). Therefore, I will give it to you.*”. Afterwards the puppet leaned towards the child and offered him/her the toy. While the prosocial puppet let the child take the object (prosocial condition), the antisocial puppet took it back and said “*No! I have decided to keep it for me!*” (antisocial condition). This procedure was repeated two more times (each time with a different toy). The order of presentation of the two puppets was counterbalanced across children. Moreover, the identity of the puppets (i.e., elephant, lion, giraffe) and whether they were pro- or antisocial or the punisher was also counterbalanced across children. This phase was followed by the Punishment phase for each puppet (prosocial vs. antisocial) separately.

*Punishment phase.* The punisher said “*Hello (name of the child). I will now hurt the (name of the puppet).*”. After an initial punishment, the punisher turned again to the child and said: “*I will now pursue the (name of the puppet) and continue to hurt it. If you want to continue watching how the puppet is hurt then you will have to put one of your coins into this box*” (while pointing to the box). *If you do not want to continue seeing how I hurt the puppet (name of the puppet) then you should drop one of your coins in your box*” (while pointing to the box). The punisher started beating the other puppet (social/antisocial) up with the stick for 5 sec. (i.e., 5 hits with the stick,

rate: 1 Hz). After the initial punishment period (i.e., 5 sec.) the theater curtain closed and both the punisher and the hurt puppet were out-of-sight of the child. Children were asked if they wanted to continue watching the punishment. If they did want to, they had to drop one of their MUs in a box (see the exact round of questions in the SI). The final round was the pursuit and punishment behind the curtain, thus the child continued hearing the puppet crying for 10 more sec. but without visual access to the punishment.

## Supplementary Results

### Studies 1 and 3

#### *Training phase*

To demonstrate that the chimpanzees perceived the sliding door as heavy, we computed the average amount of time they took to open it at stages I (i.e., door 1/3 open) and III (i.e., door closed and locked) of the training phase. Chimpanzees took on average 5.56 s to open the sliding door during Stage I and on average 11.05 s in Stage III.

#### *Preference phase*

Study 1 (direct exposure). Although chimpanzees showed no preference for requesting food from the prosocial over the antisocial agent (Wilcoxon signed rank test:  $T^+ = 89$ ,  $N = 17$ ,  $P = 0.579$ ), this could have been the result of the close physical proximity of both human agents, which might not have allowed for a clear dissociation of the subject's behavior. In a similar setup, Russell and colleagues<sup>1</sup> showed that upon witnessing an interaction between a human beggar and both a nice and a nasty experimenter, chimpanzees showed a preference for the nice over the nasty one.

Study 3 (indirect exposure). In the first preference phase (prosocial vs. antisocial), subjects begged more often from the prosocial compared to the antisocial agent (Wilcoxon exact test:  $T^+ = 1.89$ ,  $N_{total} = 14$ ,  $p = 0.033$ ).

We also computed individual data points of behaviors across both studies. The plot below shows that twice as many chimpanzees opened the door in the antisocial invisible condition in Study 1 than in any other condition across the two experiments (Figure S1).

## Study 2

### Comprehension

Comprehension of the task was good ( $M = 5.7$ ,  $St. Dev = 1.04$ ). There was a linear increase in comprehension with age ( $F(1,61) = 5.45$ ,  $p = 0.007$ ). However, there were no comprehension differences between 4- and 5-year olds ( $F(1,41) = 2.9$ ,  $p > 0.1$ ) or 5- and 6- year olds ( $F(1,41) = 2.9$ ,  $p > 0.1$ ).

### Facial expressions

During the exposure phase the facial expressions of the children revealed no differences in number or duration of smiles ( $F < 0.73$ ,  $p > 0.39$ ) and smiles with frowns ( $F < 3.1$ ,  $p > 0.1$ ) nor significant age differences ( $F < 1.9$ ,  $p > 0.14$ ). However, there was a greater number of frowns during the interaction with the antisocial than the social agent ( $F(1,62) = 6.632$ ,  $p = 0.012$ ) and no significant age-difference.

## Supplementary References

1. Russell, Y. I., Call, J. & Dunbar, R. I. Image scoring in great apes. *Behavioural Processes* **78**, 108-111 (2008).
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