



An ASAB Teaching Resource

Who's your daddy?

Paul Weeks, *Biology Department, Oxford High School*

An investigation into *Papio* baboon social structure through role play for key stage four students

Background notes for teachers

The *Papio* baboons are a genus comprising 5 species of Old World monkey. They live in large social groups (called troops) of between 10 to 200 animals and because they are also common and mainly terrestrial, are one of the most studied primate species in the world. Male baboons compete, within their troop, for position in the dominance hierarchy. This is adaptive (i.e. evolutionar-



ily advantageous) because high ranking individuals have priority to food and mating access with females, thereby increasing their "fitness" (i.e they are likely to father more offspring, increasing the chance of passing on their genes to the next generation). There is also a separate dominance hierarchy among female baboons, with similar social advantages for higher ranking individuals, but unlike males, a female's rank is inherited from her mother. Dominance also has important implications for health; lower ranking baboons tend to be more stressed, and are therefore more susceptible to a variety of stress related conditions.

Baboon range and ecology

Papio baboons live in Africa. Chacma baboons (*P. ursinus*) are found in southern Africa, Western baboons (*P. papio*) are found in West Africa, Hamydryas baboons (the sacred baboons of ancient Egypt) live in the Horn of Africa (and also the Arabian peninsula), Yellow baboons (*P. cynocephalus*) are found in south-central and eastern Africa, while Olive baboons (*P. Anubis*), the main characters in this lesson, inhabit a central region of the continent comprising around 25 countries from Kenya in the East to Guinea in the West. Baboons are adaptable animals and survive in a wide range of habitats from desert to rain forest. Olive baboons are best known from studies in

their savannah range in Kenya and Tanzania. This habitat is characterised by rolling hills, grassland and acacia trees. Regular rain (peaking in the rainy season around April) keeps the vegetation lush, and the mean day time temperature is 26-28°C throughout the year.

A typical baboon group

A group of 50 baboons will have around 7 or 8 adult males, 16 or so adult females, and offspring of a mixture of ages. The adult males in the group will be immigrants who left their natal group after puberty, when they were between 6 to 9 years old, and have joined this new group. Consequently, the adult males are usually not related. There are frequent fights between the males. This can be over access to females or desirable food, such as meat, or to reinforce or



establish their position in the dominance hierarchy. Ranking between males can change quite rapidly as a result of these fights, though a male can retain the alpha male status for a number of years. In contrast to males, females are philopatric, staying in their natal groups and are therefore a mixture of mothers, daughters, aunts and cousins.

A typical baboon day

Baboons spend the night sleeping in trees where they are presumably safer from potential predators like leopards. They leave their sleeping places some time after sunrise and the adults spend the first hour of daylight sitting in small groups where they groom each other.

Background notes for teachers

Young baboons generally play together. The troop then moves off together, walking and foraging. Baboons are omnivorous and will eat almost anything, although they seldom eat prey larger than themselves, although they can hunt baby antelope. Baboons will rest and groom in the middle of the day when it is too hot, and then forage again in the afternoon.

Baboon communication

Baboons communicate with each other using a wide repertoire of facial expressions, noises and physical gestures. The following are just a few examples of how they interact.

If a baboon raises its eyebrows and smacks its lips at you, it is being friendly and inviting – this expression has been described as the “come hither look” (there is a great account of this by Professor Louise Barrett at <http://www.bbc.co.uk/programmes/p00bk61z>).

Baboons bark if they want to raise the alarm. A big grin or yawn, that reveals the long canines (longer than an adult lion's!), is a threatening gesture.

If they are getting on well, on the other hand, male baboons will briefly yank on each other's penises when they pass each other.

Grooming, however, is the most important physical interaction. Grooming may play some role in hygiene and control of ecto-parasites (like ticks and fleas), but it is primarily a way of cementing social relationships and position within the dominance hierarchy. Lower ranking individuals generally groom higher ranking baboons. It is used in conflict resolution and as a form of reconciliation. Grooming can reduce stress and many baboons will fall asleep while they are being groomed.

Why be a high ranking individual?

There are clear benefits to being high up in the dominance hierarchy. Although all the adult males will tend to mate with a female when she is sexually receptive, it is the alpha male who gains most of the mating (over 50%) and will have exclusive mating access to oestrus females when they are most fertile. In theory, this should give him a much higher likelihood of fathering the offspring, and therefore of evolutionary fitness. This prediction has been confirmed through DNA profiling.

Dominance is also reflected in day to day interactions such as feeding and grooming, or even in apparently trivial matters such as where to sit. An alpha male has access to the best quality food (other individuals just back down when he approaches), other baboons will try to groom him to gain favour or form an alliance, and he gets to sit in the shade when it's really hot.

Being low-ranking, however, can be a constant source of worry and carries distinct and measurable disadvantages. Every other baboon can push you around, intimidate you and chase you away. You are also very unlikely to be groomed. A low ranking baboon is, therefore, a highly stressed animal. They have been shown to have elevated stress hormones in their blood, as well as a depressed immune system, a lower level of HDLs (High Density Lipo-proteins, sometimes called “Good Cholesterol” as they lower blood cholesterol levels), and hypertension, the source of heart attacks and strokes in humans.



Background notes for teachers

Studying baboon behaviour in the field

The most fundamental skill is in identifying individuals and recording their individual behaviour. How do they interact with other baboons? Who do they groom? This allows the researcher to investigate and construct the baboon society.

These field observations are supported by molecular data from individual baboons that can confirm (or contradict!) assumptions about, for example, paternity (maternity is always known). Molecular data is generated from blood samples which can be analysed for, among other things, DNA markers and stress hormones. The main challenge is getting the blood sample! Baboons are highly intelligent animals who do not like being darted and therefore take elaborate measures to avoid it. In addition, chemical markers of stress in the blood can change so rapidly that is very difficult to make controlled comparisons between individuals.

It is therefore vital that baboons are (for example) darted at the same time of day, that the baboon is healthy and uninjured, that it has not recently mated or been in a fight and, most difficult of all, it is unaware that it is about to be darted! (there is a hilarious account of baboon darting in Robert Sapolsky's brilliant book, "A Primate's Memoir"). The blood sample then has to be taken within 5 to 10 minutes of darting the baboon in order to establish the baseline stress levels, as it takes a short while for cortisol, the primary stress hormone, to reach the blood.



Keep your windows closed!

Stress related disease

The correlation between dominance hierarchy and stress is important because of the implications that stress has for the health of the individual. We know that chronic (i.e. prolonged) levels of stress can increase the risk of an animal, human or baboon, developing (among other things) diabetes, high blood pressure, atherosclerosis, impotency, depression and immuno-depression. Chemicals such as cortisol, that are released into the bloodstream when an animal is stressed, provide accurate markers of the level of stress that an animal is experiencing.

In a troop of olive baboons on the savannah of East Africa, where food is plentiful and there are hardly any predators of a healthy baboon in the safety of the group, the main source of stress is other baboons!



Lesson Plan

The following allows for a class of 24 students, made up of 16 baboons and 8 scientists. Ideas for how to involve additional students are included at the end.

Introduction

Behavioural ecology, which explores animal's behavioural adaptations in response to ecological and social conditions, is a subject that appeals to students of all ages. Yet behavioural ecology does not feature as an identifiable topic on any specification. There are certain vague references to "behavioural adaptations" when evolution and natural selection are covered, but despite forming the basis for every wildlife documentary ever made, the discipline and process of behavioural ecology is not covered in schools. There are probably many reasons for this, but one major obstacle to teaching the subject is the lack of accessible practical work that can be fitted into a 60 minute lesson. Studying baboons in the wild takes years just to habituate the animals, never mind the challenges of learning the individuals and recording what they do. The adaptive subtleties of what goes on usually require advanced statistics to unravel and watching animals can often be dull; they spend long hours doing very little. This would be difficult to undertake as A-level project work, never mind incorporating into GCSEs.

This lesson aims to give a flavour of behavioural ecology in the context of African field work, using role play. Some students will play the part of baboons, interacting with each other in the same way as a wild baboon troop. Other students play the biologists, studying the baboons in their natural habitat and trying to answer specific questions about baboon society and baboon behaviour.

Baboons

Most of the class make up the members of a baboon troop. There are adult males, adult females and young offspring of various sexes. Each baboon has a clearly defined personality. They also each have a card representing a blood sample that provides both a DNA profile and a blood cortisol measurement. Adult baboons are also given their position in the dominance hierarchy, relative to the other baboons.

Scientists

The rest of the class play biologists. Some are field biologists, tasked with observing and recording baboon interactions and collecting blood samples from each animal. The other scientists are molecular biologists, who will use the data from the blood samples. All the scientists will work together to answer the following questions.

- *What is the dominance hierarchy of the adult males?*
- *Does dominance hierarchy correlate with stress levels?*
- *What is the dominance hierarchy of the adult females? Does this correlate with stress?*
- *Which females appear to be the mothers of which infants? Are these observations consistent with the genetic data?*
- *Which male baboons are the fathers of which infants? Does the alpha male have more children than the other males?*



Lesson Plan

You will need quite a large space. A drama studio or a theatre would be ideal (book it well in advance!). An outside setting would add an air of authenticity and be great fun. Enlisting the help of a friendly drama teacher is enormously helpful, as they will have lots of good ideas for how to get the students warmed up, relaxed and happy to perform as animals. It also helps to have two teachers for the introductory session, as scientists and baboons need to be briefed separately about their roles.

An short, introductory video showing baboons and baboon behaviour (e.g. grooming) would be useful but is not essential. The extract from *Life* (narrated by David Attenborough) which shows Chacma baboons feeding on shellfish on the Cape peninsula is a fascinating illustration of their adaptability. A Powerpoint slide show illustrating what baboons look like and some of their interactions is a good alternative. Students should appreciate that:

- Baboons are highly intelligent primates who live in large, complex social groups
- Baboons have a dominance hierarchy
- Every baboon has its own unique character and personality
- Baboons largely interact through grooming each other
- Unravelling the subtleties of baboon society is challenging and relies on patient field observations.



Warm-up exercises for Baboon lesson

Try the following games/exercises.

Let's all be...

Select 10 students at random. Give them a number from 1 to 10. When you shout out their number, that student has to say loudly, "Let's all be...", inserting the animal of their choice (e.g. "Let's all be elephants!"). All the other students must then shout together, "Yes! Let's all be elephants!" and they spend 20 seconds or so pretending to be elephants. You then shout another number at random, and that student has to yell, "Let's all be aardvarks/mice/chimpanzees/whatever", the other students cry, "Yes! Let's all be etc".

Soundscape

Put the students into groups of around 5 or 6. Tell them to create the overall sound of a rainforest (monkeys, birds, insects, rain). Give them 3 minutes to work out what they're going to do, and then give each group 30 seconds to perform.

Gibberish

Put the students into pairs. Tell them that they are not allowed to talk – they must only communicate using gibberish. Then give them some scenarios to play out – e.g. an angry customer returning a broken iPhone, a boy asking a girl out for a date, someone asking for directions to the zoo, etc.

Improvised response

Get the students to stand in a circle. Number them alternately 1 and 2 (so each student is either 1 or 2). Get the 2s to stand in a smaller circle inside the 1s. 2s face out. Each 1 should be facing a 2. The 1s now initiate a dialogue with the 2s, starting with an accusation. They should improvise their own accusations, but give them some examples: "you've smashed up my car!" / "why are you juggling with my hamsters?" / "But the DNA says it's not my baby..." etc.

Give them a couple of minutes to develop the dialogue, then stop them, get the circle of 2s to rotate round one person clockwise (so everybody is facing someone new) and get the 2s to initiate a new dialogue. Continue for another 3 or 4 rounds.

Walk in a funny way

Ask the students to spread themselves around the room. Then get them to walk around, changing the way they walk according to the following:

- Through treacle
- On a very slippery surface
- With an orange balanced on their nose
- Sticking their bottoms out
- With their legs bent and knees apart
- With their chin and shoulders thrust forward.

Allocating roles

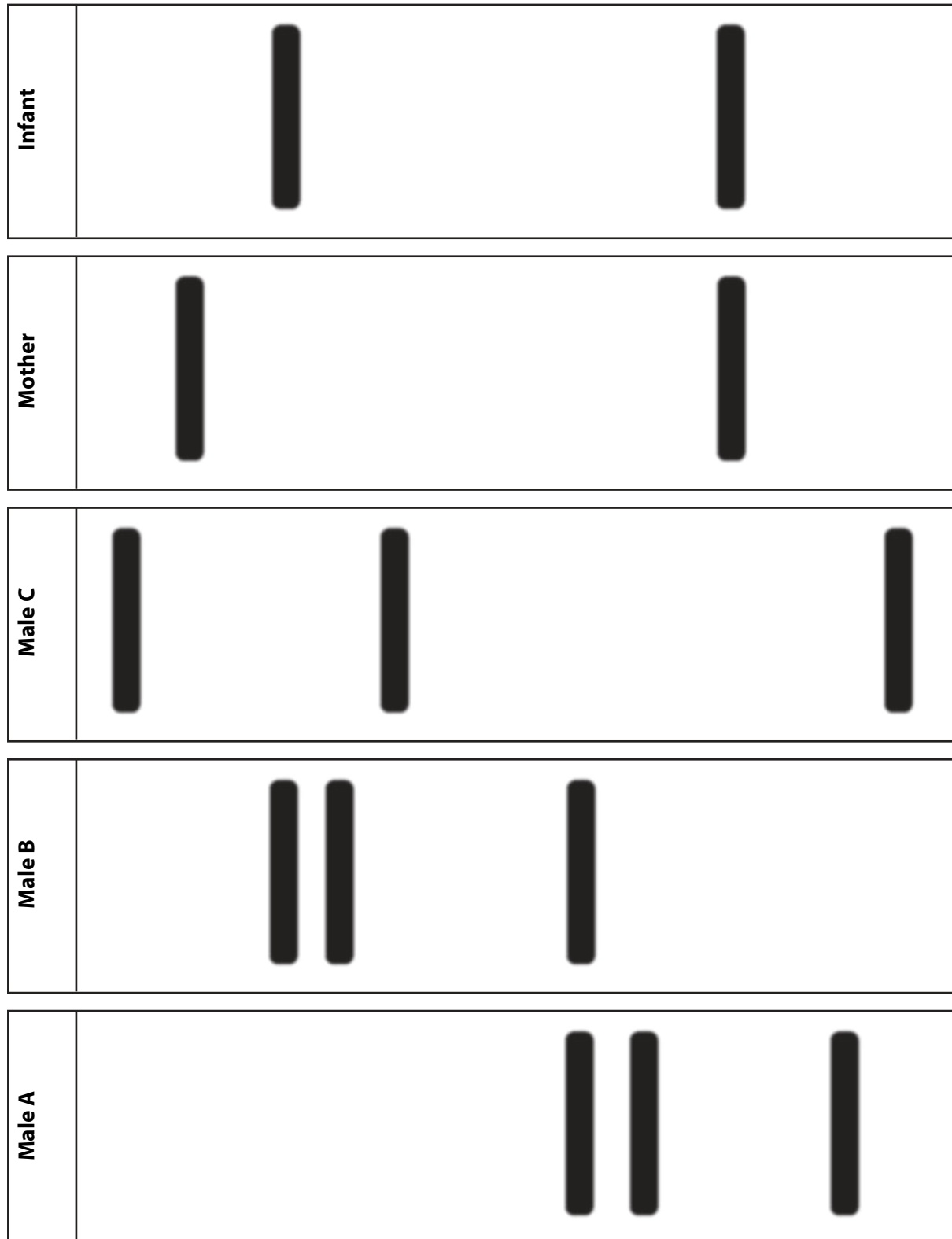
You obviously need to have done this in advance. Once the warm up is finished, divide the class into two and take the scientists to a separate area to explain the following. Leave the baboons with the drama teacher who can take them through further warm-up work (alternatively, another teacher could brief the baboons on who they are – see below).

Scientists

The 6 field biologists need to have a clipboard and pencil each. Their job is to observe the baboons interacting and record all relevant behaviour that will help them answer the questions set. They will also need to make a large number of small paper aeroplanes for “darting” the baboons. Any baboon that they successfully hit with a dart must surrender its blood sample which should be taken immediately to the molecular biologists for analysis. Warn them that baboons are highly intelligent animals who do not like being darted, so they’ll have to be subtle!

The molecular biologists will be waiting for delivery of the blood samples. Their job is to try and work out the paternity of all the infants based on the DNA profiles. Use the exemplar profiles provided to illustrate how this works (the bands on an infant’s DNA profile must be a mixture from the mother and the father – there must be no unexplained bands and the bands must match **exactly**).

The field biologists will, eventually, be able to report the apparent dominance hierarchy, which will enable the molecular biologists to see if stress, as measured by blood cortisol concentration, is correlated with position in the hierarchy.



The infant baboon inherits 50% of its DNA from its mother, and 50% from its father. We know who the mother is from observation, and we can see that the bottom band on the infant's profile uniquely matches the bottom band of the mother's profile. So we must look at the other band to determine the father. Of the putative males, only Male B has a band that corresponds to the infant's top band. We can therefore deduce that the father is Male B.

Briefing the Baboons

Remind all the baboons about baboon behaviour. They spend most of their time either foraging or grooming. They should not be constantly trying to get attention (this is the single most difficult aspect of this lesson, controlling the urge of the baboons to show off!). Warn them that the scientists will try to get blood samples by throwing paper darts at them – and that if they are hit by the dart they must surrender their bit of card. But also tell them that they do not like being darted, and should feel free to take evasive action!

Give them their individual bits of card with their DNA fingerprint and cortisol reading on.

The characters are as follows:

Adult males (number denotes position in dominance hierarchy, with 1 being the alpha male).

Adult male baboons (in order of dominance hierarchy)

Solomon

Alpha male: effortlessly powerful and frighteningly intelligent. You exert benign power, but are not afraid to slap down rivals hard. You tolerate children. All the females want to groom you. You get the best food, the best seats, the best everything. If someone has something you want, you just take it.

Menasseh

Second ranked male: trying desperately to become alpha male, so constantly challenging Solomon. But Solomon is more powerful and more intelligent, and you always back down. You hate children.

Nebuchednezzar

Third ranked male below Solomon and Menasseh. You are much less powerful than these 2, so take out your frustrations by attacking Isaac a lot. You hate children.

Isaac

Fourth ranked male below Solomon, Menasseh and Nebuchednezzar. You prefer the company of females and try to form attachments by grooming them.

Nathaniel

Bottom ranking male: not remotely interested in testosterone driven dominance activity – just loves playing with the offspring.

Emphasize the fact that none of the baboons can speak – they must only communicate through grooming and grunts.

The baboons can be initially suspicious of the scientists, but should quickly learn to ignore them – they have become “habituated”.

Adult female baboons

Leah

Daster and Babba are your babies. You are the alpha female, but are a bit neurotic about it and run around a lot reminding the other females. You harass Rachel a lot, because Rachel is bottom ranking female and you’re a bully.

Devorah

Second ranking female below Leah (you are her daughter). Moogle is your baby. You’re a very happy mum who likes babysitting for other females.

Miriam

Third ranking female below Leah and Devorah. : Pompom is your baby. She’s your first baby and you constantly worry, especially if she moves away from you.

Bathsheba

Fourth ranking female below everyone except Rachel. Diddy is your baby, but you’re not very maternal and not very interested. You much prefer the company of adult males.

Rachel

Much the nicest of the female baboons, you get on well with everyone. Tiny is your baby.

Offspring (and parents)

All baby baboons are fun, inquisitive, playful. They run around and play with each other, try to play with the adult males, climb over researchers, run away from their mums, etc.

IMPORTANT!

Do not reveal who the fathers are until after the scientists have presented their findings!!!

Daster (mother = Leah; father = Solomon)

Babba (mother = Leah; father = Solomon)

Moogle (mother = Devorah; father = Solomon)

Pompom (mother = Miriam; father = Solomon)

Diddy (mother = Bathsheba; father = Nebuchednezzar)

Tiny (mother = Rachel; father = Nathaniel)

Controlling the lesson

Use narration to direct the baboons through the day. Start them asleep in the trees, and describe the sunrise – a colourful description of the African savannah, its colours and sounds and climate is a good way to set the scene and help them get into role. Let them behave for 5 minutes or so – and the scientists make observations and then announce that it's midday, it's too hot to forage, and they're going to sit around and groom for a bit. After another 5 minutes or so, allow them to interact more fluidly again (feeding, interacting, playing) and 5 minutes after this, announce the end of the day – the baboons go to sleep, and the scientists go back to their tent to try and unravel some of their observations.

Talk them through a second day – and on the second day scientists can attempt to take blood samples.

Dominance interactions can be encouraged by leaving desirable food items around the place – I found that chocolate worked well. A lower ranking animal must surrender desirable food to a higher ranking animal! It can also be fun to describe the arrival of a leopard or a lion, the only animals that could seriously threaten an adult baboon. Will they react appropriately?

You could end the lesson with a change in dominance hierarchy as the alpha male loses out in a confrontation with the male below him.

Acknowledgements

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References

Sapolsky, R. M. 2001. *A Primate's Memoir – Love Death and Baboons in East Africa.* London, Jonathan Cape.

Reviewing the lesson

Bring everyone into a circle. Start with the scientists. Possible questions might include

- *What was it like when they first met the baboons?*
- *Which aspects of the research were most fun? Most difficult?*
- *What did they notice about the baboon personalities?*
- *What have they found out from the genetic profiles? Can they establish who the parents are for all the offspring? Can they explain this to the baboons? (the baboons will not know who has fathered which infant)*
- *Did the dominance hierarchy correlate with stress levels? There is an obvious anomaly – can they suggest an explanation?*

Alternatively, the scientists could be asked to prepare a presentation in which they describe and summarise their results, observations and conclusions.

Either way, this must be followed by some feedback from the baboons. If this is discussion based, questions could include:

What did it feel like to be:

- *The alpha male?*
- *The alpha female?*
- *The lower ranking male?*
- *The lower ranking female?*
- *An infant?*

What was it like having to communicate without speaking?

- *Was this easy?*
- *Difficult?*
- *Fun?*
- *How did you resolve any problems?*

Extension of the activity

The possible “add-ons” to this lesson are endless.

These are just some suggestions.

It is usually worth pointing out that this 60 minute lesson condenses years of dedicated work in the field. You could discuss the challenges of African field work and what it might be really like (reading extracts from the Robert Sapolsky book is entertaining and enlightening).

Students are always intrigued by the implications for human society. What are the similarities and differences? Do humans have a dominance hierarchy? Are there similar effects on stress? And health?

Discussion and comparison of other primate social systems is also interesting (e.g. how do baboons differ from chimpanzees? How do they both differ from gorillas?).

Larger classes

The individual baboons described here comprise of adult males, adult females and infants. Additional students could be incorporated as juvenile males and females, who generally just play and forage together, but who must always give way to adults. Again, the challenge for the scientists is to work out who these individuals are the offspring of. With any class, it is worth emphasizing that they may not find out the answer to a particular question, or they may get it wrong, or the behavioural observation may not seem consistent with the molecular data (in which case their behavioural observation is likely to be wrong) **AND IT DOESN'T MATTER!**

Pitfalls and how to avoid them

The scientists can get so excited at the thought of trying to dart baboons that they immediately rush in, paper darts flying. When briefing the students, tell them they can't dart any baboons until the second day, when the baboons will be better habituated, and that they must concentrate on gathering observational data first.

Baboons can be very possessive of their DNA! Tell them that they must surrender their cards if hit by a dart.

Students sometimes impose their preconceptions on their data, assuming, for example, that each baby will have a separate mother and father – this makes a great teaching point, but it might be worth suggesting in advance that baboons are not necessarily like humans!

The students playing the baboons find it very difficult not to talk to each other. It rather spoils things if one baboon is yelling, “I'm second in command here!” at the other baboons! It is vital to emphasize that baboons **CANNOT TALK!!!!**

The students playing the baboons also find it very difficult to do anything quietly – they feel an urge to constantly be doing things. Control this through the narrative, giving clear guidance on when they should just be sitting down, grooming each other.

Casting the various roles could be a sensitive issue and it's important to get it right. It can help to cast against type – could a quieter student be a high ranking male? Could a keen but less able student be a scientist? However you choose to do it, always emphasize that they are playing roles, not themselves.

Appendix

Solomon

Alpha male: effortlessly powerful and frighteningly intelligent. You exert benign power, but are not afraid to slap down rivals hard. You tolerate children. All the females want to groom you. You get the best food, the best seats, the best everything. If someone has something you want, you just take it.

Leah

Daster and Babba are your babies. You are the alpha female, but are a bit neurotic about it and run around a lot reminding the other females. You harass Rachel a lot, because Rachel is bottom ranking female and you're a bully.

Menasseh

Second ranked male: trying desperately to become alpha male, so constantly challenging Solomon. But Solomon is more powerful and more intelligent, and you always back down. You hate children.

Devorah

Second ranking female below Leah (you are her daughter). Moogles is your baby. You're a very happy mum who likes babysitting for other females.

Nebuchednezzar

Third ranked male below Solomon and Menasseh. You are much less powerful than these 2, so take out your frustrations by attacking Isaac a lot. You hate children.

Miriam

Third ranking female below Leah and Devorah. : Pompom is your baby. She's your first baby and you constantly worry, especially if she moves away from you.

Isaac

Fourth ranked male below Solomon, Menasseh and Nebuchednezzar. You prefer the company of females and try to form attachments by grooming them.

Bathsheba

Fourth ranking female below everyone except Rachel. Diddy is your baby, but you're not very maternal and not very interested. You much prefer the company of adult males.

Nathaniel

Bottom ranking male: not remotely interested in testosterone driven dominance activity – just loves playing with the offspring.

Rachel

Much the nicest of the female baboons, you get on well with everyone. Tiny is your baby.

Appendix

Daster

(mother = Leah; father = Solomon)

All baby baboons are fun, inquisitive, playful. They run around and play with each other, try to play with the adult males, climb over researchers, run away from their mums, etc.

Pompom

(mother = Miriam; father = Solomon)

All baby baboons are fun, inquisitive, playful. They run around and play with each other, try to play with the adult males, climb over researchers, run away from their mums, etc.

Babba

(mother = Leah; father = Solomon)

All baby baboons are fun, inquisitive, playful. They run around and play with each other, try to play with the adult males, climb over researchers, run away from their mums, etc.

Diddy

(mother = Bathsheba; father = Nebuchednezzar)

All baby baboons are fun, inquisitive, playful. They run around and play with each other, try to play with the adult males, climb over researchers, run away from their mums, etc.

Moogle

(mother = Devorah; father = Solomon)






All baby baboons are fun, inquisitive, playful. They run around and play with each other, try to play with the adult males, climb over researchers, run away from their mums, etc.

Tiny

(mother = Rachel; father = Nathaniel)

All baby baboons are fun, inquisitive, playful. They run around and play with each other, try to play with the adult males, climb over researchers, run away from their mums, etc.


Appendix

Nathaniel Cortisol conc 8	
Issac Cortisol conc 155	
Nebuchednezzar Cortisol conc 52	
Menasseh Cortisol conc 25	
Solomon Cortisol conc 5	

Appendix

Rachel	
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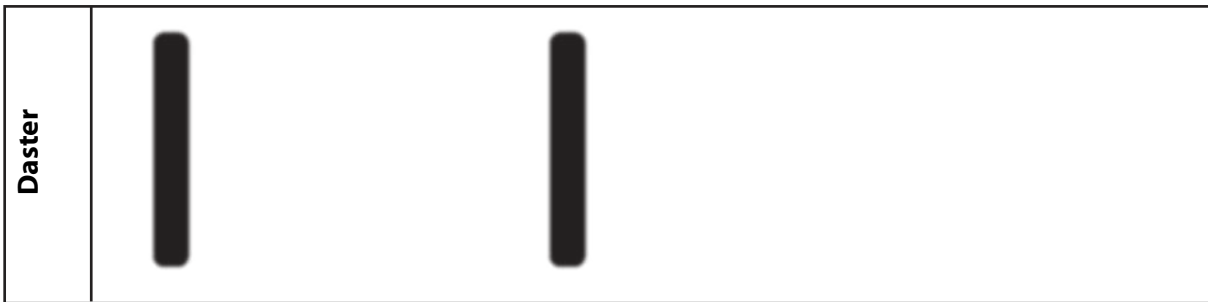
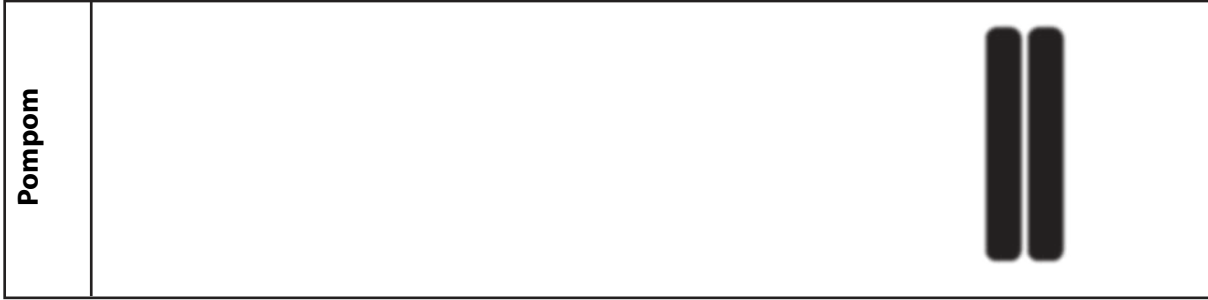
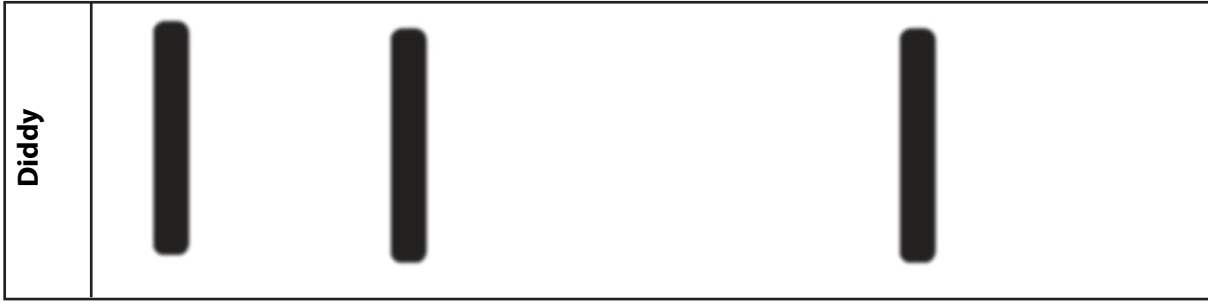
Bathsheba	
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Miriam	
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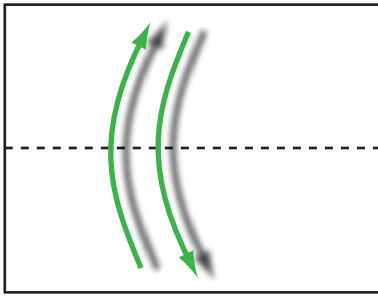
Devorah	
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Leah	
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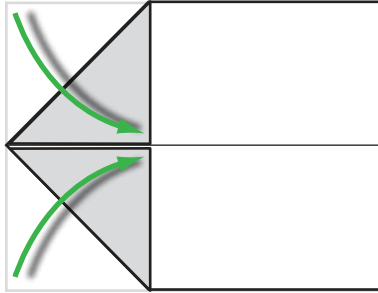
Appendix



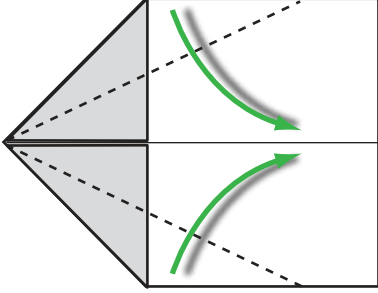
Basic paper dart



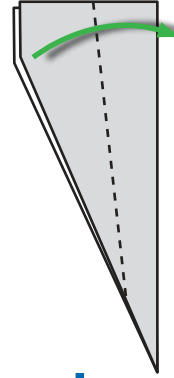
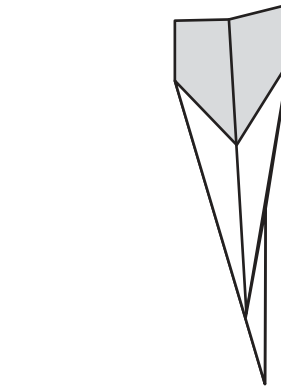
Start with a sheet of A4 paper. Fold in half to crease and unfold.



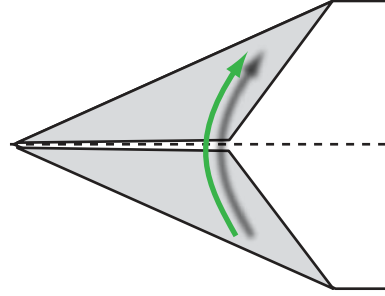
Fold in the two top corners.



Fold in the two corners to the centre.



Fold out to form the wings.



Fold in half.