**How do African Elephants (*Loxodonta Africana*) React to Voice Playbacks of Local Tribes Who Have Been Known to Poach Elephants?**

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Word Count:

Date of Submission:

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**Abstract**

The objective of the abstract is to provide an effective précis of the aims, method and results of your study. This section should be no more than 200 words in length and does not count towards the 6,000 words. You are advised to look at a number of published abstracts from work in an area similar to your project, and use these as models

**Acknowledgements**

* Karen McComb & Lucy Bates
* Lucy King
* Tasmin Humphrey and Graham Hole for statistical advice
* Family and friends for moral support

**Intro (1500)**

**Culture**

**What is culture?**

Investigating the occurrence of culture in non-human animals has been a popular topic over the past few decades as it was originally thought to be exclusive to humans (Galef, 1992; Whiten, et al., 1999). Culture, or also known as traditions, is behavioural information that has been passed down by other beings of the same species through social learning (Boyd & Richerson, 1996; Rendall & Whitehead, 2001; Laland & Janik, 2006). Culturally inherited behaviour has been observed in a number of animals including chimpanzees, birds, and macaques (Whiten, et al., 1999; Laland & Janik, 2006; Laland, 2008). For example, Whiten, et al. (1999) found 24 behavioural variations including, grooming, tool usage and dating behaviours, in Chimpanzees across Africa in a longitudinal study. The differences between behaviours was not found to be due to the different environments, meaning the behaviour must have evolved somewhere along their ancestry line (Whiten, et al., 1999).

Definition being used: The ability to pass down behavioural information and traditions over generations through social learning.

**Can it be seen in animals?**

***Previous research.***Whiten, et al. (1999) -

No hard evidence that there is culture within chimpanzee communities. Only one behaviour was found to vary which was nut-cracking but not the extent that it would be a socially learnt behaviour, exclusive to that specific community.

***Is it applicable to species other than humans?***

Rendall & Whitehead (2001) -

Some evidence of culture seen in cetaceans.

**Elephants**

https://www.elephantvoices.org/elephant-sense-a-sociality-4/elephants-are-socially-complex.html

**Unique social system**

Elephants have a unique social structure where they are able to form close relationships that allows for a deeper connection that almost contend to relationships between humans (Ree, 2012).

**Could culture be found in this social context?**

[2007Hierarchyandsocialorganizationineles.pdf](about:blank)

**Poaching**

**How does it affect the elephant populations?**

**Comparison of Studies**

**Behaviour to fear**

**Current Study**

***What is the aim?***

***How will this be achieved?***

***What are we looking for specifically?***

Is the way elephants respond to potential threats (voice playbacks) culturally influenced?

Comparing elephant fear responses to humans generally across the different populations.

Aim: Consider the pervasiveness of cultural behaviours in elephant interactions.

**Methods**

***Materials***

A total of 28 videos were used to compare behaviours of elephants from two sites in Kenya: 14 videos from Amboseli National Park (McComb, Shannon, Savialel, & Moss, 2014) and 14 videos from Samburu and Buffalo National Reserves (Soltis, et al., 2014). All 14 videos provided by Soltis, et al. (2014) were used but McComb, Shannon, Savialel, & Moss, 2014) provided 28 videos so it was decided to only use 14 of them to make sure there was an equal amount of material for each of the sites. A mixture of seven strong and seven weak samples were taken randomly from the McComb, Shannon, Savialel, & Moss (2014) sample to ensure it was representative of the population.

McComb, Shannon, Savialel, & Moss (2014) also provided a spreadsheet of all the videos coding and the behaviour recording sheets to help corroborate our findings.

**Procedure**

Secondary analysis of data of video footage was used, previously obtained through observational field studies of wild African elephants reacting to voice playbacks of local tribes who are known to attack elephants, Samburu (Soltis, et al., 2014) and Maasai (McComb, Shannon, Savialel, & Moss, 2014). Each video had a playback Excel sheet where observations of behaviours were described, length of occurrence and the appearance of urgency. The reactions to the voice playbacks were focused on the first reactor and the matriarch. If the matriarch was the first reactor then only her behaviour was recorded. If it was not clear who the matriarch was, then only the 1st reactor was recorded. In the rare case where all reactions were not captured at the same time, then a general observation of who is seen first to react was noted. All videos were then coded into a spreadsheet by the definitions provided below and in *Appendix A.* The spreadsheet and behaviour recording sheets provided by McComb, Shannon, Savialel, & Moss (2014) for their videos was used to corroborate results to ensure nothing was missed and the right behaviours were being observed.

**Definitions**

Definitions used to categorise behaviours were taken from McComb, Shannon, Savialel, & Moss, 2014) except for *Foot Raise* which was implemented for this specific study. Specific categories and scales are provided in *Appendix A.*

**Results**

**Analysis**

Multiple hypotheses and tests were run to test if there are cultural differences in elephant’s fear responses to their local human tribe. These hypotheses were chosen by looking at the collected observational data and choosing factors that are most likely to denote fear responses that could be influenced by cultural differences.

**Latency to Retreat**

The first hypothesis looked at the matriarch’s and first reactor’s latency to retreat in response to the playback. A comparison using a Mann-Whitney U test was carried out between matriarchs from Amboseli and Samburu, and between first responders from both populations as the data was non-normally distributed. Matriarch latency to retreat was assumed to take longer in Amboseli (*Mdn* = 18 seconds) than in Samburu (*Mdn* = 11 seconds) but was found to be statistically non-significant, *U* = 21, (*Z* = -.13), *p* = .896, r = -.03.

Meanwhile the first reactor’s latency to retreat was assumed to be quicker in Amboseli (*Mdn* = 9) than in Samburu (*Mdn* = 9) but again, was found to be non-significant, *U* = 17.5 (*Z* = -.27), *p* = .79, r = -.07.

**Retreat**

#### Matriarchs

A chi-square test found whether the matriarch retreated or not was specific to their population*,* Fisher’s Exact: (1) = 6.68, *p* = .018, as were first reactors, Fisher’s Exact:(1) = 6.30, *p* = .033. *Figure 1* shows the comparative differences in number of retreats depending on where they are from.

*Figure 1.* Number of retreats according to the population the responders belonged to.

To consider this further, a comparison of populations was taken depending on if they retreated in the same direction, where the responder was positioned and whether they were running or walking.

A chi-square test was performed to examine the relation between whether the direction of retreat was the same or not in matriarchs according to their native population. The relation found between these variables was significant, Fisher’s Exact: (1) = 11.34, *p* = .001. Significant relations were also found between the responder’s position in retreat and population, *X2* (2) = 12.68, *p* = .002, and between whether they were running or walking and population, *X2* (2) = 12.93, *p* = .002.

#### First Reactors

Similar tests were run for the first reactors in each of the groups. Whether the direction of retreat was the same or not in matriarchs was also found to be significantly different in Amboseli and Samburu, Fisher’s Exact: (1) = 8.02, *p* = .013. This was also the same case for the first responder’s position in retreat, *X2* (2) = 10.22, *p* = .006, and whether they were running or walking, *X2* (2) = 8.39, *p* = .015.

## Behaviours

The third hypotheses chosen was to look at whether the behaviours observed that are denoted to alert behaviours (smelling, head raising, listening, calling and foot raising) varied by population. To do this, we looked at whether the behaviour was exhibited by the matriarch and or the first reactor, then we measured the frequency before, during the playback, in the first 10 seconds of playback and after.

### Listening

#### Matriarchs

Listening occurred in all observed matriarch cases but one, *Storms* from theSamburu population, because it was not clear who the matriarch was. This will be discussed in detail in the discussion. Due to this result, a chi-square test could not be run due to listening being a constant variable. To see if there was a relationship between listening behaviours and the frequency they were observed in relation to the playback, a repeated measures ANOVA was conducted[[1]](#footnote-1).

Mauchley’s test indicated that the assumption of sphericity had been violated, *X2* (2) = 21.83, *p* = .544. The descriptive statistics for the three conditions, *before, 10 seconds* and *after* are displayed in *Table 1.* There was an approaching significant main effect of when the listening behaviour was observed disregarding the differences in populations, *F* (1.09, 14.15) = 3.81, *p* = .068. Although, when population interaction is included, the occurrence of the listening behaviour becomes strongly non-significant, *F* (1.09, 14.15) = 2.18, *p* = .161.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Stimuli** | | **N** | **Mean** | **Std. Deviation** |
| **Before** | Amboseli | 12 | .50 | 1.000 |
|  | Samburu | 3 | 1.00 | 1.732 |
| **10 Seconds** | Amboseli | 12 | 1.25 | .754 |
|  | Samburu | 3 | 1.67 | .577 |
| **After** | Amboseli | 12 | 6.08 | 5.265 |
|  | Samburu | 3 | 2.00 | 1.000 |

*Table 1.* N, mean, and standard deviation for frequency of listening behaviour observed in matriarchs for the three-time conditions, respective of their populations.

#### First Reactors

All first reactors were observed to be listening, making it a constant, so a chi-square was not needed to be performed. To explore the hypothesis further, a repeated measures ANOVA was performed to see when listening behaviours occurred most frequently in relation to playback. All descriptive statistics for the frequency of exhibited listening behaviour during the three, time conditions, before, 10 seconds and after are displayed in *Table 2.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Stimuli** | | **N** | **Mean** | **Std. Deviation** |
| **Before** | Amboseli | 11 | .27 | .647 |
|  | Samburu | 5 | .60 | 1.342 |
| **10 Seconds** | Amboseli | 11 | 1.55 | .688 |
|  | Samburu | 5 | 1.40 | .548 |
| **After** | Amboseli | 11 | 5.64 | 5.801 |
|  | Samburu | 5 | 1.00 | 1.000 |

*Table 2.* N, mean, and standard deviation for frequency of listening behaviour observed in first reactors for the three-time conditions, respective of their populations.

Mauchley’s test indicated that the assumption of sphericity had been violated, *X2* (2) = 27.63, *p* = .532. A non-significant effect was found for when the listening behaviour occurred independently of the populations, *F* (1.06, 14.89) = 3.53, *p* = .078, including when the interaction between populations was considered, *F* (1.06, 14.89) = 3.11, *p* = .097.

### Head Move

#### Matriarchs

A chi-square was not able to be performed as head movement was seen to be a constant for all cases. The next step was to see if there was an interaction between the head movements observed and the three-time conditions for playback. To do this, a repeated measures ANOVA was performed. Below in *Table 3*, the mean and standard deviation are reported for each of the three time-conditions.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Stimuli** | | **N** | **Mean** | **Std. Deviation** |
| **Before** | Amboseli | 12 | 1.17 | 1.467 |
|  | Samburu | 3 | 2.00 | 1.732 |
| **10 Seconds** | Amboseli | 12 | 1.50 | 1.168 |
|  | Samburu | 3 | 2.00 | 1.000 |
| **After** | Amboseli | 12 | 7.75 | 7.399 |
|  | Samburu | 3 | 3.00 | 1.732 |

*Table 3.* N, mean, and standard deviation for frequency of head movement behaviour observed in matriarchs for the three-time conditions, respective of their populations.

Sphericity cannot be assumed due to Mauchly’s test being violated, *X2* (2) = 20.43, *p* = .550. The number of head raises by matriarchs observed, within the three-timed conditions, was found to be non-significant, *F* (1.10, 14.30) = 3.01, *p* = .102. When looking at the interaction of population with the observed behaviours in the timed conditions, the significance level drops further, *F* (1.10, 14.30) = 1.61, *p* = .228.

#### First Reactors

Similarly, head movement in first reactors was found to be a constant so a chi-square test could not be run. A repeated measures ANOVA was run to see if there was an interaction between observed head movements, the three-time conditions and if the population influenced these results. Below in *Table 4*, the mean and standard deviation are reported for each of the three time-conditions.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Stimuli** | | **N** | **Mean** | **Std. Deviation** |
| **Before** | Amboseli | 11 | .73 | .786 |
|  | Samburu | 3 | 3.67 | 4.041 |
| **10 Seconds** | Amboseli | 11 | 2.55 | 1.635 |
|  | Samburu | 3 | 2.00 | 1.000 |
| **After** | Amboseli | 11 | 7.36 | 7.311 |
|  | Samburu | 3 | 2.00 | .000 |

*Table 3.* N, mean, and standard deviation for frequency of head movement behaviour observed in first reactors for the three-time conditions, respective of their populations.

Mauchly’s test of sphericity was violated so it cannot be assumed, *X2* (2) = 18.26, *p* = .553. Once again, a non-significant result was found meaning there was not a significant difference between the behaviours observed and the time-conditions they were seen in, *F* (1.11, 13.26) = 1.14, *p* = .311. The result remains non-significant when looking to see if there is a relationship between the populations and the behaviours seen, *F* (1.11, 13.26) = 2.49, *p* = .137.

### Smelling

#### Matriarch

A chi-square test was run to compare the number of observed investigate smelling behaviour was dependent on the population it was performed by. The result was found to be non-significant, showing that observed smelling behaviour was independent, as seen in *Figure 2*, Fisher’s Exact: (1) = .054, *p* = 1.000. A repeated measures ANOVA was conducted to see if there was an interaction between observed investigative smelling and when the behaviour occurred in relation to playback. In *Table 4*, the mean and standard deviation are reported for each of the three time-conditions.

*Figure 2.* Number of observed investigative smelling behaviour by matriarchs in each population.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Stimuli** | | **N** | **Mean** | **Std. Deviation** |
| **Before** | Amboseli | 12 | .08 | .289 |
|  | Samburu | 4 | .00 | .000 |
| **10 Seconds** | Amboseli | 12 | .25 | .452 |
|  | Samburu | 4 | .25 | .500 |
| **After** | Amboseli | 12 | 1.83 | 3.380 |
|  | Samburu | 4 | .25 | .500 |

*Table 4.* N, mean, and standard deviation for frequency of investigative smelling behaviour observed in matriarchs for the three-time conditions, respective of their populations.

Mauchly’s test of sphericity was violated so it cannot be assumed, *X2* (2) = 29.68, *p* = .527. There was not a significant difference between the investigative smelling behaviours observed and the time-conditions they were seen in, *F* (1.05, 14.75) = 1.17, *p* = .301. A non-significant interaction was found between when smelling was observed and the population they were seen in, *F* (1.05, 14.75) = .83, *p* = .382.

#### First Responder

Another chi-square test was run to see if smelling in first reactors was dependent on the population they belong to. The results found show that the behaviour is independent, meaning there is no relationship between the occurrence of smelling behaviour by first reactors to the population they respond to, as seen in *Figure 3,* Fisher’s Exact: (1) = .00, *p* = 1.000. As always, a repeated measures ANOVA was conducted to see if there was an interaction between observed investigative smelling and when the behaviour occurred in relation to playback. *Table 5*, shows the mean and standard deviation for each of the three time-conditions.

*Figure 3*.Number of observed investigative smelling behaviour by first reactors in each population.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Stimuli** | | **N** | **Mean** | **Std. Deviation** |
| **Before** | Amboseli | 11 | .09 | .302 |
|  | Samburu | 5 | .00 | .000 |
| **10 Seconds** | Amboseli | 11 | .55 | .688 |
|  | Samburu | 5 | .40 | .548 |
| **After** | Amboseli | 11 | 3.00 | 3.768 |
|  | Samburu | 5 | .20 | .447 |

*Table 5.* N, mean, and standard deviation for frequency of investigative smelling behaviour observed in first reactors for the three-time conditions, respective of their populations.

Sphericity cannot be assumed as Mauchley’s test was violated, *X2* (2) = 24.38, *p* = .541. No significant difference was found between the investigative smelling behaviours observed by first reactors and the time-conditions they were seen in, *F* (1.08, 15.16) = 2.73, *p* = .117. The result remained non-significant when looking between when the smelling behaviour was observed and the population they were seen in, *F* (1.08, 15.16) = 2.54, *p* = .131.

### Calling

#### Matriarch

A similar procedure to the *Smelling* analysis was followed. A chi-square test was run and found calling was not dependent on the population it was performed by, as shown in *Figure 4,* Fisher’s Exact: (1) = .003, *p* = 1.000. A repeated measures ANOVA could not be run as a call was only observed once in each population. DO ELEPHANTS REDUCE NOISE PRODUCED WHEN ENCOUNTERING A HUMAN PREDATOR?

*Figure 4*.Number of observed calls by matriarchs in each population.

#### First Responder

As seen above,in *Calling – Matriarchs*, both cases in Amboseli and Samburu where calling occurred once in each, both first reactors were the matriarchs, meaning the results would be replicated in this case.

### Foot Raising

#### Matriarch

A chi-square was run and found that the occurrence of foot raising by matriarchs was not dependent on the population they belonged to, Fisher’s Exact: (1) = 2.33, *p* = .222. *Figure 5* shows that no foot raising was observed in the Amboseli sample but was in Samburu. In order to find a statistically sound finding, a bigger population should be used to be able to generalise the finding accurately. A repeated measures ANOVA could not be performed due to the lack of data.

*Figure 5*. Number of observed foot raises performed by matriarchs in each population.

#### First Responder

Similar to the matriarch condition, a chi-square was conducted and found to be non-significant, meaning whether the first reactor was observed to foot raise did not depend on the population they were from, as seen in *Figure 6*, Fisher’s Exact: (1) = .37, *p* = 1.000.

*Figure 6.* Number of observed foot raises performed by first reactors in each population.

A repeated measures ANOVA could not be accurately conducted as foot raising was only observed after the playback had played.

## Bunching

The fourth hypothesis was to compare the populations by their bunching intensity before, immediately as playback had begun to play, 30 seconds and 60 seconds after playback had started. A Mann-Whitney U test was carried out comparing each of the four conditions.

The first condition was *Before* playback had begun. Amboseli (*Mdn* = .00) and Samburu (*Mdn* = 2.00) was found to significantly differ in bunching intensity, *U* = 25.00 (*Z* = -3.54), *p* < .001, r = -.68.

Secondly, *Immediately* after playback, Amboseli (*Mdn* = 1.00) and Samburu (*Mdn* = 2.00) did not significantly differ, *U* = 67.50 (*Z* = -1.47), *p* = .142, r = -.28.

In the third condition, *30 seconds* after playback, Amboseli (*Mdn* = 1.50) and Samburu (*Mdn* = 2.00) did not significantly differ, *U* = 87.00 (*Z* = -.53), *p* = .597, r = -.10.

Finally, in the fourth condition, *60 seconds* after playback, Amboseli (*Mdn* = 1.00) and Samburu (*Mdn* = 2.00) also did not significantly differ, *U* = 69.50 (*Z* = -.43), *p* = .667, r = -.09.

## Matriarch was the First Responder

The fifth hypothesis questioned if the matriarch was the first responder depended on the population they belonged to. A chi-square test was run and found a non-significant result, as seen in *Figure 7*, Fisher’s Exact: (1) = .62, *p* = .695.

*Figure 7*. Frequency of when the matriarch was also the first reactor in each population.

## Matriarch’s Position

The sixth hypothesis tested whether the position of the matriarch in relation to the group during retreat depended on the population. A chi-square was conducted and found a non-significant result, meaning that where the matriarch was positioned did not dependent on the population they belonged to, *X2* (2) = 5.31, *p* = .070. However, it must be noted the chi-square test had four cells with an expected count less than five, making the results less reliable. As *Figure 8* shows, there was an observed difference in positioning between Amboseli being predominantly more in the back whereas Samburu more in the front. It will be discussed whether the sample size could affect the statistical significance of the current findings.

# Discussion

## Main findings

## Strengths

## Weaknesses

None of the observations of cetacean culture summa

rized in this paper come from research directly on cultural

transmission – they are by-products of observational stud

ies of behaviour, vocalizations, or populations. Yet, together,

they constitute strong evidence that, from the ethnographic

perspective, these animals do have culture. Thus, there is a

clear case for studying the cultural transmission of infor

mation directly as parts of the research agendas of the long

term field studies of whales and dolphins. - Rendall & Whitehead (2001), p.324

## Future Implications

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# References

Boyd, R., & Richerson, P. (1996). Why Culture is Common, but Evolutionary Culture is Rare. *Proceedings of the British Academy, 88*, pp. 77-93. Retrieved from https://pdfs.semanticscholar.org/4661/ec3ffe1c0aabbadb2925d5aba1792a94fda7.pdf

Galef, B. (1992). The Question of Animal Culture. *Human Nature, 3*(2), 157-178. http://dx.doi.org/10.1007/br02692251

Laland, K. & Janik, V. (2006). The Animal Cultures Debate. *Trends in Ecology and Evolution, 21*(10), pp. 542-546. http://dx.doi.org/10.1016/j.tree.2006.06.005

Laland, K. (2008). Animal Cultures. *Current Biology, 18*(9), R366 – R370. http://dx.doi.org/10.1016/j.cub.2008.02.049

Laland, K, Odling-Smee, J., & Myles, S.  (2010). How Culture Shaped the Human Genome: Bringing Genetics and the Human Sciences Together. *Nature Reviews Genetics, 11*(2), 137 – 148. http://dx.doi.org/10.1038/nrg2734

McComb, K., Shannon, G., Savialel, K., & Moss, C. (2014). Elephants Can Determine Ethnicity, Gender, and Age from Acoustic Cues in Human Voices. *Proceedings of The National Academy of Sciences, 111*(14), 5433-5438. http://dx.doi.org/10.1073/pnas.1321543111

Ree, A. (2012). African Elephant Social Structure: Visual, Tactile, and Acoustic Communication that Underlies Social Behaviour.

Rendell, L. & Whitehead, H. (2001). Culture in Whales and Dolphins. *Behavioral and Brain Sciences, 24*(2), 309 – 324. http://dx.doi.org/10.1017/s0140525x0100396x

Soltis, J., King, L., Douglas-Hamilton, I., Vollrath, F., & Savage, A. (2014). African Elephant Alarm Calls Distinguish Between Threats from Humans and Bees. *Plos ONE, 9*(2), e89403. http://dx.doi.org/10.1371/journal.pone.0089403

Whiten, A., Goodall, J., McGrew, W., Nishida, T., Reynolds, V., & Sugitama, Y. et al. (1999). Cultures in Chimpanzees. *Nature, 399*(6737), pp. 682-685. http://dx.doi.org/10.1038/21415

# Appendix

## Appendix A – Definitions of Behavioural Categories Used in Playback Spreadsheets (taken from McComb, Shannon, Savialel, & Moss, 2014).

* Definition of footswinging added for the purpose of this study.

**Avg age with matriarch** – Average age of the adults within a group, including the matriarch

**Avg age no matriarch** – Average age of the adults within a group, excluding the matriarch

**Matriarch Behaviours** (listening – retreat) – Responses exhibited by the matriarch, regardless of the rest of the group.

**Other Behaviours** (listening – retreat) – Responses exhibited by other adult females within a group, does not include the matriarch.

**Group Behaviours** (listening – retreat) – Responses exhibited by any adult female within the group (matriarch included). These behaviours are shown at the end of the spreadsheet.

**Listening** – Cessation in behaviour, ears held open and interest in the playback stimuli.

**Prolonged Listening** – Clear evidence that an individual has listened for a minimum for 3 mins.

**Head Move** – Evidence of head raising and shaking, indicative of an alert response.

**Smell** – Up or down trunk smelling following the playback in an attempt to gain further information with regards to the caller or the threat.

**Bunch** – Reduction in diameter of the group in response to a perceived threat or unfamiliar family.

**Call** – Audible rumbles that are given following the playback.

**Approach** – Distinct move towards the speaker, which requires a discernible change in direction.

**Retreat** – Distinct move away from speaker as a result of playback.

**Group move** – Distinguishes whether a group were moving (1) prior to playback or not (0).

**Bunching intensity** – Speed and time taken for reduction in diameter, (3) fast and clearly obvious brunch with a dramatic reduction in diameter (< 30s for bunching response). (2) Bunching less hurried, but group clearly move together and there is a cessation in behaviour such as feeding (1-3 mins for bunching response). (1) Very subtle bunch that may just be a reduction in overall diameter or calves moving to mothers. More often than not behaviour such as feeding will continue.

**Calves to adult F** – Movement of calves to adult females, including mothers and allo-mothers.

**Relaxation time** – Time taken for group to relax after playback and resume foraging moving etc. (0) No response (1) < 1 min to relax (2) < 3 min to relax (3) < 6 min to relax and (4) < 12 min to relax.

**Group to matriarch** – After playback do females and calves move to the matriarch (1) or not (0).

**Matriarch Pos** – Position that matriarch spends the majority of her time following playback (relative to the group). (1) front (2) middle and (3) back.

**Change in Pos** – Records whether the matriarch changed position (1) or not (0) – comparing her position prior to and after playback (relative to the group).

**Intercept** – Classified as the matriarch moving herself between the group and playback to intercept and investigate the stimuli. This has to be an active change in position and approach by the matriarch.

**Group Bunch N –** Any sign of bunching after playback, with or without the involvement of the matriarch.

**Foot Swinging -** A foot swing is often seen as a sign of anxiety in elephants. They will typically raise one of their front legs and let it hover above the ground.

1. A similar test will be performed on all observed behaviours to see when they most frequently occurred. The statistical results from the repeated measure ANOVAs must be taken with caution due to the non-normally distributed nature of the data. [↑](#footnote-ref-1)