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CONCEPTUALIZING PRIMATE TEMPORALITY: AN ARCHAEOLOGICAL VIEW OF BABOON BEHAVIOR THROUGH ALBERT

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Abstract: Although leave-taking in non-human species has been preliminarily investigated in a few species, the mechanisms driving encounter ends remain unstudied. In 1976 Albert and Kessler published a landmark paper, outlining theories about what drives social encounter ends and providing a framework of internal and external motivations leading to separation. This framework has been underused in aiding our understanding of how proximate mechanisms for separation drive leave-taking and offers a valuable opportunity to better understand how separation and behavior relate to one another. Having previously identified leave-taking in wild chacma baboons (*Papio ursinus*), in the current paper, we apply this framework to their leave-taking to better understand how the motivations to leave impact leave-taking. Using GLMMs with binomial error structure, our results suggest that internal motivations to end interactions are better predictors of orientation-shifting behavior when compared to external motivations. We argue that these results validate the use of Albert and Kessler's framework across species and suggest that leave-taking may have evolved to signal internal drivers of interaction ends, a behavior that has become elaborated in human behavior.

Keywords: Leave-Taking, Interaction, Baboon, Separation, Evolution

Introduction

Introduction to the temporal place just like human encounters, animal encounters must come to an end. There has been a recent increase in the interest surrounding non-human primate leave-taking, defined as behaviors occurring at the end of social separation (Baehren, 2022), with evidence that chimpanzees (Heesen et al., 2021) and baboons (Baehren and Carvalho, 2022) end social interactions with specific behaviors that are comparable to those of humans, such as gestural and postural changes. Such interaction endings represent temporary pauses of continuity within ongoing relationships and (Albert and Kessler, 1976) milestone paper outlines a variety of proximate mechanisms to understand these endings. Building on such theories of why interactions end could help us

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understand the proximate drivers of leave-taking. Despite several testable hypotheses being generated in their paper, the empirical analysis to support these remains lacking. Between two parties have ceased. They situate these endings within ongoing social relationships, where the ending is a type of temporal boundary between two types of experience: Being alone and being with others. Whereas (Albert and Kessler, 1976) refer only to human populations throughout their paper, here we apply these theoretically to the social behavior of non-human species and empirically to chacma baboons (*Papio ursinus*), in order to understand the evolutionary origins of the proximate mechanisms to end interactions and their relationship with leave-taking. Chacma baboons pose good models for the understanding of such endings since they live in cohesive groups that experience regular short-term separations within interacting dyads. Previous research has highlighted their propensity to show leavetaking in such scenarios (Baehren and Carvalho, 2022) and as such, they could provide good models for understanding how such separations and leave-taking are related to one another. The framework from Albert and Kessler (1976) closely parallels research and conceptualization of nonhuman leave-taking. Baehren (2022) outlines levels of separation that reflect differing extents and permanence of interaction ends. At the low level are short-term recurring separations and at the high level are long-term separations. Such short-term separations have been investigated successfully in baboons (Baehren and Carvalho, 2022). Similarly, Albert and Kessler (1976) refer specifically to "routine everyday events" as an important backdrop for understanding separations. In addition to this, Albert and Kessler (1976) make reference to the social unit at play in separations, with a focus on two-person social encounters, but the potential to consider separation at the group or national level. Paralleling this in the non-human setting, Baehren (2022) levels of separation present fission-fusion as a gradient that exists across all species to differing extents and has been applied to baboon dyads (Baehren and Carvalho, 2022). As such, the theories that Albert and Kessler present for proximate drivers of separation are well aligned with the frameworks already established for leave-taking research in non-humans.

Additional Problems of Causal Attribution

Despite this alignment, there are some challenges with applying a theoretical framework designed for humans to the study of non-human species. Albert and Kessler (1976) outline problems of causal attribution of both the real and the expressed reason for terminating a social encounter; something which is an important consideration in human leave-taking. The expressed reason can be thought of as the justification, sometimes mutually agreed on, for the cause of the interaction's end. In addition, they introduce internal and external reasons for interaction termination, where internal reasons are those related to the interaction itself (positive or negative) e.g., a joint task has been brought satisfactorily concluded, or because the interacting individuals become hopeless, bored, or conflicted. External reasons refer to those outside of the interaction, e.g., the closing of a door, the entrance of a third party, departure of a plane, where environmental influences cause the interaction to cease. This forms a 2 × 2 matrix whereby interaction endings can be either internally or externally motivated and can be real or justified. For example, they describe a scenario where the real reason for termination is boredom, but the expressed reason is external, e.g., a fabricated appointment (Cell 2, Table 1). Humans give external justification for any termination, except when the permanent ending is desired, or the positive internal reason is explicitly obvious. Furthermore, when the real reason is external and obvious it almost always serves as the justification as well. In cases where internal justification is needed an attempt will be made for it to be positive.

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Table 1: Replica of Table 1 from Albert and Kessler (1976): The source of the real reason and the provided justification for ending

Justification			

Real reason	Internal	Cell 1	Cell 2
External	Cell 3	Cell 4	

Table 2: Adaptation of Table 1 from Albert and Kessler (1976): The source of the real reason and the provided justification for ending in non-human species

		Justification	

Real reason	Internal	Cell 1	N/A
	External	N/A	Cell 4

However, in non-human species, it is much more difficult to disentangle real and justified reasons for interaction termination. Although differences between actual knowledge and communicated knowledge have been investigated in non-human species (e.g., work on deception, (Johnson et al., 2005), the evidence is limited in terms of its widespread existence across species and even across individuals. As such, for the purpose of this research, we treat real and justified reasons for terminating encounters as equal in non-human species and thus only cells 1 and 4 are relevant (Table 2) when compared to human leave-taking (Table 1) and we will simply consider the internal and external reasons for leaving.

Internal and External Processes of Ending

Albert and Kessler (1976) deem the distinction between internal and external motivations to be a fundamental one. It is thought necessary to describe the motivational forces of interaction ending to fully understand the ongoing social relationship of coming together and going apart again. In fact, they go as far as to state that "the full meaning of social interaction is known only when its end is known" and argue that determining processes as internal and external is less about convenience but more a reflection of the fundamental categories that make up endings. This remains unstudied empirically in all species and thus, here we outline the internal and external processes of endings raised by the authors and discuss their applicability to non-human species. The first internal ending process that Albert and Kessler (1976) refer to is the "summary process", whereby individuals give an overarching takeaway of the social encounter. They are often symbolic in nature, expressing key themes of the encounter and enabling the interactants to remember the interaction, usually (though not always) positively. In doing so, this also places the interaction in the past, historicizing it, often using past tense to mark this shift. Despite the clear importance of summary processes in navigating human interaction endings, Albert and Kessler (1976) pose that it is "largely a product of cognitive activity and relies heavily on language. At its core, it is an exercise in the conceptualization of history." This is another aspect of behavior that is difficult to see parallels in non-human species. Although mental time travel is documented in some primate species e.g., chimpanzees (Cheke and Clayton, 2010), the ability to communicate summative statements referring to past events is beyond the scope of current research (McGrew and Baehren, 2016). The other internal ending process that Albert and

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Kessler (1976) discuss is that of resource exhaustion. They outline that this process involves a finite resource central to the encounter (without which it cannot occur). The resources relevant here include more obvious examples such as a limited food source that is the basis of an interaction, as well as the limitation of more personal resources such as energy and time. It is well understood that non-human species must balance their time between activities to maximize their reproduction and survival (Fehlmann et al., 2017). Some primate species have even been shown to have vastly different social interactions when freed from the constraints of food availability (García et al., 2021). As such, measuring the impact of resource availability on leave-taking could easily be investigated in species beyond humans. Social psychology gives us many theories as to why social interactions come to an end. Consistency models, such as those on imbalance, describe a necessary harmonizing of the interpersonal relationship (Heider, 2013) and dissonance, where conflicting beliefs or behaviors lead to discomfort and alteration (Festinger, 1957) give one type of framework. Additionally, exchange theories e.g., argue that an ending will occur when the value of pursuing a relationship falls below the value of an alternative relationship. In addition, social exchange theory takes a cost-benefit approach where individuals are assumed to maximize benefits and minimize the costs of their interactions. We believe these theories are relevant to the discussion of internal ending processes as both relate to the dyad dynamics central to the ongoing relationship and can be applied to non-human relationships by investigating the behaviors during and following social separation. In addition to the processes that are within the social interaction itself, (Albert and Kessler, 1976) outline a number of external processes that motivate individuals to cease their interactions. The first of these external processes refers to the physical environment in which the interaction takes place. Environments have built-in endings, e.g., a path that two people are walking along which then splits into two, prompting separation. The physical environment also provides distractions which can prompt an individual to terminate the current encounter in favour of such an alternative. These environment features map neatly onto those experienced by non-human species, where there are alternative activities for individuals to participate in, which may drive the decision to end a current interaction. Also external to the dyadic interaction, the wider social environment can motivate interaction ending, either by the entrance of a third party or by imitation of others' separations. The entrance of a third party, causing the withdrawal of an original individual, is known in animal studies as displacement (Troisi, 2002) and could easily be relevant to this process. Albert and Kessler (1976) also describe the contraction of the social environment, whereby other departures in the wider social group facilitate a "general exodus". This too would be directly relevant to non-human species and indeed positions the research somewhere between the two separate (yet related) concepts of group movement and individual separation, as defined by Baehren (2022). Processes for ending social interactions in non-humans This research aims to apply the above insights to the study of social interaction endings in wild chacma baboons (*Papio ursinus*). We first identify which of the processes outlined by Albert and Kessler (1976) can be tested on non-human species (Table 3) and group these into the respective internal and external categories. Following this, we hypothesize that leave-taking in social interactions is more likely with internally motivated endings than externally motivated endings. We expect chacma baboons to need to communicate such temporal shifts that may not be as intuitive as external processes such as distractions, imitations, or displacement by a third individual. These internal features of the interaction, such as social imbalance, exchange, or predicted exhaustion of a key resource, may not be as obviously apparent as could warrant signal production. Although research on other primate signals is overwhelmingly in support of their use

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to reference real-world, referential objects, intrinsically social signals such as greetings are known to reflect the intricacies of the social interaction itself. We might thus expect primate species to use leave-taking to extricate themselves from social interactions brought to a close by internal forces.

Table 3: Internal and external processes and their applicability to non-humans

	Process	Application to non-humans
Internal	Summary	No- focused on linguistic summaries
	Social exchange	Yes
	Imbalance	Yes
	Resource exhaustion	Yes
External	Built-in endings	In theory possible but difficult to get large enough sample size
	Distractions	Yes
	Imitating others	yes
	Entrance of third party	Yes

Materials and Methods

Baboon Models for Leave-Taking

Baboons have recently been investigated with regards to leave-taking and found to shift orientation towards the direction of separation when leaving social interactions, compared to asocial separations (Baehren and Carvalho, 2022). Baboons pose a good model for human behavioral evolution, sharing a common ancestor with humans between 21 and 25 million years ago (Langergraber et al., 2017). Savannah baboons are so-called because of similar ecology and social organization patterns (Smuts et al., 2008), including yellow baboons (*Papio cynocephalus*), chacma baboons (*Papio ursinus*), and olive baboons (*Papio anubis*). These species exist in large, femalebonded groups where the males disperse out of their natal group, whereas females are philopatric (Grueter, 2014). With similar environments to our Pleistocene environments, the savannah and woodland backdrop of savannah baboons are important for understanding the emergence of our genus. (Jolly, 2001). Furthermore, savannah baboons provide important models for understanding the selective pressures driving social interactions. In this cohesive species, bonds between females are important, with females forming equitable, enduring bonds with other females (Silk et al., 2010). Such relationships have been shown to improve offspring survival and female life expectancy (Silk et al., 2010). Male-female "friendships" are particularly wellmodeled in baboons (Buchan et al., 2003), where males care for offspring even in cases with low paternity certainty (Huchard et al., 2010). This behavior is thought to have varying roles across baboon species, a counter strategy to infanticide in chacma baboons, protection against nonlethal forms of aggression in more tolerant species (Lemasson et al., 2008), and better protection from harassment, usually from genetic fathers (Nguyen et al., 2009). Within their communicative behavior, baboons coordinate group movement to maintain cohesion (Stueckle and Zinner, 2008; Strandburg-Peshkin et al., 2015) and exhibit ritualized greetings (Smuts et al., 2018). Savannah baboons have the necessary close-knit social groups to investigate short-term departures and are a good model for investigating the

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origins of potential leave-taking behaviors. Using them as a model for this supposed universal human behavior will allow us to understand the evolutionary history and drivers of its emergence.

Study Site and Subjects

Gorongosa National Park covers 4067 m² across central Mozambique (Fig. 1A), where the base camp, i.e., Chitengo, is the home range to two troops (Fig. 1B). One of these troops, comprising 37 individuals, is the study troop. Within this troop, 15 juveniles were excluded from the current study, leading to a sample of 22 identifiable adult individuals. Infants were also excluded due to a lack of separation from adults. Baboons of Gorongosa National Park, Central Mozambique, inhabit a range of habitatsL closed canopy savannah, rainforest, montane grasslands, rivers, and caves (Martinez et al., 2019; Bobe et al., 2020; Santander et al., 2022). Modern environments similar to the ones inhabited in the past by Australopithecines 4.2-2.3 million years ago "certainly included present-day Gorongosa National Park" (Biologist, 2014; Bobe et al., 2020).

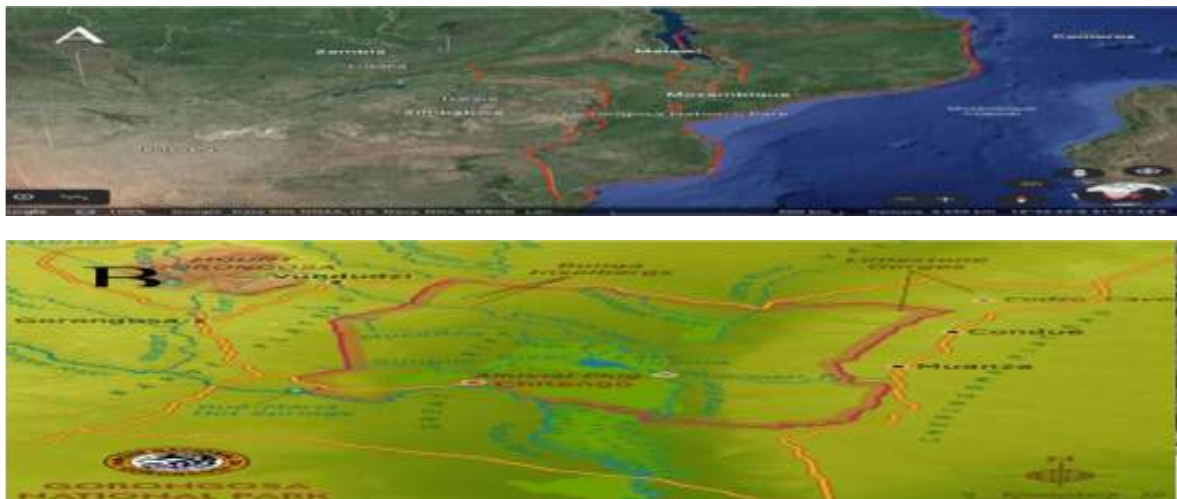


Fig. 1: (A) Location of Gorongosa National Park within Mozambique, adapted from Google Earth; (B): positioning of Chitengo camp within Gorongosa National Park (<https://eowilsonfoundation.org>)

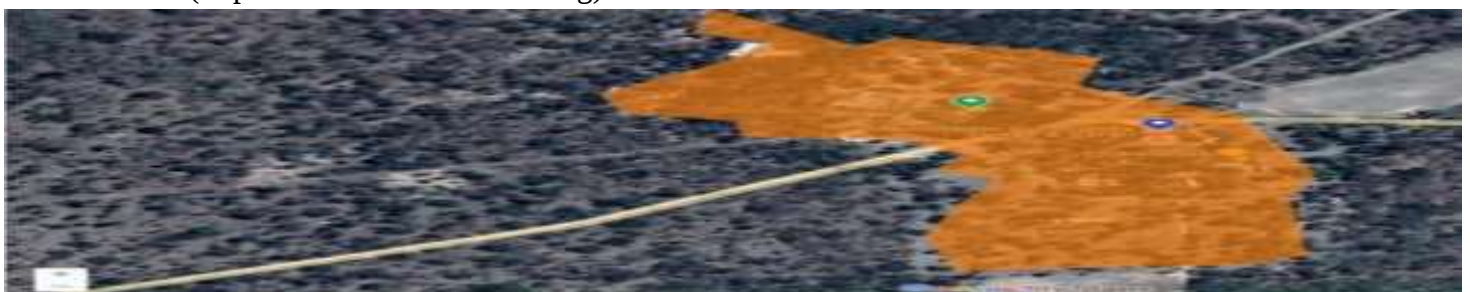


Fig. 2: Map of Chitengo camp (adapted from Google Maps), highlighting the study area of the troop in orange. The campsite is marked with a green pin and the lodge is marked with a blue pin The camp occupies around 0.157 km² with a perimeter of around 2.13 km (Fig. 2). It is a tourist camp and thus the populations are well habituated,

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allowing them to be observed well at close range, largely unaffected by observer presence. Subsequently, the behavior of the population is impacted by an anthropogenic environment, leading to potential idiosyncrasies beyond the species' typical behavior. Despite this, the opportunistic nature of baboons means that the Chitengo troop is not unique in this regard and the terrain habituation makes this setting and population ideal for recording spontaneous interactions of baboons (Fig. 3). 65 h of video footage were taken in Chitengo camp, Gorongosa, Mozambique from Oct-Dec 2018. Video footage taken during the daily follows was done on a Nikon P900 83X optical zoom mounted on a tripod. The footage was taken opportunistically from when at least one individual was visible until all individuals had moved out of the shot, thus including a selection of spontaneous interaction across dyads. The footage was imported into the behavioral coding and analysis software BORIS (Friard and Gamba, 2016) and each video was played repeatedly as necessary to capture all movements. This software also allowed for more accurate inter-coder reliability. This method was necessary since leave-taking occurs retrospectively, i.e., it happens before the parting event. Parting events were identified first and then rewound to code the potential leave-taking behaviors preceding them. Each “observation” was a unit of measurement”, defined as being from the start of an interaction to the moment where the separation occurs. In turn, separation was defined as a movement of at least 1 m away from the other individual in the dyad. Dyads were selected opportunistically, using every identifiable pair on the footage and data collected exhaustively. The parting individual within the dyad refers to the individual who first separates. Interactions included all social behaviors present in the footage, including grooming, copulating, and joint infant handling. 216 observations were identified within the footage, where behaviors were recorded all over in a 3-min window prior to departure. Measures of internal and external variables were also recorded in association with each observation (Table 4). These measures, as independent variables, were recorded as binary occurrences in this pre-parting window (yes/no). The dependent variable was recorded as the presence of orientation shifting towards the direction of parting (yes/no), determined in leave-taking in previous research (Baehren and Carvalho, 2022). Individual IDs for both the receiver and signaller and activity duration (mm: Ss) were also recorded for each observation. Although the videos were randomised across subgroups there was a bias in the proportion of videos including certain individuals compared to others. For example, Pequeno (n = 2) was observed much less frequently due to being peripheral and less central to the group, thus less likely to be in observable social interactions, compared to Maizey (n = 52). We accounted for this in the statistical models but still warrants consideration that the findings may not be applicable across all individuals, even if the findings are significant across the population.

Analyses

All analyses were conducted in R version 3.6.3 and alpha values were set at 0.05. Analyses are conducted at the observation level, where each observation contributes one data point. Generalized Linear Mixed-effects Models (GLMMs) with binomial error structure were used to investigate the influence of the explanatory variables on a binary response variable (shifting orientation in the direction of parting, or not) for each observation. Due to the repeated sampling of individuals across observations, we included individual IDs of both signaler and receiver as random factors in the models, by adding random intercepts models using the package lme4.

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Fig. 3: Example of the video footage where a social interaction (Grooming) comes to an end

Table 4: Variables associated with internal and external motivations to end interactions

Process Measure
Social exchange does departing
Individual move to another social interaction
Immediately after focal interaction? (0/1)
Internal Imbalance is there an infant grabbing? (0/1) Resource exhaustion is there copulation
Call (0/1) Duration of interaction (mm: Ss) Distractions Do departing individual look towards something else before leaving? (0/1)
External imitating others are other individuals visibly departing? (0/1)
Entrance of Does a third party the third party join before departing
Individual leaves? (0/1)

Generalized Linear Mixed-effects Models (GLMMs) with binomial error structure were used to investigate the influence of explanatory variables on a binary response variable (orientation in the direction of parting, or not). Due to the repeated sampling of individuals across observations, we included individual IDs of both signaller and receiver as random factors in the models, by adding random intercepts models using the package lme4 (Bates et al., 2014).

IO Reliability

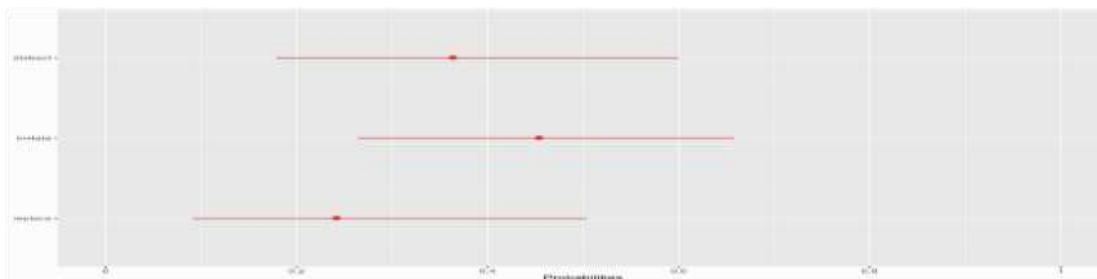
We assessed inter-observer reliability with a second coder who was naïve to the research hypotheses coding over 10% of the observations. The observations used in inter-observer reliability were selected at regular, predetermined intervals throughout the complete study dataset, ensuring a representative cross-section of the data in our comparison. We concluded that our data was collected reliably if the proportions of agreement observed between the two observers using Cohen’s Kappa were significantly different from those expected by chance. Cohen's kappa values are considered good if ranging from 0.4-0.6 and very good if between 0.6 and 0.8 (Watkins and Pacheco, 2000). Inter-observer reliability was deemed very well, all measures produced similarity that was significantly more than would be expected by chance. We first calculated Cook's distances to look for any potential influential observations that could affect the accuracy of the models (Nieuwenhuis et al., 2012). Looking at the association with orientation, we identified around four potentially influential observations for the external model and four for the internal model that could be considered as outliers, however, we ultimately decided not to remove them, as they could reflect true differences in our observed orientation behavior. We then checked for

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collinearity between the variables (maximum VIF = 1.087). Since these assumptions were satisfied, we deemed the models suitable for analysis and decided to run and interpret all observations to obtain the first insights into the intentionality of the behavior. In addition to looking at whether each model significantly predicted leave-taking behavior, we also used Akaike's information criterion corrected for small sample size AICc (Burnham et al., 2011) to compare our models and understand how likely they were based on our data (Duboscq et al., 2016). We considered the model having the smallest AICc value as the one explaining best our observations.

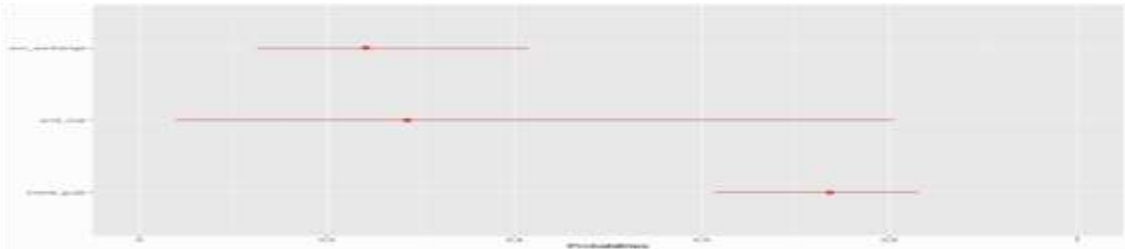
Results

Previous work has demonstrated that baboon leavetaking behavior, specifically, the orientation of the body in the direction of parting, is used significantly in social interaction endings when compared to proximity or solo endings (Baehren and Carvalho, 2022). Following this, we examine whether, within social separations, internal or external motivations for ending better predict leave-taking behavior. We predict that external motivations for ending social interactions will be better predictors of leave-taking than internal motivations in wild chacma baboons. We analyzed 216 social interactions to examine the relationship between internal and external factors driving separation, with the predetermined presence of leave-taking events. A likelihood ratio test showed a significant difference between the full and null models ($\chi^2 = 21.468$, $P = 0.000667$), showing that our full model was more informative than the corresponding null model. The comparison of the model weights between the two models provides the greatest support for the internal, which had a 100% chance of explaining the data better than the external model. These results suggest that the internal motivators for leave-taking best predict orientation shifting in chacma baboons when compared to external motivators. The specific results of the models highlight some interesting results. For instance, infant grabbing was the predictor most likely to lead to orientation-shifting behavior (Table 5). This behavior has around 75% association with the shifting orientation (Fig. 4B). Lack of social exchange was negatively associated with orientation shifting behavior, meaning that not moving to another social interaction was associated with a lack of leave-taking. Replacement by a third individual also approached significance. In contrast, features of the "outside world" i.e., separate from the interaction, were not significantly associated (Fig. 4A), such as other individuals moving away or distracted by other noninteracting individuals (Table 6). These findings suggest that features relating to the interaction itself are better drivers of leave-taking in chacma baboons than those relating to the outside world.



(a)

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(b)
Fig. 4: Relationship between orientation shifting and the; (A): External and; (B): Internal predictors of separation

Table 5: Results of the GLMM testing the internal model where * denotes statistically significant values (p-value <0.05)

	Estimate	SE	Z	CI	P
Intercept	-0.51	0.23	-2.23	-0.96-0.06	0.03*
Social exchange	-1.15	0.41	-2.80	-1.95-0.34	0.01*
Duration	0.00	0.00	0.96	0.00-0.00	0.34
Copulation call	-0.92	1.19	-0.77	-3.25-1.42	0.44
Infant grab	1.03	0.29	3.54	0.46-1.60	0.00*

Table 6: Results of the GLMM testing the external model where (*) denotes values approaching statistical significance (p-value <0.05)

	Estimate	SE	Z	CI	P
Intercept	0.01	0.16	0.09	-0.29-0.32	0.93
Distract	-0.56	0.49	-1.13	1.53-0.41	0.26
Imitate	-0.19	0.43	-0.43	-1.02-0.65	0.66
Replace	-1.14	0.59	-1.94	-2.30-0.01	0.05(*)

Discussion

Albert and Kessler (1976) presented a valuable framework almost fifty years ago to help conceptualize reasons for interaction endings and how this can translate into the endings themselves. Until now, there has been no empirical test of this framework and no discussion of its application to non-human species. Understanding how such proximate drivers of endings relate to leave-taking can help us understand the evolution of social strategies to navigate interactions. In non-human primates specifically, this can help us understand how and why leave-taking may have evolved to become a possible universal in humans (Baehren, 2022). Building on previous research identifying leave-taking in wild chacma baboons (Baehren and Carvalho, 2022) the results of this study suggest that orientation in the direction of parting reflects the internal motivation to end interactions rather than external drivers of the behavior from the outside world. When investigating motivators to leave social endings, orientation is significantly less likely when separation is driven by external factors. This suggests that leave-taking behaviors may be inhibited when the motivation to leave is from features intrinsic to the social interaction. One potential reason could be the "obviousness" of external motivations to leave; as Albert and Kessler (1976) argue, if a sudden fire causes an interaction to cease then it is unlikely that much time must be spent to make this clear. However, this may only be true in such "emergency" or "unexpected" endings and may not be true in predictable

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external endings, such as resource exhaustion and thus does not sufficiently explain the lack of external drivers of leave-taking. One further explanation for this could be that at such a low level of separation (the dyad level), distraction and imitation may not necessitate leave-taking because the group as a whole retains its cohesion, despite the dyad separation. Internal drivers-to-end interactions may be more important for navigating low-level separations and external drivers may prove to be of greater importance when considering sub-group separation or group fission. There was a significant association between orientation shifting and internal reasons to leave, suggesting that this behavior is used differentially to manage expectations of internally motivated endings. There is no available data to compare the results of this study directly to human separations, but Albert and Kessler (1976) suggest that human populations acknowledge both internal and external reasons to leave. They discuss internal motivations to end as a process requiring complex communication about factors outside the social interaction, where humans have uniquely evolved the reflective, summarising features that give specific internal needs to tie up the interaction. They state that "internal reasons are those related to the content and history of the interaction itself". That orientation shifting seems driven by such internal reasons to end interactions, raises the possibility that this mechanism of leave-taking could have a deeper evolutionary origin than previously thought. Further application of this framework on other species would help us to better understand the evolution of leave-taking in relation to its motivating factors, but our current findings suggest that internal motivations to end interactions could be the primitive, shared condition in primates that drives leave-taking, whereas external drivers could be derived in humans, or indeed Great Apes. This could reflect the suggestion made by Albert and Kessler (1976) that human language allows for specific reference to the real and justified reasons for ending. In non-human species, external reasons to end may be obvious and require no communication. Further, they likely do not have a system of leave-taking that can refer to "justified" reasons for ending, whereas internal reasons are often justified as external and this could put less selective pressure on the communication of external reasons in general. Evidence suggests that many species of non-human primates use referential communication to reference things in their environment (Seyfarth and Cheney, 2018) and can also employ tactics of deception to deliberately create false expectations and influence the behavior of others (Whiten and Byrne, 1988). However, that such deception could be used to refer to a motivational state and not to tangible features of the environment, remains to be understood. These results further raise the possibility that humans have further developed a process that originally functioned to signal the ending of internal factors to better differentiate between the two categories. Although in baboons some predictors of both internal and external motivation to end are meaningful in predicting orientation shifting, it seems that humans can refer more specifically to the reason for leaving. As outlined by Albert and Kessler (1976), human language can refer to features of the interaction itself e.g., summarising and well-wishing. Furthermore, human language can refer to things beyond the immediate interaction e.g., past, or future interactions. The concept of mental time travel in non-humans is controversial (Cheke and Clayton, 2010), but even conceptualization of present moments in time would require additional cognitive abilities to communicate this during social interaction. In contrast, reference to more tangible features of the external environment is well documented in many non-human primate species (Fichtel, 2020). Our results are consistent with other findings that baboon leave-taking is intentional (Baehren and Carvalho, 2022), here showing that it is consistently associated with features of the interaction. Albert and Kessler (1976) discuss at length the problem of causal attribution, whereby real and justified reasons for leaving are given in human leave-taking (Table 1).

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This is an interesting concept that has no obvious equivalent in nonhuman species (Table 2). For instance, the real reasons seem unable to be concealed or expressed in other species, if boredom is the motivation to leave then it is not justified to use another more socially acceptable reason. Albert and Kessler suggest internal reasons for ending the interaction may be avoided as they could make the interaction less positive e.g., acknowledging boredom, upset, or even that the interaction is over. In a sense this is related to the choice that the interaction is to be terminated, or as framed by Albert and Kessler (1976), it is "related to the suspicion that... somehow something has gone wrong with the interaction". They propose that there is a socially learned drive to give an external justification for any termination, apart from when a positive internal reason is obvious. Without the ability of non-human species to give a different "justified" reason rather than a "real" reason, this could help explain why internal drives do not significantly predict orientation shifting. It is interesting that chacma baboons are significantly less likely to shift orientation in externally motivated endings; this could reflect a more sudden end for which leave-taking is not able to be prepared. We argue it is more likely a lack of the human disposition to prefer external justifications for endings. Although the results presented here provide the first empirical support for the relationship between internal separation drivers and leave-taking, the wider relevance must be carefully considered. Expanding this paradigm to a dataset with a larger sample size would improve the replicability of our findings and our confidence in them. The variables used in the present study are specific to the context of the chacma baboons in Gorongosa National Park and future research would benefit from further expansion to other areas. For example, infant grabbing was used as a proxy of imbalance biases this criterion to female baboons that exhibit this behavior. On the other hand, behavior such as food sharing would be a good measure of resource exhaustion but is not seen in baboon species. Thus, although chacma baboons have provided a useful model to begin exploring these proximate drivers of separation, the findings may not apply to all non-human primate species. The question of whether external drivers of separation relate to leave-taking in species more closely related to humans, such as chimpanzees, remains to be answered and we have thus yet to uncover when this evolved. Indeed, although Albert and Kessler (1976) framework is written with humans in mind, we also lack data on what this looks like empirically. All of these avenues must be explored if we are to have a holistic understanding of how drivers of separation impact leavetaking more widely.

Conclusion

To summarise, the association in chacma baboons of internal motivations to leave social interactions and eliciting leave-taking behavior could be explained by (1) The obviousness of some external reasons, which may not need to be communicated, (2) The apparent inability in non-humans to use techniques such as summarising and mental time travel to communicate features of the interaction which may reflect internal motivation to leave and (3) A lack of social taboo around internal reasons to justify interaction ends. All three of these hypotheses should be further explored, although may prove difficult to test empirically. Importantly, these findings do not suggest that external reasons to leave interactions are not related to driving separation. Indeed, social exchange, imbalance, and resource exhaustion were found to be common reasons to leave social activities. Rather, the findings instead support the idea that these motivations to leave were not significant in predicted orientation leavetaking behavior. Many further questions are raised as a result of applying this framework to non-human species. For instance, expanding the investigation of motivations to end interactions in chimpanzee or spider monkey populations would give insights into how the construction of endings could differ in a fission-fusion species. Furthermore, we may

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expect the importance of internal motivations to end interactions to differ in such a species which is more closely related to humans and in which mental time travel is better documented. Expanding this research to chimpanzees could help us understand the evolutionary changes in leave-taking behavior, for example, did leave-taking in internally driven interaction ends evolve before the homo-pan split? The findings of this research are of great importance in leave-taking research, as they fill the gap in understanding how processes driving the separation itself could also be driving leave-taking. Research in human populations documents well how the nature of leaving affects the presence and expression of leave-taking (Knapp et al., 1973; Duranti, 1997; Rababah and Malkawi, 2012), but this is the first evidence that the same could occur beyond humans. Although context has been considered previously, the subtleties of the endings of social interactions have been ignored. This study extends our understanding of leave-taking beyond just the behavior itself to consider a process that includes the motivation to end and the subsequent construction of such an ending. Albert and Kessler's 1976 milestone paper gives us an important theory underpinning the conceptual archaeology of a temporal place and indeed emphasizes that "the full meaning of a social interaction is known only when the end is known".

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