**Theoretical Introduction & Research Question**

*Theoretical Introduction*

Acquiring a broad range of feeding techniques (e.g. recognizing different food items and differentiating the edible ones from those that are not) is one of the most important skills an immature orangutan must acquire before reaching adulthood. Studies have shown that wild orangutans eat more than 200 different food items (Bastian, Zweifel, Vogel, Wich, & van Schaik, 2010; Vogel et al., 2014). Two other studies by Schuppli et al., (2016) and Jäggi, Van Noordwijk, & Van Schaik (2008) proposed that these food items differ in terms of their required processing techniques and their availability in the populations’ habitat. These facts elevated the difficulty of this survival game. An important question is, how do immature orangutans acquire those skills and knowledge? Up until the age of weaning (at age of 8), an immature orangutan spends most of the time with its mother and much less time with other association partners (Jäggi et al., 2008). The two major ways of acquiring feeding skills that have so far been observed in orangutans are peering (sustained, attentive close-range watching of the activities of a conspecific, Schuppli et al., 2016) and begging (the solicitation of food items, Jäggi et al., 2008; Jäggi, van Schaik, Fischer, & Burkart, 2010).

Previous studies have also pointed out the at first sight surprising fact that the orangutan mother usually plays an inactive role in the acquisition of the offspring’s feeding skills, which means that based on the observational data from the previous studies so far, orangutan mothers neither use any form of active teaching nor actively share the food with their offspring (Jäggi et al., 2008; Jäggi, van Schaik, Fischer, & Burkart, 2010). Previous research also stated that teaching of the orangutan mother has been observed neither in the wild nor in captivity (Jäggi et al., 2010). In fact, orangutan mothers either accept the begging of the offspring (i.e. being tolerant by letting their offspring take a food item and showing no objection) or reject it (i.e. being not tolerant by showing aggression towards the begging offspring or keeping the food on her own) (Jäggi et al., 2008). Furthermore, immature orangutans grow up relevantly slowly which means that orangutan mothers may not have next offspring until the current child reach the age of 7-8. But because we expect orangutan mothers to try to maximize their reproductive output, they should invest into their offspring’s skill acquisition, this way, they can reach independence more easily. Yet, unlike humans, orangutan mothers seem way more ignorant and less caring towards this skill acquiring process of their offspring. This is not only very fascinating, but it might also contribute to answering the question why it takes immature orangutans longer than any non-human great ape to reach adulthood.

From the perspective of the immature orangutan, Jäggi and colleagues (2008) discovered that there is a negative correlation between the begging of the immature focal subject and its age, a negative association between the feeding competence of the immature orangutan and the occurrence of the begging, and a positive correlation of the complexity of the food item and the begging behavior of the immature orangutan. However, besides the seemingly passive role of the orangutan mother, it is not known if so, then to what extent orangutan mothers adjust their tolerance during begging and what factors affect the mother’s tolerance during the begging behavior. Thus, the novelty of this study is to discover the orangutan mother’s role in the acquisition of their offspring’s feeding skills.

*Research Question*

What is the role of the mother in feeding skill acquisition in immature Sumatran orangutans? I aim to investigate this by elucidating what factors affect the mother’s tolerance during the begging of her offspring?

**Research Hypotheses**

My dependent measure is the orangutan mother’s tolerance (i.e. whether the mother lets the begging offspring take the food item or not), which is a binomial outcome in our data set. In this study, I have six main predictors. First, I hypothesize that as the immature orangutan grows older, the mother shows less tolerance during begging. This prediction is based on the Parent-Offspring Conflict (POC) theory by Trivers (1974) in which he argues that the older the offspring is, the more competent it will be, and thus it needs less parental support, and at the same time, the more sense it makes for the mother to reduce her investment, so that she can get energetically ready for having the next baby. Hence, I expect more conflicts when older immatures beg for food from their mothers and that the mother will be more likely to reject her offspring’s begging, whereas shows higher tolerance towards a younger offspring’s begging.

Secondly, I assume that the more advanced the feeding competence of the offspring is for a given food item, the less likely the mother accepts its begging for this specific food item. I will approximate immature orangutan’s feeding competence by measuring how long it takes it to process a food item (from holding it to swallowing it), in percentage of the mothers feeding speed. This measure has been established in a study by Schuppli et al., (2016), which examined the development of immature orangutans’ feeding competence in two different populations. The negative association between the feeding speed and the mother’s tolerance we anticipate is once again based on Trivers’ POC theory (1974), which suggests that as an offspring develops increasingly advanced feeding skills, the mother’s support of the offspring should become less. This implies that if an immature orangutan with good-enough foraging skills begs food from its mother, the mother would be reluctant to share the food with it.

Thirdly, I expect that the more effort (in terms of processing intensity) it takes the immature orangutan to acquire a certain food item, the more tolerant the mother is when the offspring solicitates the food item from her. In a previous study it was shown that more complex food items require higher skill level and that competence is in more complex food reached later (Schuppli et al., 2016). Thus, I expect that the mother will be more tolerant when the offspring is begging for a food item which requires a higher level of feeding skills, especially if those are beyond the offspring’s foraging skills. Noteworthily, the measure of complexity of a food is derived from the number of steps it takes a subject to process the food item, which is also adapted from the measure from Schuppli et al., (2016).

Furthermore, I predict that the rarer the food item is, the higher the tolerance of the orangutan mother. Falkner in her master’s thesis (2015) stated that there is a negative association between the rarity of the food item and the occurrence of the mother-child conflict. The conclusion about the mother-offspring conflict from her study is drawn from Trivers’ POC theory (1974).

My next hypothesis is that the poorer the physical condition of the immature focal individual is, the more the orangutan mother needs to support it and the more tolerant she will be when sharing food. This assumption is taken from the POC theory, which claims that “the weaker and more vulnerable the offspring is, the more effort is selected from the parent to take care of it.” (Trivers, 1974, p. 257). The way I assess the subject’s physical condition is to compare the length of its arm to the mean of the body size at this age. The method is called Matrix-assisted laser desorption mass spectrometry imaging (i.e. non-invasive laser photogrammetry) proposed by Vens-Cappell et al., (2015), which is used in an observational study with behavioral data on Sumatran and Bornean orangutans’ foraging skills by Schuppli and colleagues (2016).

The final predictor is that the general tolerance of the orangutan mothers in the zoo is higher than that of the mothers in the wild. I believe so because there are more food resources in the zoo than there are in the wild, so that the captive orangutan mother can afford to be more tolerant once the offspring begs the food from her.

**Method (Data Collection)**

The study is observation-based. I will use data that was already collected on wild orangutans in their natural habitat (the Suaq Balimbing Forest (3°42′N, 97°26′E, Aceh Selatan, Indonesia) and additionally collect data on captive orangutans at the Leipzig Zoo (51.349°N 12.369°E, Leipzig, Germany). The observation periods in the Zoo will mostly take place during the feeding periods, as I expect begging to happen around the feedings. I then note down details of all observed begging events with the help of an electronic coding scheme (also video recording when necessary. In terms of the data collected from the wild, I will extract the begging events between the mothers and the offspring from the raw data and enter them into a systematic data set. In the zoo, I also broadly look at the begging between the immature and partners other than the mother to examine if the begging target is mainly the mother among all the possible partners, as I know it is the case in the wild. By now, there have been about 1300 begging events collected from the wild (N=16, age:0-15), no data from the captivity so far but I plan to collect 100 begging events from the zoo (N=2, age: 3-5). The expected number of begging events from the zoo is much smaller and not longitudinal. However, I will compare the zoo data points to data collected on wild orangutans at the same age. This is to test my final hypothesis which is about the difference in begging between the wild and the zoo.

**Planned Analyses**

Because the subjects have been observed repeatedly throughout their development, I will analyze the data by using general linear mixed models with the R programming language (R x64 3.5.2). I will include the individual and the food item as random effects (random intercepts) because they both occur repeatedly in the data set. Because of the longitudinal nature of my data points from the wild, I consider the age variable as an additional random effect (random slope) in my mixed model. In the end, because my dependent variable is a binary outcome (the mother accepts/ refuses), the full mixed model will have a binomial family structure (Field, Miles, & Field, 2012).

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