Pant hoot development in male juvenile chimpanzees (*Pan troglodytes*)

Master thesis

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Abstract

The pant hoot, the long-distance call of chimpanzees, is an important feature of their vocal repertoire. Previous studies have already addressed the acoustic structure, potential functions and correlations with other behaviours in adult males. Yet, little is known about the pant hoot in young individuals. This study aims to investigate the development of pant hooting behaviour in young male chimpanzees. Reactions of the subjects to adult pant hoots were observed in order to identify which relevant caller features, such as sex or rank, were triggering responses from young subjects, such as increase of attention or vocal reactions. Observing reactions to calls allows to better understand which variables of adult calls might be socially relevant for young male chimpanzees to acquire full capability of pant hooting. Data collection occurred in the Sonso community, in Budongo Forest, during six months. The subjects were 7 male chimpanzees, aged between 5 and 21 years old. Results showed that neither sex nor rank of the pant hoot initiator were factors that could explain attention from young males. However, subjects tended to be more attentive to male than female pant hoots and higher than lower ranking males. Regarding vocal reactions, subjects joined adult pant hoots indiscriminately of the sex of the pant hoot initiator, but joined high-ranking males significantly more often than low-ranking ones. Taken together, these findings suggest that young males are starting to distinguish adult calls and learn how to respond strategically to them.

Introduction

Pant hoots in adult individuals

The pant hoot is the long-distance call of chimpanzees; adult male chimpanzees produce them commonly (Goodall 1986). Adult male pant hoots are very structured with specific and ordered acoustic units that are similar across individuals. A pant hoot includes a sequence of four distinct phases: introduction, build-up, climax, and let-down. Each phase can contain the repetition of a single element which is the smallest constituent unit defining this phase; the repetition of this unit constitutes then the phase (see Fig. 1; Marler and Hobbett 1975).

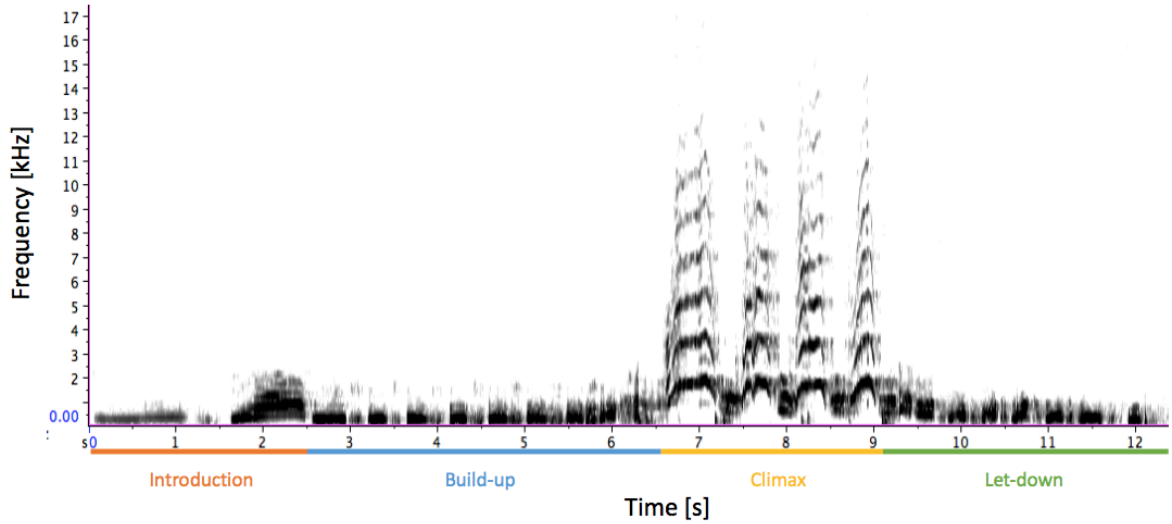

Figure 1. Example of call sequences of a pant hoot (courtesy of Pawel Fedurek)

Regarding the function of pant hoots, Fedurek et al. (2014) demonstrated that the male pant hoot is "…positively correlated with the rank of the caller, the presence of parous females in estrus, and the consumption of high-quality food"; thus, the pant hoot seems to convey social cues such as status. Furthermore, Fedurek et al. (2014) concluded that adult male pant hoot production was related to movements of parties. Chimpanzees live in a fission-fusion society, meaning that their community often separates (fission) into smaller parties that can reunite during the day (fusion) (Kummer 1968). Indeed, females and males tend to live apart, especially in East-African chimpanzees (Wrangham 2002). It is common for them to sleep in mixed groups and reunite during the day on the same feeding tree, but it is also common for females to wander alone, with other females or, for mothers, with their dependent offspring. Whereas males spend more time together (Wrangham 2002); they sometimes "patrol", meaning that they move silently in group along the borders of their home-range (Goodall 1986; Gilby and Wrangham 2008). Fedurek et al. (2014) also showed that more pant hoot calls occurred prior to fusion of two male parties, suggesting that pant hooting somehow function to coordinate and cooperate between individuals, by displaying identities and status.

For females, it has been argued that they also produce pant hoots, mainly because the acoustic structure of female long-distance calls is different. Moreover, there is no systematic documentation of female long-distance calls in the literature and adult female "pant hoots"

have not been studied in terms of their acoustic structure and compared to those of the adult males. Anecdotal observations suggest that females often change the order of the strict sequence seen in males. For example, female can start with climax elements and continue with build-up elements (Cat Hobaiter, personal communication).

Pant hoots in young individuals

From five years old onwards, young individuals start to "explore" the daily social life and activities of their communities. As Pusey (1990, p. 203) puts it: "Over this period, the initially playful juvenile, dependent on its mother, establishes itself as an independently functioning individual capable of sex-specific adult behaviour, either in its natal social group or in a new group". Young males start to try to associate more often with other adult males, although it is difficult to persuade the mother to stay around while doing so (Pusey 1983; Watts & Pusey 1993; personal observations). Furthermore, the frequency of pant hooting increases with age in young chimpanzees (Pusey 1990). Thus, by hearing and producing more and more pant hoots, pant hoots become more and more a relevant feature of their social life.

In a general way, male young chimpanzees also produce vocalizations and participate in social activities with adults and infants of the community (Goodall 1986). Due to lack of research focused on young adult male pant hoots, the pant hoot of young males is not yet well described, unlike that of adult males. Strübin (2016) investigated pant hoots in young adult males (16-20 years old) and sub-adult males (10-15 years old). He found that young adult and sub-adult males also conveyed individuality in their calls, like adult males (Mitani et al. 1996) through features such as identity and age. Moreover, Strübin (2016) showed that the climax phase is more similar between socially affiliated than non-affiliated individuals, which suggests that some social learning is taking place.

Nevertheless, young individuals do not yet pant hoot fully like adults, since their age shapes their pant hoot (Strübin 2016): young adults' pant hoots are not as consistent as their elders'. Young individuals still develop their call, in order to optimize it and perform it fully. They have to learn for example how to optimize their pant hoot acoustically, when it is appropriate to pant hoot, and what to conclude from a heard pant hoot (information such as the caller's identity, age and sex, quality of food, parous females in oestrus, social affiliations).

Aims of this study

This study aims to address the development of chimpanzee pant hoot behaviour, in order to further understand its function, but also to investigate if social learning plays an important part in the acquisition of chimpanzees' vocalizations.

Unlike Strübin (2016), this study does not aim to describe the pant hoot acoustics of young males, but to describe the behaviour of young chimpanzees in response to the calls of elders, a new perspective in understanding the acquisition of pant hoots. I collected data on

my subjects' reactions to calls to better understand which variables of adult calls might be socially relevant to young male chimpanzees.

Hypotheses

In this study, I tested the hypotheses (1) whether male juveniles are more attentive to male or female calls, (2) whether they are more attentive to high than a low ranking male, (3) whether they are more likely to join a male or female pant hoot, and (4) whether they are more likely to join high than a low ranking male.

The two first hypotheses address the attention of my subjects to elders. If the pant hoot is a socially acquired behaviour, younger individuals are expected to pay attention to elders, in order to learn this behaviour. The third and fourth hypotheses allow to address the question with whom young individuals want to affiliate.

For hypothesis (1), if they pay more attention to female calls, this would suggest that male activities are not important for them yet and that they are mainly interested in female activities. Whereas, if they pay more attention to male calls, this would suggest interest in male activities and disinterest for female activities.

For hypothesis (2), pant hoot transmits information such as status (Fedurek et al. 2014). Therefore, young males have the possibility to decipher the rank of the individual. Furthermore, high ranking male chimpanzees are often preferred social partners, for example they are more attractive grooming partners (Watts 2000) or they can offer more efficient support during agonistic interactions (Slocombe & Zuberbühler 2007). Therefore, paying attention to their calls could help young individuals to strategically associate with such preferred partners.

For hypothesis (3), if my subjects join more their mother or other females, it would suggest they tend to stay socially in the female group, whereas, if they join more the males, they are already trying to integrate the male group. Indeed, Fedurek et al. (2013) showed that adult males prefer to chorus with long-term social partners or with a neutral individual, when the preferred partner is not around. They concluded that the pant hoot is a way of displaying short-term social affiliations: "For example, males were more likely to be involved in reciprocated grooming, coalitionary support and joint nonvocal displays on days when they chorused than on days when they did not." (Fedurek et al. 2013).

For hypothesis (4), in addition to the previous argument, Fedurek et al. (2013) also reported that the rank difference was not relevant in the likelihood of another individual joining the call. This means that low ranking individuals (which is the closest category young male individuals could be assigned to) can join high ranking individuals, regardless of their status. This implies that joining a higher ranking call is not costly for young individuals and they are free to choose whom to join. Therefore, if young males choose higher over lower ranking calls, this would imply first a capacity to recognize adult male ranks and secondly a preference for potential affiliation with high ranking individuals.

Methods

Study site

The data collection for this study took place in the Budongo Conservation Field Station in Uganda between August 2016 and January 2017. The Budongo Forest Reserve covers 792 km^2; 428 km^2 is moist semi-evergreen tropical forest (Newton-Fisher 2003).

The community studied was the Sonso community. Its home range is approximately 7km^2 (Newton-Fisher 2003). The community is well habituated; habituation started in 1990 (Reynolds 2005) and the community has been regularly studied since then. At the beginning of my study, the community consisted of 64 individuals. Following the definitions of Reynolds (2005), there were 23 female adults, 10 male adults; 3 male sub-adults, 4 female sub-adults; 3 male juveniles, 11 female juveniles; 8 male infants, 2 female infants. During the study, two infants were born.

The Ugandan Wildlife Authority and the Ugandan National Council for Science and Technology granted the permission for conducting this study.

Sample size

My main subjects were initially young males: the three juvenile males, Jacob (JB) (born in 2011), Mbotella (MB) (born in 2009), Klauce (KC) (born in 2006) who fell into the sub-adult category during my data collection, and the youngest sub-adult male James (JS) (born in 2006), who had just turned to this category. Later on in the study, I included the male sub-adults Kasigwa (KS) (born in 2003) and Zed (ZD) (born in 2001), and the male adult Kwezi (KZ) (born in 1995). I chose to include these three last subjects because Kasigwa and Kwezi were still associating a lot with their respective mothers, whereas Zed had lost his mother when he was 6 years old and ended up in the care of his older brother Zalu.

Data collection

Data were collected over 56 observation days. Following Fedurek et al. (2013), I followed a focal animal during the day, between 8 am to 4 pm. I recorded all data in a notebook and transferred them in a Microsoft Excel document daily. I recorded pant hoot vocalisations of my subjects with a Marantz solidstate recorder and a Sennheiser ME67 directional microphone. I included calls in a database if I was sure of the caller's identity.

Following my subjects, I took continuous behavioural samples, about their positions, their behaviour, their reactions and party composition. I reported these occurrences in my behavioural samples, specifying who I or my field assistant saw/heard joining the call to form a duet or a chorus.

As mentioned above, in this study, I tested whether male juveniles

(1) were more attentive to male or female calls
(2) were more attentive to high than low ranking males
(3) were more likely to join male or female pant hoots
(4) were more likely to join high than low ranking males

Whenever possible, I reported the identity of the call initiator and, if this was impossible, I reported "N/A".

To test hypotheses (1) and (2), I observed and reported the reactions of my focal to all pant hoots occurring while I was following him. I noted in binary (1 when doing it, 0 when not doing it) whether they were attentive or not. I considered my focal as attentive, when they stopped their current activity (like grooming, feeding, or resting) and looked somewhere else than where they were looking right before (towards the source of the call or to a partner).

To test hypotheses (3) and (4), I observed and reported the reactions of my focal to all the pant hoots occurring while I was following him. I noted in binary (1 when doing it, 0 when not doing it) whether they were joining the call or not with any type of vocalization (mainly pant hoots, pant grunts, food grunts). In the end, responses were almost always pant hoots with only very few exceptions, like pant grunts. For the analyses, I did not consider the calls initiated by my subjects.

I also had a category "No reaction" in which I noted in binary (1 not reacting, 0 when reacting). This served as a cross-check for the categories mentioned above.

It happened that it was impossible to decipher the reaction of my focal, because he was not in sight; in those cases, I reported "N/A".

For hypotheses (2) and (4), females call initiators are then not considered, because only the male hierarchy was considered, since my subjects are males and are supposed to set themselves into the male group.

Statistical analyses

I stored my data on an Excel file. For the behavioural analyses, I used the software R (Version 3.2.2).

For hypothesis (1), I used a generalized linear mixed model, GLMM, (Bates et al. 2015) with binomial distribution. The sex of the call initiator was set as fixed effect, while my subjects' ID and the initiator ID were set as random factors, in order to account for pseudo-replication (same individual for different recorded measures).

For hypothesis (2), I used a generalized linear mixed model, GLMM, (Bates et al. 2015) with binomial distribution. The numerical rank of the call initiator was set as fixed effect, while my subjects' ID was set as the random factor, in order to account for pseudo-replication (same individual for different recorded measures). Ordinal rank could not be used with GLMM, because Zefa ZF (ranked 9^{th}) leads a perfect separation (100% of my subjects being

attentive to him). I then ran another test to further explore the results. Here, I used a GLMM with rank (fixed effect) as categorical variable (see Table 1) and subjects' ID as random effect, in order to account for pseudo-replication (same individual for different recorded measures).

For hypothesis (3), I used a generalized linear mixed model, GLMM, (Bates et al. 2015) with binomial distribution. The sex of the call initiator was set as fixed effect, while my subjects' ID and the initiator ID were set as random factors, in order to account for pseudo-replication (same individual for different recorded measures).

For hypothesis (4), I used a generalized linear mixed model, GLMM, (Bates et al. 2015) with binomial distribution. The numerical rank of the call initiator was set as fixed effect, while my subjects' ID was set as the random factor, in order to account for pseudo-replication (same individual for different recorded measures). Ordinal rank could not be used with GLMM, because Pascal PS (ranked 8^{th}) leads to a perfect separation (0% of my subjects joining him). We used Nakagawa & Schielzeth (2013) pseudo R^2 to explore the effect size for the variable rank on the likelihood to join calls. To further explore the data, we ran another GLMM with rank (fixed effect) as categorical variable (see Table 1) and subject ID as random effect, in order to account for pseudo-replication (same individual for different recorded measures).

As mentioned above, for hypotheses (2) and (4), females call initiators were excluded from the analyses. For hypotheses (2) and (4), we excluded Simon (SM) (ranked 5^{th}) and Zalu (ZL) (ranked 9^{th}), because they were only represented with three calls in the data set.

For all hypotheses, a brief analysis of residuals was performed: no outliers, and no departure from the normality of the random effects were noticed. We also checked visually that the residuals are not correlated for a given focal ("acf" function).

Male ranking data

Jakob Villioth (unpublished data), who collected data on aggressions between October 2015 and June 2016, kindly shared his results for the male ranks, obtained through Elo-rating test (Neumann et al. 2011).

At the beginning of my data collection, in August 2016, two individuals, Nick (NK) and Zig (ZG), had definitely disappeared; thus, they were removed from the ranking data for this study.

Furthermore, Zed (ZD), who occupied the last rank, was also removed, because there was no exploitable call of him.

Finally, Kwezi (KZ) (ranked 10^{th}) was both a subject and a call initiator. Thus, he could not react to his own calls. In the statistics analyses, he was set random as a focal, like all other individuals; this allowed running the test with him in each role. However, this disadvantaged the results for the rank 10, that he occupies.

Sample size

For hypothesis (1), 24 female calls and 137 male calls were exploitable. For hypothesis (3), 25 female calls and 140 male calls were exploitable. See Table 1 for sample size of hypotheses (2) and (4).

Table 1. Adult male ranks and sample size for hypotheses (2) and (4)

Rank	Rank category	Name	Abbreviation	Hypothesis (2)	Hypothesis (4)
1	High	Hawa	HW	23	24
2	High	Musa	MS	18	19
3	High	Frank	FK	13	13
4	Mid	Kato	KT	13	13
5	Mid	Simon	SM	3	3
6	Mid	Squibs	SQ	8	8
7	Mid	Zefa	ZF	10	10
8	Low	Pascal	PS	17	17
9	Low	Zalu	ZL	3	3
10	Low	Kwezi	KZ	19	19

Overview of the males' ranks and rank categories (data from Jakob Villioth, unpublished data) combined with the sample size of exploitable calls per male for hypothesis (2) and (4).

Results

Are male juveniles more attentive to male or female calls?

Young males were a little bit more attentive to male initiators (64.23%; n=137) than female ones (56.52%; n=24) but this difference is not significant (GLMM; Z= 0.807; p = 0.420) (see Fig. 2).

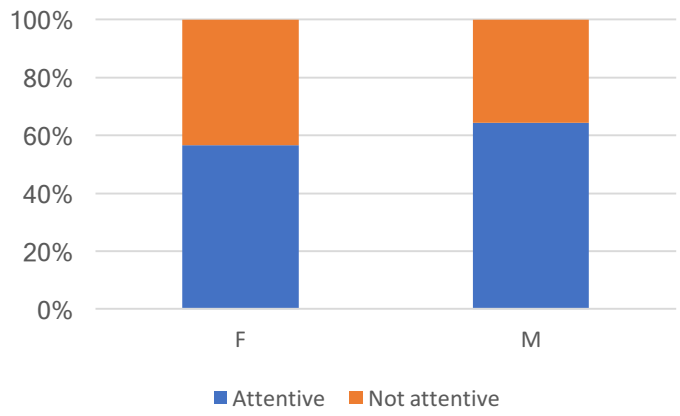

Figure 2. Comparison of young males' attention to male (M) and female (F) calls.

Are male juveniles more attentive to high than low ranking males?

Results showed a slight tendency of subjects to pay more attention to higher than lower ranked males; but this tendency was not significant (GLMM: Z= 0.872; p=0.384; see Fig. 3). In a second model, I entered rank as categorical variable but there was no significant effect either (analysis of deviance: Chisq= 4.391, d.f. = 2, p = 0.111; see Fig. 4).

There was only one male to whom subjects always paid attention: Zefa (ZF) (ranked 7th). I collected 10 calls from Zefa. James (JM) was attentive to Zefa 4 times out of 4 calls; Klauce (KC) 2 out of 2; Kasigwa (KS) 1 out 1; Mbotella (MB) 3 out of 3.

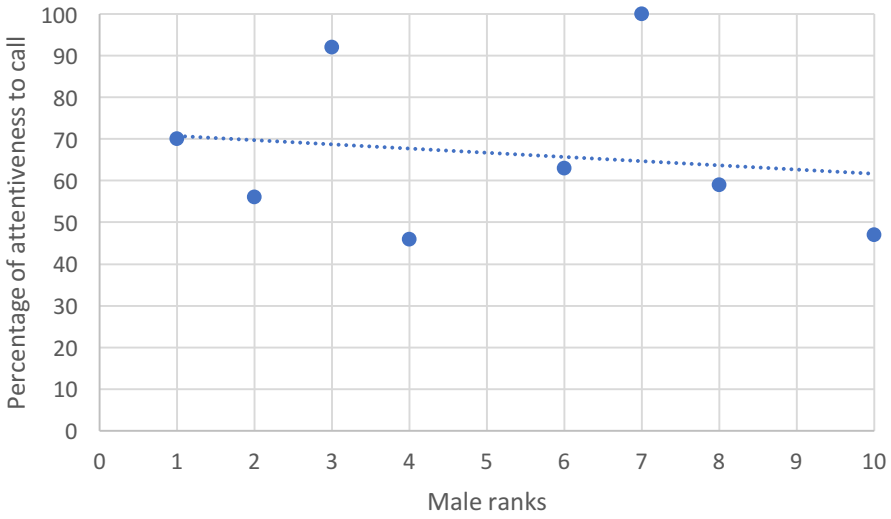

Figure 3. Young males' attention to adult male calls according to rank.

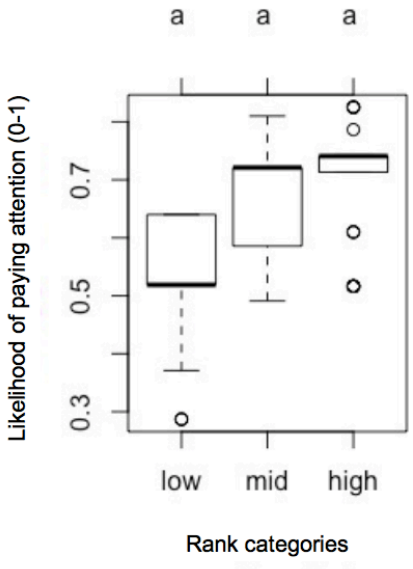

Figure 4. Likelihood of young males' attention to adult male calls according to rank categories.

Are male juveniles more likely to join male or female pant hoots?

Subjects joined indifferently of the call initiator's sex: they joined females 24% of the total number of calls (n=25) and males 24.29% (n=140) (see Fig. 5).

The difference of attention between male and female callers was not significant (GLMM; Z= 0.070; p=0.945; see Fig. 4).

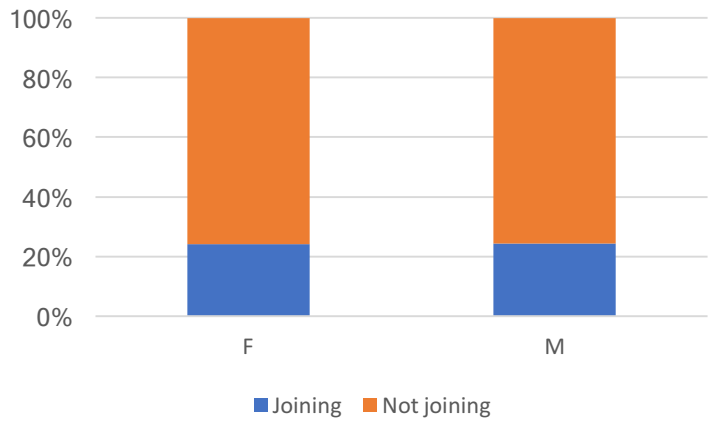

Figure 5. Comparison of young males joining male and female calls.

Are male juveniles more likely to join high than low ranking males?

Subjects joined higher ranking males significantly more often than lower ranking ones (GLMM: Z= -2.235; p-= 0.026; see Fig. 6), but effect size was rather small (pseudo-R-squared: marginal 0.1005920, conditional 0.1998992; a medium effect size corresponds to R-squared between 0.13 and 0.26). If ranks were entered as categorical variables (see Table 1), differences remained significant (analysis of deviance: Chisq= 8.1523, d.f. = 2, p = 0.017). Post-hoc Tukey-like analysis revealed a significant difference between low and high ranked callers (adjusted p-values): low vs. mid: Z = 1.424; p = 0.3234; low vs. high: Z = 2.745; p = 0.0161; mid vs. high: Z = 1.444; p = 0.3136 (see Fig. 7).

There was only one male to whom subjects never paid attention: Pascal (PS) (ranked 8th). I collected 17 calls from Pascal. James (JM) was attentive to Pascal 0 out times out of 11 calls; Klauce (KC) 0 out of 4; Kwezi (KZ) 0 out 1; Zed (ZD) 0 out of 1.

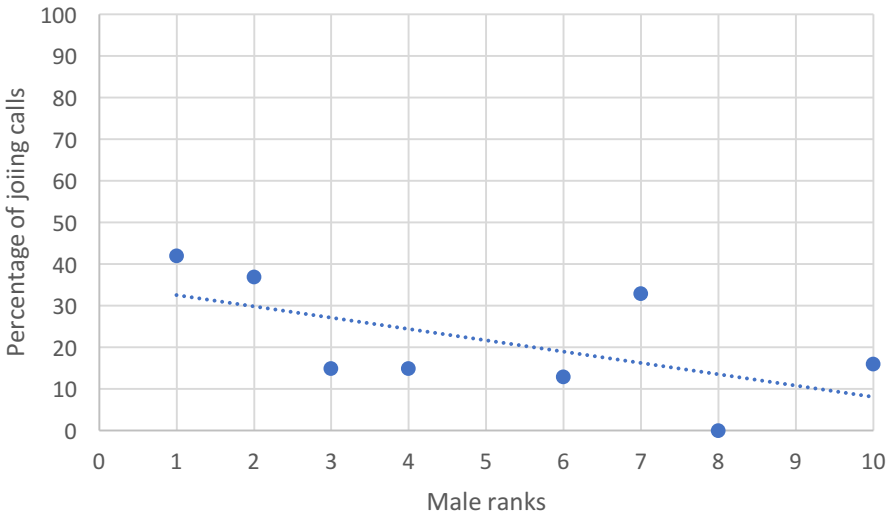

Figure 6. Young males joining adult male calls according to rank.

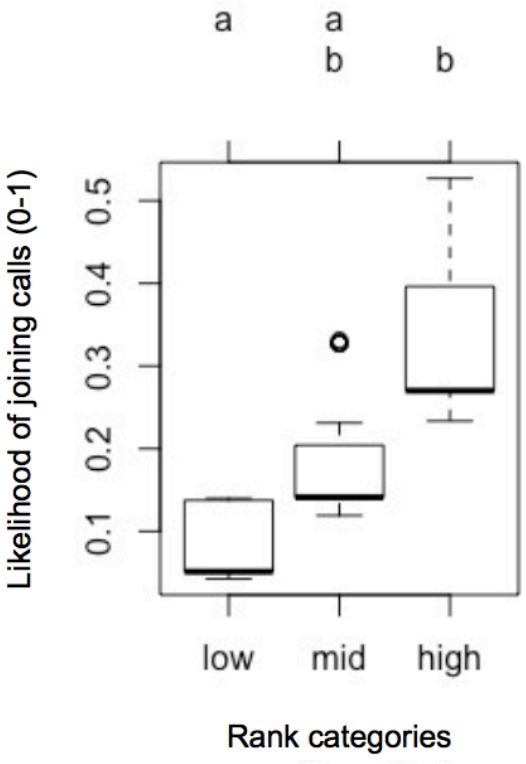

Figure 7. Likelihood of young males joining adult male calls according to rank categories.

Discussion

This study revealed that young male chimpanzees showed no sex-specific difference in paying attention or joining calls of adult individuals. However, adult male rank had an effect on the likelihood of young males joining calls.

Are male juveniles more attentive to male than female calls?

First, the results showed that my subjects were attentive to the pant hoot of their elders. They were attentive to more than half of the calls they were exposed to. Paying attention is a precondition to social learning. For example, Tomasello et al. (1987) showed that young individuals learned tool use by observing an adult using the tool. They concluded that this might be due to social acquisition: young individuals needed among other things to be attentive to the adults to learn. Applying the same reasoning to the pant hoot, my subjects need to be attentive to their elders to learn. Nevertheless, it would be interesting to compare the percentage of subjects' attention with the behaviour of male infants to see if there was actually an increase in the attention parameter between infant and juvenile/sub-adult ages. It is possible that attention to pant hoots does not change.

Secondly, the results showed that the sex of the caller was not important for my subjects to select which calls to be attentive to; it means the sex of the caller was not particularly relevant for my subjects. On the one hand, this conclusion can imply that juvenile chimpanzees need to learn vocalizations from both females and males. This could be explained by the fact that chimpanzees of this age spend a lot of time with females, their mother and her social partners, but they will later integrate the males' group (Goodall 1986). Therefore, listening to the females' calls has direct impacts on the juveniles in their current daily life. But they tend to leave their mothers to integrate into the male group (Pusey 1990; Pereira and Fairbanks 1993), meaning that male vocalizations get more and more relevant for them. On the other hand, these results are consistent with another conclusion: scientists commonly assume that male adults pay less attention to female than male pant hoots. Nevertheless, no scientific work has been conducted yet to confirm this. It is possible that even adult males pay attention to pant hoot indifferently of the sex of the caller, similar to the results found in this study.

It is relevant here to link these first observations about sex difference with the results of the second question. Results from the second question showed that my subjects always paid attention to Zefa, who is the father of at least two of my subjects. It would be interesting to investigate upon an effect of maternal kinship in the attention of my subject and if this level of attention varies in relation to her presence or absence within the subject's party. However, my sample size is too small to deduct anything about that (only 5 occurrences during which my focals were present to their mother's call).

Are male juveniles more attentive to high than low ranking males?

I found a slight tendency for juvenile males to pay more attention to higher than lower ranking males but the difference was not statistically significant, neither for individual nor for categorical ranks.

This suggests that differences in ranks, like the sex difference, does not trigger greater attention towards pant hoots. This means that, after this study, it is still not clear how young male chimpanzees discriminate between pant hoots. This might be due to restrictions such as my small sample size or the duration of the data collection. Further investigations are needed.

However, one could argue that this lack of discrimination between ranks comes from the fact that being attentive to both calls of higher ranking males and of lower ranking males is relevant for subjects. Higher ranking males might actually not always be preferred. For example, in the feeding context, it might be beneficial to associate with lower ranking males, who would not displace young individuals as easily (Vogel 2005). While, as explained above, paying attention to high ranking individuals is interesting for young males in order to integrate the adult male group efficiently (Pusey 1983; Pusey 1990).

Zefa's results stand out. My subjects always paid attention when the caller was Zefa (ZF) (ranked 7th), who has been confirmed to be the father of at least two of my subjects (Klauce and James). Kasigwa's father is not Zefa, but Bwoba (BB) dead in 2009. Mbotella's father is still unknown, but Zefa might well be the father. Chimpanzees might be able to deduct relatedness through a combination of physical features, such as facial resemblance (Parr & de Waal 1999) and patterns of association (Parr et al. 2010); therefore, James and Klauce might be aware of their kinship with Zefa. In many primate species, grooming and agonistic support are more often directed towards kin (Silk 2002; Shino 2006). Thus, it would be a strategic advantage to know the location of their father through pant hoot.

An alternative explanation could be related to Zefa's age. Zefa was the single oldest male in the community at the time of the data collection (34 years old; on average 10 years older than all other adult males). Due to this age, he might have superior knowledge of, for example, food source within the home range. Therefore, it would also be a strategic advantage to pay attention to his calls.

Are male juveniles more likely to join male or female pant hoots?

The results showed that the sex of the caller did not determine whom subjects decided to join. The sex of the caller did not have any effect on the likelihood that my subjects join a call: they joined males and females to the same extent (24% of all calls, for both sexes).

It was predicted that my subjects joined individuals of the sex that is the most relevant for them. Since they joined both sexes indiscriminately, it is not possible to draw any conclusion on this. Nevertheless, this result is quite surprising when related to the fourth hypothesis of this study, which is discussed below.

Since the sex of the initiator is not a predictor, it would be interesting to investigate other variables triggering my subjects to join a call: whether the mother is absent or present, whether high-quality and/or abundant food is available, whether the individual that they join is within the party or how far he/she is.

Overall, my subjects show a preference for not joining the calls, no matter who initiates (24% of joining VS 76% of remaining silent). According to Fedurek et al. (2017), pant hooting is energetically costly for chimpanzees; this might explain this high percentage of silence.

Stealth could be another explanation. On one hand, Fedurek et al. (2014) showed that fission-fusion parameter was relevant for pant hooting and mentioned the cost of fusion between two parties. For example, fights can sometimes occur (Nishida et al. 1999). On another hand, females might also want to keep their food resource hidden from the males (Reynolds and Reynolds 1965). However, the theory that pant hoot attracts conspecifics to food source has not been yet clearly confirmed, although pant hooting is related to the quality of the food consumed (Fedurek et al. 2014). Since young chimpanzees, and especially juvenile ones, spend a lot of time with their mother, they might actually rely on their mother to decide whether it is beneficial to give the opportunity to other parties to fuse with them: the mother would maybe want to avoid conflict or keep the food source for herself and offspring. Therefore, remaining silent would be an advantage, because younger chimpanzees would avoid signalling their position to "unwelcomed guests", while their mother know who to avoid and who to fuse with.

Are male juveniles more likely to join high ranking male individual rather than low?

The results showed that my subjects are selective in joining adult male calls in regard to their rank. They prefer to join high ranking males over lower ones.

We saw above for hypothesis (2) that my subjects were not sensitive to the ranks in their attention, unlike hypothesis (4). This leads to different insights.

First, paying attention and joining a call are clearly distinct. Overall, my subjects were attentive in more cases than they were joining. Being attentive did not necessarily mean that they would also join the calls. They are distinctive functions. Being attentive is a way of retrieving information, while joining is a way to signal to others.

Hence, this suggests that my subjects might use pant hoot strategically. As they acquire information about their environment listening to pant hoot, they choose who to join in their calls. Fedurek et al. (2013) concluded that the male pant hoot allows males to display their short-term social bonds; this could be the case for younger males as well. By pant hooting with an individual, my subject could show him his intention of cooperating with him, but also show to other individuals around his intention of cooperating with this individual (Fedurek et al. 2013). My subjects might then aim to ally with higher ranking males, who are socially preferred partners (Watts 2000; Slocombe & Zuberbühler 2007).

However, this result is surprising when related to the third hypothesis, which showed that they join indistinctly males and females. If young males find advantage in joining high ranking males for the reason explained above, what is then their advantage in joining females to the same extent as males?

Finally, this result is interesting in respect to the cognitive abilities of my subjects. At this age, my subjects already seem to have at least a notion of male hierarchy, i.d. that some males are politically more powerful than others, since they distinguish between males of different ranks. So far, few studies of free ranging chimpanzees have address the development of cognitive abilities (Wobber et al. 2014). This result offers potential hints for further investigations about young chimpanzees' cognitive abilities.

Potential shortcoming of the study

The data collection took place during only six months, while its subject is about the development of young chimpanzees. Chimpanzees grow over a period of 20 years (Pusey 1990). Therefore, this study can only be a short insight of this development, showing some tendency, rather than conclusive results.

Moreover, the sample size of female calls was very small. Even though the statistical model took that into account, it is not possible to exclude the possibility that the results are due to random effects.

Furthermore, in a general matter, my subjects' sample was quite small and disparate in ages. The small size is due to the short collection time, the field conditions, and the lack of subjects (4 juvenile male chimpanzees in Sonso community). Later during the data collection, I chose to include two sub-adult males and one adult male for the reasons explained above, which led to a motley sample.

Finally, concerning the sample of adult male calls, there were only three exploitable calls for each Simon and Zalu. This ended up into eliminating these two from the analyses of hypotheses (2) and (4), restricting statistical power even further. Moreover, since two of the ranks were missing, the results are less meaningful and reliable.

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