

Effects of Conspecific Image Familiarity and Sex on Bonobo (*Pan Paniscus*) Attention

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BRIEF. Examining the preference of bonobos to look at familiar and unfamiliar images of varying sexes in order to gain an understanding of bonobo social attention.

ABSTRACT. Bonobos (*Pan Paniscus*) differ from other species of apes such as chimpanzees (*Pan troglodytes*), as they have been shown to possess a heightened social awareness when compared to other genetically similar species of apes. This increased social awareness may impact how bonobos perform on social tasks when compared to other apes. Previous research found that a group of bonobos and chimpanzees chose to look at familiar digital images of the dominant sex, which in the case of bonobos, is females. This study aims to determine if these findings are consistent among other groups of bonobos and varying procedures. To conduct the experiment, seven bonobos (M_{age} : 20.6 years) were presented with an image of a familiar and unfamiliar bonobo. Video footage of the trials was used to determine which image they chose to look at for a greater period of time. It was found that the bonobos looked significantly less at images of unfamiliar females than both familiar females and unfamiliar males. This is partially in line with the findings of previous research which could indicate that, in bonobos, it is evolutionarily more important to differentiate between familiar and unfamiliar females because of the structure of their female-dominated societies.

INTRODUCTION.

Bonobos (*Pan Paniscus*) and chimpanzees (*Pan troglodytes*) are genetically similar, but behaviorally, they are vastly different. Among other morphological and behavioral differences, chimpanzees are known to live in patriarchal, male-dominated societies, whereas bonobos tend to live in matriarchal, female-dominated societies [1], [2], [3]. Another difference between the two apes is the differences in social attention. Bonobos have been shown to be more socially aware than other species of apes such as chimps, meaning, they are better at picking up social cues and are keen to sense potential arguments and disturbances in the group [4], [5]. There are three proposed explanations of this phenomenon, as adapted from a 2021 study conducted by Nolte et al.; differences in brain structure between the two apes, differences in feeding ecology, and the idea of self-domestication in bonobos.

A 2012 study examining the differences between bonobo and chimpanzee brains found that bonobos have more grey matter in areas of the brain such as the right anterior insula, the amygdala, and a pathway linking the amygdala and the ventral medial prefrontal cortex [6]. Those specific areas of the brain are linked with perceiving the individual's distress, as well as the distress of another member of the group. Fruit availability is another factor that may have led to bonobos' increased social awareness. While their habitats are small, wild bonobos live in nutrient-rich habitats with readily available fruit access throughout the year [7]. Wild chimpanzees, on the other hand, live in habitats where fruits and other foods are less readily available year-round [7]. This leads the female chimpanzees to spend more time foraging away from the group, whereas the bonobos are able to spend more time with the group may be able to form stronger social connections than the chimpanzees. The last theory discussed is the self-domestication hypothesis proposed by Hare et al [8]. This hypothesis

states that due to the bonobo's female-dominated, matriarchal societies, the females will select non-aggressive males as mates, and therefore positively reinforce nonaggressive behaviors [8].

The social structure of the bonobo society is another factor that could influence the preference of bonobos to look at images of varying sex and familiarity. The matriarchal nature of the societies may impact the image the individuals prefer to look at. A similar study to the one conducted here found that both chimpanzees and bonobos tend to spend more time looking at digital images of familiar faces of the dominant sex; which in the case of bonobos, is the familiar female [9]. This study differs from the one presented here, as a different group of bonobos is being studied, the medium from which the pictures are presented is different, and other details of the method such as the size of images, time-frame images were presented, and frequency of trials was altered. This study aims to confirm and expand upon the results of Lewis, et al. To see if bonobo image preference is altered based on variations of individuals and experimental setups, or if the results remain constant despite the variations.

The findings of this study may be used as a stepping stone to understand how the variations between the chimpanzees and bonobos (such as societal differences and variations between the dominant sex) may impact their cognitive and social abilities. It also aims to gain incites into the behavior of the lesser-studied bonobos, so that the results of this study may be used to compare to that of the more readily studied chimpanzee.

This study aims to investigate whether the bonobos' heightened social awareness leads to an increased attention to pictures of conspecific images based on the familiarity and sex of the bonobo imaged. Based on the nature of bonobo societies, as well as previous research, it is hypothesized that bonobos will prefer to look at familiar females.

MATERIALS AND METHODS.

Subjects.

Seven bonobos (*Pan paniscus*), 4 males (M_{age} : 23.8 years), and 3 females (M_{age} : 16.3 years) participated in this study. They were located at the Ape Initiative in Des Moines, Iowa, and were between the ages of 11 and 40. They were housed in a containment area with space for both indoor and outdoor activities, ample enrichment opportunities, and sufficient access to food and water throughout the study. The subjects were not forced in any manner to be a part of the study. All subjects had the option to walk away without finishing the trial. All of the subjects had some amount of experience with participating in projects similar to the one conducted.

Conspecific and Control Images.

For the conspecific trials, sets of two images were selected: one image of a familiar conspecific (accessed from the Ape Initiative web-site) and one image of an unfamiliar conspecific (accessed from the "Bonobo Banner" Facebook group, consisting of bonobo pictures from various zoos and sanctuaries). If an image was known to come from a zoo where one of the subjects was previously located, it was

excluded to prevent the likelihood that the unfamiliar conspecific was not entirely unfamiliar to a subject.

To keep the images consistent, the image only captured their head, neck, and bust. Each familiar conspecific image was paired with an unfamiliar conspecific image so that the posture and sex of the individual in each of the sets would remain constant. After selecting the seven familiar and seven unfamiliar photos, photo editing features in Clip Studio Paint were used to replace the image background with a plain white one. Images were printed in the same 21 cm by 21 cm dimensions and were subsequently laminated. Finally, the back of the images was labeled with a unique number identification between 1-14 so that experimenters could remain blind when coding the images.

Table 1. Subject name, sex, and age (in years).

Name	Sex	Age
Kanzi	M	40
Nyota	M	23
Maisha	M	21
Teco	M	11
Elikya	F	24
Mali	F	14
Clara	F	11

General Procedure.

Subjects were presented with the paired familiar and unfamiliar conspecific image simultaneously (see Figure 1). Male images and female images were never paired against each other due to the unequal number of male and female individuals. Testing was conducted in a controlled environment without the presence of other individuals. Over the course of experimentation, the subjects viewed the nine image sets (seven conspecific sets and two control sets) three times. The order of each set, as well as the side the image was displayed on, was predetermined and randomized. The images were held up, 60-90 cm away from each other, for a total of 20 seconds. After the 20 seconds had elapsed, the images were promptly removed and the participants were given a squirt of juice as a reward for participation.

Video and Data Analysis.

Video footage from the trials was coded by the main experimenter to see which image the subjects looked at for a longer duration. The image that was observed for a longer period of time was coded as a one and the image that the subjects looked at for a lesser period of time was coded as a zero. Some individuals spent much more time looking

at either image (regardless of the familiarity) than other individuals, and this 1/0 system was used to prevent underrepresentation of subjects that spent less overall time looking at either image. The benefit of giving each individual an equal weight in the data, outweighed the potential loss of the total looking times of each individual. After the videos were coded, the data was divided into four groups: unfamiliar female, unfamiliar male, familiar female, and familiar male. A two-way ANOVA and two t-tests were used to determine which of the four groups the subject looked at for longer. A t-test was used to compare the familiar to unfamiliar control images. To test for a side bias among the data, a final t-test was used.

A second experimenter coded 56.7% percent of the trials, and a Cohen’s Kappa test was used to test inter-rater reliability. When the main experimenter and secondary experimenter disagreed, a third experimenter was used as a tiebreaker.

Six female trials (two control and four conspecific) and three male trials (all three conspecific) had to be taken out of the analysis due to the poor quality of the video and the subsequent inability to determine the viewing preference of the subject.

RESULTS.

The two-way ANOVA identifying whether the percentage of trials where the subjects looked at the four different groups was impacted by the sex and familiarity of the imaged bonobo showed a significance within the data $F(2, 6) = [2.45]$, $p = [0.02]$. The alpha value of this study was set at 0.05. A t-test comparing the familiar to unfamiliar control trials showed that the familiar control image was looked at significantly more $t(6) = [1.943]$, $p = [0.004]$ (see Figure 2).

In order to determine if there was a significant difference between the trials where the subjects looked longer at the familiar female image, unfamiliar female image, familiar male image, and unfamiliar male image, two t-tests were conducted. The male and female trials were not directly compared to the male trials due to the unequal number of male and female individuals. The first t-test revealed that the familiar female image was looked at significantly more than the unfamiliar female image $t(6) = [1.94]$, $p = [0.02]$ (see Figure 3). The second t-test, comparing the familiar male to the unfamiliar male revealed no significance $t(6) = [1.94]$, $p = [0.09]$ (see Figure 3). The final t-test, examining the presence of side bias, showed no significance $t(20) = [1.73]$, $p = [0.87]$. This provides evidence that subjects were not looking at the images based on the side they were located on.

The Cohen’s Kappa test was used to compare the ratings of the main experimenter to the secondary experimenter. Out of the 102 trials the second experimenter rated, there were four total disagreements. This

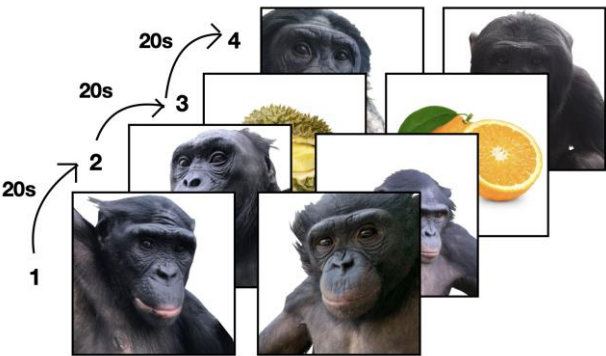


Figure 1. An example of what a subject would see in one repetition of nine sets of paired images. Two image pairs consisted of a familiar and unfamiliar fruit image and the other seven consisted of a familiar and unfamiliar conspecific image. Each pair of images were observed by the subjects for 20 seconds.

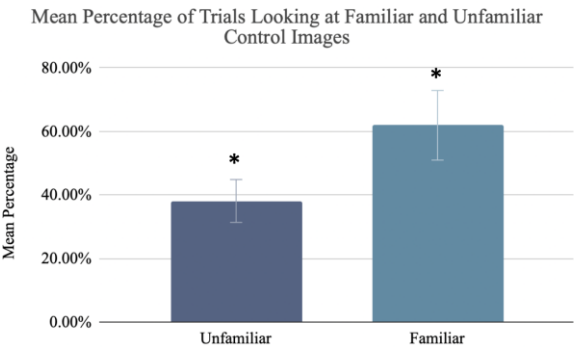


Figure 2. Average percentage of trials in which the subjects chose to look at the familiar or unfamiliar control image. The darkblue bar represents the unfamiliar control image. The light blue bar represents the familiar control image. * $p < 0.05$.

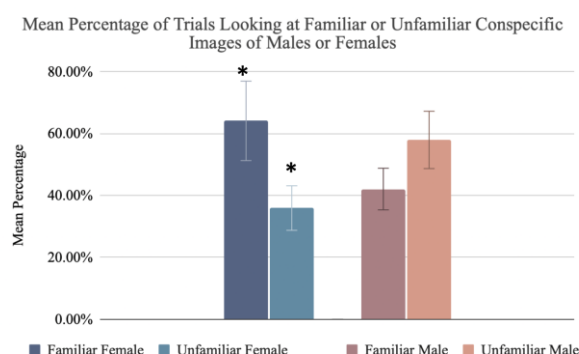


Figure 3. Average percentage of trials in which the subjects (both male and female) chose to look at the familiar or unfamiliar image of the conspecific male or female. The blue bars represent the percentage of trials for which subjects looked at the familiar or unfamiliar conspecific female image (out of 100%). The red bars represent the percentage of trials for which the subjects looked at the familiar or unfamiliar male conspecific image (out of 100%). The darker shades of both colors represent the familiar conspecific images and the lighter shades of both colors represent the unfamiliar conspecific images. * $p < 0.05$.

equates to a 96% agreement or an almost perfect agreement (Cohen's Kappa = 0.90).

DISCUSSION.

This project aimed to determine whether the sex and familiarity of conspecific images influenced bonobo looking time. Analysis revealed that bonobos looked at images of familiar females more than unfamiliar females and showed no preference between familiar and unfamiliar male images (as seen in Figure 3). This indicates that bonobos prefer to look at familiar female individuals as opposed to familiar and unfamiliar members of the opposing sex. One explanation for this phenomenon is that bonobos selectively give attention to dominant female members of the society because they are deemed as more important than the subordinate male. Since all animals have a limited attention span, they have to subconsciously choose what warrants their attention [10]. This remains true for social interactions. Bonobos generally live in female-dominated societies, and this remains true for the group of individuals located at the Ape Initiative [2]. Because of this female-dominated nature, it is hypothesized that this phenomenon occurs because the bonobos find it rewarding to give the majority of their attention to high-ranking individuals. This may be to increase social ranking or to prevent potential fights between individuals. Interestingly enough, this is not limited to bonobos. A similar study done on humans found that people of a lower social class pay more attention to other people when those individuals are in a higher social class [11]. This finding leads to the question of where this tendency to give attention to high-ranking individuals evolved in primates.

These findings are consistent with the findings of a 2021 study performed by Lewis et al. which found that both bonobos and chimpanzees preferred to look at the familiar individual of the dominant sex [9]. The Lewis et al. study differed from the current study in its methodology and bonobos tested. This strengthens the findings that the familiar female is more attended to than any other group because it shows the consistency of the finding regardless of variations in image medium, individuals observed, time interval used, and data collection method.

As for the control trials, subjects showed a preference for looking at familiar control images as opposed to unfamiliar ones (as seen in Figure 2). This indicates that the subjects could tell a difference between the images, and follows the same trend seen in the conspecific data.

Despite efforts to control outside influences, there were some limitations to this research. The first and foremost limitation is the small sample size. This is a persistent issue throughout animal behavior and is especially challenging when studying an endangered species such as bonobos. A larger sample size outside of the individuals at the Ape Initiative could provide more validity to the findings. Coding subjectivity is another limitation. The gaze of the subjects was followed and timed by the experimenters, meaning that it was exposed to human error. To limit its effect on this research a second researcher was used to confirm the findings of the main researcher. While this research aims to understand the social attention of bonobos through image preference, it does not account for other influencing factors such as personal relationship with the imaged familiar individual and differences in differences between the societal structure of wild and captive bonobos.

Future research can be conducted to determine whether humans and chimpanzees follow the same trends seen with bonobos. Since bonobos are one of humans' two closest living relatives, the results of this study could help to predict how humans will react to a similar task, as well as determine where social attention evolved in humans. The procedure could be modeled off the one presented here, with the only difference being the species of the subject tested. Other less closely related primates such as gorillas, orangutans, and old-world monkeys can be studied to gain insight into the evolutionary roots of this trend in social attention, and whether other apes show the same preference. Eye-tracking technologies can be used to get more qualitative data. This is a common practice in bonobos and humans and can increase the credibility of the findings [9], [12].

As animals are going extinct at the highest rate in documented human history, it is increasingly important to study animal behavior [13]. This is especially true for endangered species such as bonobos, who are less studied compared to other apes such as chimpanzees. There needs to be more research documenting the behavior and interactions of animals in order to ensure that humans are able to protect them, even if that means creating artificial habitats in which they can thrive. This holds true for other conservation efforts such as captive ape breeding programs. For conservation efforts such as breeding, the compatibility of two individuals needs to be guaranteed before they are introduced to prevent the potential for any conflict. Even seemingly minute details such as the increased social awareness in bonobos are likely to have an effect on how they interact with their environment and other individuals. Ethology and the study of bonobos and other animal behavior is essential in order to prevent the continuation of mass biodiversity loss and ensure the health of animals, people, and the environment.

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REFERENCES

1. C. B. Stanford, The social behavior of chimpanzees AND Bonobos: Empirical evidence and shifting assumptions. *Current Anthropology*. **39** (4), 99–420 (1998).
2. A. R. Parish, Female relationships in bonobos (*Pan paniscus*). *Human Nature*. **7**, 61–96 (1996).
3. F. B. Waal, Bonobo Sex and society. *Scientific American*. **272** (3), 82–88 (1995).
4. S. Nolte, J. Call, Targeted helping and cooperation in zoo-living chimpanzees and bonobos. *Royal Society Open Science*. **8** (3), (2021).
5. F. Kano, S. Hirata, J. Call, Social attention in the two species Of pan: BONOBOS make more eye contact than chimpanzees. *PLOS ONE*. **10**(6) (2015).

6. J. K. Rilling, J. Scholz, T. M. Preuss, M. F. Glasser, B. K. Errangi, T. E. Behrens. Differences between chimpanzees and bonobos in neural systems supporting social cognition. *Social Cognitive and Affective Neuroscience*. **7** (4), 369–379 (2011).
7. J. C. Mitani, D. P. Watts, Jeremiah S. L. Ecological and social correlates of chimpanzee party size and composition. *Behavioural Diversity in Chimpanzees and Bonobos*. 102–111 (2002).
8. B. Hare, V. Wobber, R. Wrangham, The self-domestication hypothesis: Evolution of bonobopsychology is due to selection against aggression. *Animal Behaviour*. **83** (3), 573–585 (2012).
9. L. S. Lewis, F. Kanoc, J. M. G. Stevens, J. G. DuBois, J. Call, C. Krupenye, Bonobos and chimpanzees preferentially attend to familiar members of the dominant sex. *Animal Behaviour*. **177**, 193–206, (2021).
10. R. Dukas, Causes and Consequences of Limited Attention. *Brain, Behavior and Evolution*. **63**, 197–210 (2004).
11. P. Dietze, E. D. Knowles, Social class and the motivational relevance of other human beings. *Psychological Science*. **27** (11), 1517–1527 (2016).
12. M. L. Mele, S. Federici, Gaze and eye-tracking solutions for Psychological Research. *Cognitive Processing*. **13** (1), 261–265 (2012).
13. N. E. Stork, Re-assessing current extinction rates. *Biodiversity and Conservation*. **19** (2), 357–371 (2009).



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