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Personality Components of Wild Male African Elephants (*Loxodonta africana*) in Amboseli, Kenya

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Abstract – Personality, consistent individual differences in behavior across time and contexts, has been assessed for over 200 non-human species. Personality components have been quantified in both captive and wild female African elephants (*Loxodonta africana*); male personality traits have been explored in working Asian elephants (*Elephas maximus*), and behavioral consistencies have clearly been demonstrated in wild African males. Personality assessments therefore constitute a useful method for understanding individual variance in behavioral traits for elephants. Here we present a rating-based personality score for 55 wild male African elephants, ranging in age from 11-55 years, by observers who had known the males as individuals for at least ten years. We found five robust personality dimensions using principal component analysis. Component 1 (30% of the variance) was characterized by high levels of permissiveness, predictability, and sensitivity and may be related to the evolution of complex social interactions. Component 2 (17% of the variance), negatively correlated with age, represented apprehension, insecurity and fearfulness. Component 3 (12% of variance) was defined by irritability, aggression, tension, and being active. Component 4 (9% of variance) was characterized by high levels of equable, predictable and gentle ratings, and may also be related to group cooperation and positive social dynamics. Component 5 (4% of variance) was also negatively correlated with age and defined by playfulness and curiosity. We illustrate the rich individual differences among adult male African elephants which can be identified and quantified by knowledgeable human observers to create personality profiles.

Keywords – Personality, Elephant male life history, Male social sensitivity, Bellicosity

Personality, the presence of consistent individual differences in behavior across time and contexts, has been studied in over 200 species of nonhuman animals including marine and terrestrial mammals, fish, invertebrates, insects, and birds. Personality, or temperament, emerges from the analysis of persistent behavioral propensities and consistency of trait dimensions across contexts (Highfill et al., 2010). The diversity of species where personality has been demonstrated suggests that it is not just a human phenomenon, but an important aspect of individual biology that guides behavioral responses through time and situations (Réale & Dingemanse, 2012). While some aspects of temperament may be more likely to be expressed when individuals are stressed (marmots, baboons, guppies: e.g., Sih et al., 2012), other elements influence day to day activities, such as interactions with social companions.

The presence of complex life-histories combined with unique genetic inheritance creates variation in behavior, preference, and personality (Dall et al., 2004; Smith & Blumstein, 2008). The Five Factor model from human personality studies, partitioning trait variance into openness to experiences,

conscientiousness, extraversion, agreeableness, and neuroticism, has been mapped onto the description of personality in some non-human animals (Gosling, 2001; Gosling & Vazire, 2002). Although many species do not exhibit the same components, reference points and a common language create the capacity for cross-species comparisons (Costa & McCrae, 1992; Gosling, 2001; Gosling & Vazire, 2002; Highfill & Kuczaj, 2007). Furthermore, studies have validated personality constructs through behavioral observations (Uher, Asendorpf, & Call, 2008; Horback, Miller, & Kuczaj, 2013; Tkaczynski et al., 2019; O'Connell-Rodwell et al., 2024) or outcomes such as reproductive success or mortality (Réale et al., 2010; Altschul et al., 2018), which are critical to understanding the evolution and maintenance of personality dimensions.

For elephants, as with non-human primates (Weiss, 2017), human observer ratings successfully capture individual personality differences. The expression of traits such as boldness, being active, aggressiveness, curiosity or exploratory, and sociability predicted individual responses to the presentation of novel objects (e.g., Barrett & Benson-Amram, 2021) and to environments associated with captivity (Tetley & O'Hara, 2012; Horback et al., 2013). Both wild and captive female African elephants (*Loxodonta africana*) exhibit at least four different personality components, defined as leadership, playfulness, gentleness, and constancy (Lee & Moss, 2012; Horback et al., 2013). In the wild, females who scored highly on traits such as effective and confident were individuals associated with effective family unit leadership and social cohesion (Lee & Moss, 2012). The existence of agreeable and predictable personality profiles underly the high levels of cooperation seen in female elephant multi-level sociality (Wittemyer et al., 2005).

Semi-captive Asian elephants (*Elephas maximus*), which work for set periods during the day under close human supervision and roam during the night, have been shown to exhibit distinct personality components, including attentiveness, sociability, and aggressiveness (Seltmann et al., 2018). The component structure did not differ between males and females, although males were rated by their mahouts (keepers) as higher on aggression and lower on sociability than were females (Seltmann et al., 2019). High levels of human interaction, as well as the structured way in which these individuals' time is managed – similar for all elephants under human care – might impact the expression of personality in a way that differs from the range of personality profiles that could be observed in a natural environment (see also Rossman et al., 2017; Williams et al., 2019).

Personality has recently been quantified in wild male African elephants through a detailed analysis of replicable behaviors in a sample of 34 adult males (O'Connell-Rodwell et al. 2024). Consistent clusters of behaviors were found: affiliation, aggression, dominance, anxiety and relaxed responses. Some behaviors were more apparent in younger compared to older males and varied with social context and associates. Male elephants thus have well documented individual differences in temperament (Evans & Harris, 2008; Wieruckac et al., 2021), leadership (Allen et al., 2020; O'Connell-Rodwell et al., 2011), and at least for some associates, both flexible responses to social contexts and robust replicable behaviors (O'Connell-Rodwell et al., 2024). Here we focus on males only rather than attempting to discriminate among females and males as was successfully done by Seltmann et al. (2019) due to limited samples. The lives of male elephants are often shorter, less predictable and arguably more cognitively and physically demanding than are the lives of females, since males do not have the protection and collective knowledge of a family group to rely on after independence from the family (Lee et al., 2011). They do however often associate in age-graded groups with other males (Evans & Harris, 2008; Chiyo et al., 2011; O'Connell-Rodwell et al., 2011; Wilkie & Douglas Hamilton, 2018), which could equally enable social learning and cooperation, despite intense competition during annual reproductive musth periods (Poole et al., 2011). Thus males face unique life history transitions and social contexts across their lifespan that are not seen in females and we still have limited knowledge of the factors contributing to male lifetime reproductive success, making the assessment of male personality of theoretical importance.

Our aim here is to use long-term insights into an individual male's behavioral traits derived from over 50 years of observations and to relate these traits to individual differences in personality. We suggest that a deeper understanding of the nature of male personality traits should enhance our understanding of how males cope with their uncertain and dynamic world.

Methods

Ethics Statement

The Amboseli Elephant Research Project takes place with permissions from the Office of the President Republic of Kenya, the Kenya Wildlife Service, the National Council of Science and Technology, Kajiado County Council, and is partnered with the Wildlife Training and Research Institute of Kenya. Ethical clearance is associated with all permissions, and observations are conducted in accordance with ASAB (2025) guidelines on the ethical treatment of wild animals during research. If elephants showed any reaction when approached by a vehicle, observers retreated and waited until the elephants no longer responded.

Subjects and Study Site

The elephant population in and around Amboseli National Park, Kenya, has been monitored continuously since 1972 (Moss, 1988, 2001; Moss et al., 2011). The population has varied in size from 480 to ~2000 over the course of the study (Moss et al., 2011; Lee et al., 2022). The Amboseli Elephant Research Project team members are familiar with the elephants as individuals and are aware of variations in behavior as a result of long-term (50+ years) observations on known individuals. We identify individuals and family groups from ear marks and shape, body traits, tusks, and other physical characteristics. We regularly record behavioral associations between individuals and families (Moss, 1988; Moss et al., 2011). There are also extensive demographic data on individuals (over 4,000 elephants), including births, deaths, sightings of individuals and groups, and interactions such as those between musth males or males with females (Moss, 2001). Males in this population leave their natal or birth family at a median of 13.2 years (range 8-18, N = 440). Once independent, they range with other adult males and non-kin families (Lee et al., 2011). Male groups, in the absence of estrus females, tend to be small (2-36 individuals, median = 3) by comparison with female groups (2-550 individuals, median = 20). At the start of the study in 1972, independent males (over 15) made up 46% of the adult population; in 2024 this was 49%.

The average age of the male elephants within the sample was 32 years, with a range of 11 to 55 years. The youngest individual rated was M902 (Espresso) at 11 years and the oldest was M126 (Bad Bull) at 55 years of age (Table S1). All rated males were independent of their birth families and thus considered as full adults and integrated within male social networks and hierarchies.

Procedure

We used subjective observer ratings, provided by five raters, on 55 independent male elephants, using adjectives previously applied to elephants in the study of female personalities (Lee & Moss, 2012). We initially used 31 adjectives (Table S2) for the 55 male elephants. Ratings were made on a 1 to 5 Likert scale: (1) Attribute never displayed; (2) Attribute present but rarely displayed; (3) Attribute present and displayed, but the individual falls halfway between the two extremes of never and very frequently; (4) Attribute displayed frequently; (5) Attribute displayed very frequently (the individual displays an extreme manifestation of the item).

The original adjectives and their specific definitions derive from Stevenson-Hinde & Zunz (1978), where personalities were statistically described for rhesus macaques. The use of adjectives has been robustly replicated in studies over the long-term (see Murray & Diaz, 2025) and those used here are also concordant with descriptors consistently validated for apes (King & Figueredo, 1997; Weiss, 2017). Some of the original English adjectives were difficult to translate into male behavior for non-native English speakers, so ratings for three authors (NN, KS, PCL) were arrived at by discussion of elephant actions and behaviors that composed an adjective, and then a single agreed value was entered on a Likert scale (see below). Discussions of adjective fit with behavior is not typical in personality studies, and we recognize the potential for bias introduced by the English speaker in the group of three raters. She, however, had equally

extensive experience (over 45 years) in elephant observations, as did the other raters. When rated by the group of three observers, a consensus score for each adjective was agreed among these observers based on the frequency and intensity of the behaviors observed. The other two authors (VF: 12 years, CM: 52 years) independently rated males that were well known to them on the same adjectives and scale. We treated the three separate ratings (VF, CM & Group) as independent assessments of different males.

Each of the five raters had extensive experience with the rated male elephants. Since ratings were derived either as a consensus or individually, and different males were chosen by each rater or the rating group as a function of long-term knowledge of a male, no inter-observer concordance could be attempted. Inter-observer concordance has been substantiated by many studies (Gosling & Vazire, 2002), and independence of ratings from the rater's personality is also well validated. We therefore assumed that humans who were highly experienced (from twelve to 50+ years) in observing elephant behavior would hold constructs about elephant activity and behavior in common (see also Lee & Moss, 2012), making their assessments if not reliable, at least based on similar long-term appreciation of elephant behavior. All ratings were collected in 2023 but were based on knowledge of the males from 1994 to 2023 when the males were of full musth age or independent.

Data Handling and Analysis

Adjectives that researchers thought did not apply to at least 80% of individuals were removed entirely from the data set, leaving 25 adjectives. Adjectives removed included cooperative, distractible, intelligent, paternal, opportunistic, and strong. Each individual was ranked for each of the 25 adjectives. Mean scores were used when a male was rated by more than one observer (n = 2 males rated independently twice). Males rated both in and out of musth (n = 6) were also given a mean score (musth promotes greater aggregation with females as well as heightened competition with other males). Missing values for a trait score for an individual were replaced with the mean score for that adjective in analysis (65 out of the total 3,469 values).

Principal component analysis (PCA) in SPSS 25 (IBM Corp) was performed on the trait scores to identify emergent personality components (Wold, Esbensen, & Geladai, 1987; Costello & Osbourne, 2005). Upon inspection of initial scree plots from PCA with and without rotation, five initial eigenvalues were identified and analysis proceeded using rotation to account for intercorrelation in adjective ratings. The component correlation matrix is presented in Table S3.

Given the relatively small sample size for the number of adjectives, an exploratory factor analysis was undertaken as a confirmatory process in R (R Studio, package *psych*) to validate the latent constructs derived from the PCA described below. The EFA used polychoric correlations to account for linearity in Likert ratings, finding Kaiser-Meyer-Olkin factor adequacy of 0.75, validating five similar factors which cumulatively explained 58.4% of the sample variance (Table S4). We used this EFA as sufficient confirmatory evidence for proceeding with the PCA reported below. PCA enables better comparison with other studies, and we did not assume that a latent variable would underly any dimensions extracted.

Each individual was assigned a score for its position on each of the principal components identified (Wold et al., 1987) (Table S5). These scores were also compared with the known age of individuals at the time of rating using Pearson correlations (Eisinga, te Grotenhuis & Pelzer, 2012), testing for linear age effects. All probabilities reported are two-tailed, and a significant difference from the null hypothesis was taken as $p < .05$. Power for the PCA was low (55 individuals, 25 adjectives per individual), so results need to be considered with some caution.

Results

Five initial eigenvalues were identified upon inspection of initial scree plots, as discussed above. PCA was then run with extraction limited to five components with promax rotation and Kaiser Normalization, and which converged in 11 iterations. The Kaiser-Meyer-Olkin measure of sampling adequacy was found to be 0.75 and Bartlett's test for sphericity = 594.2 ($p < .001$). Five personality

components accounted for 71.5% of variance (Table 1). The rotated component matrix shows the loadings for the adjectives that were most salient to that component as *r* values. This included adjectives that were both negatively and positively correlated with each component as indicated in Table 1.

Table 1

Component Loadings (With an R2 of Greater than 0.25) from Principal Components Analysis (Promax Rotation with Kaiser Normalization), with Percentage of Variation Explained by Each Component

	1: Socially sensitive 29.9% of variance	2: Apprehensive 17% of variance	3: Bellicose 11.8% of variance	4: Equable / relaxed 8.7% of variance	5: Playful 4.3% of variance
Sensitive	**.832**				
Social Other Males	**.760**				
Popular	**.732**				
Protective	**.686**				
Equable	.657			**.707**	
Predictable	.634			**.777**	
Social All Others	.606				**.754**
Solitary	**-.614**				
Gentle			-.654	**.758**	
Insecure		**.848**			
Apprehensive		**.847**			
Fearful		**.817**			
Deferential		**.560**			
Effective		**-.595**			
Confident		**-.763**			
Irritable			**.871**		
Active			**.858**		
Aggressive			**.824**	-.692	
Tense			**.804**		
Slow			**-.491**		
Permissive				**.825**	
Excitable				**-.610**	
Eccentric				**-.767**	
Curious					**.753**
Playful					**.746**

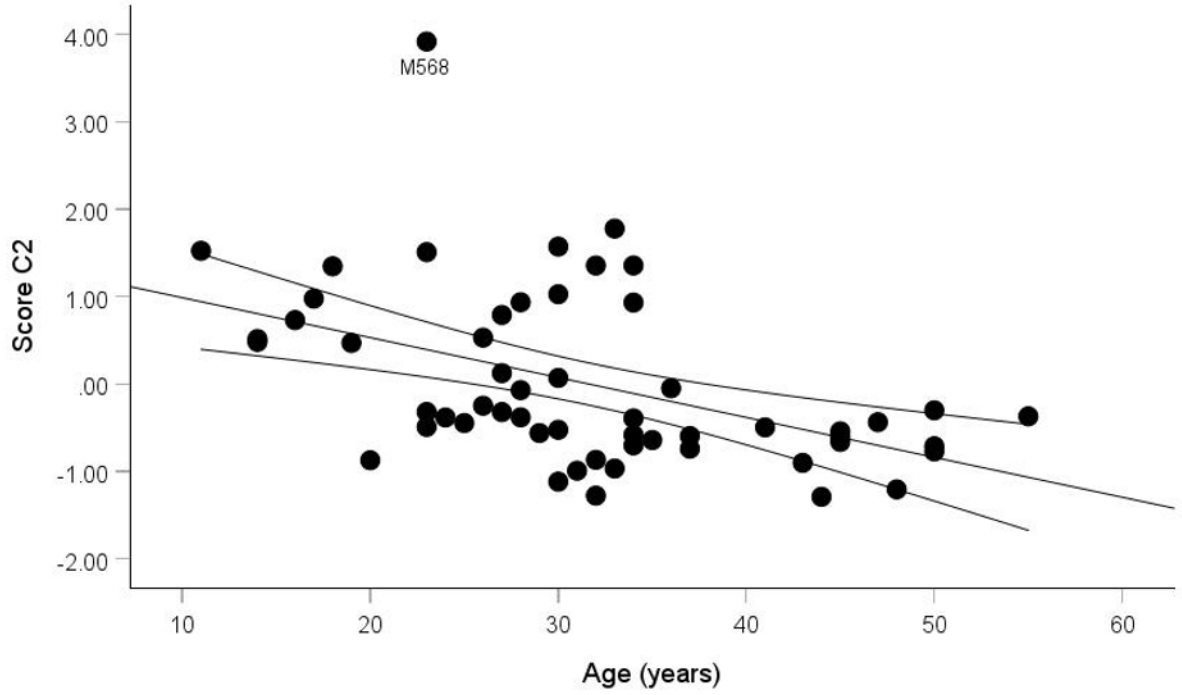
Note. Highest loadings shown in Bold. Extraction Method: Principal Component Analysis. Rotation Method: Promax with Kaiser Normalization.

Component 1, Socially sensitive or Sociability, explained ~30% of the variance and had high loadings for Sensitive, Sociable with other males and Popular, plus low loadings for Solitary. These terms reflect the generally high sociability captured by this component and may be associated with social cohesion and/or cooperation with others. This component does not refer simply to the act of being popular with same-sex conspecifics, but represents more of the individual's pro-social actions towards others in a way that could be consistently identified by the observers. There was a weak trend for a negative association with male age (Pearson r = -0.239, N = 55, p = .08), such that older males tended to be scored lower on social traits, but there was considerable variance in individual scores irrespective of age.

Component 2, Apprehensive accounting for 17% of total variance, had high loadings for apprehensive, insecure, fearful, and deferential and negative loadings for confident. Males scoring high in Apprehension were ranked by observers as acting with caution toward their environment and during their interactions with other individuals. This component had an underlying age dimension, such that it tended to decrease with age (Figure 1).

Figure 1

Individual scores on C2



Note. Apprehensive by male age with linear trend line and 95% Confidence Intervals (Pearson r = -.468, N = 55, p = .002). The outlier (M568) was a male who transferred from his natal family at an early age.

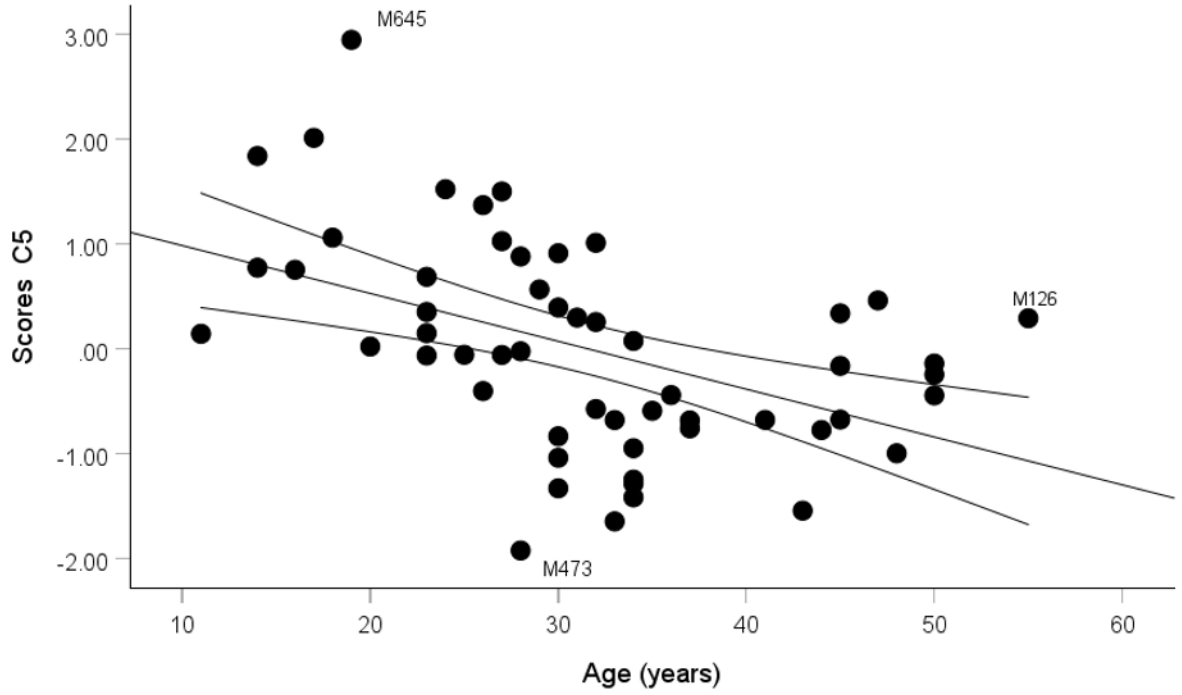
Component 3 is referred to as "Bellicosity" and we suggest that it contains negative dimensions of conscientiousness, unpredictability and instability (Goldberg, 1990), plus encompassing the tension and excitability of an individual. C3 explained ~12% of overall variance with high loadings for irritable, aggressive, and tense. Gentle and slow also loaded negatively. Interestingly, given that the sample contained a mixture of young and musth-age (over 30 years) males, Bellicosity was unrelated with male age (r = -.0042).

Component 4 appeared to reflect males who were gentle, equable, permissive and predictable. While not directly related to "being social" in the sense of C1, these males could be considered easy going and relaxed, and corresponds with the Constancy component identified for females (Lee & Moss, 2012). There was again no association with a male's age in this sample (r = -.141, p = .30).

Component 5 explained 4.3% of variance and had high loadings for curious, playful, and social with all others. This component is referred to as "Playfulness". Playfulness had individual scores which were negatively associated with increasing age (Figure 2). Like C4, a similar component, also named Playful was identified in wild female elephants (Lee & Moss, 2012). Elephants, regardless of sex, are more playful as younger individuals and become less playful as they age although play continues throughout life (Lee & Moss, 2014). Females scoring high for Playfulness were also ranked as being open and curious about new experiences as well highly social and active. Among males, being playful was a less generalized social trait.

Figure 2

Individual Component Scores on C5 (Playful) Plotted Against Male Age



Note. Linear trend line and 95% CI is shown (Pearson R = -0.467, N = 55, p = 0.002). Even the oldest males (e.g. M126) scored above zero on C5. Some individuals were rated as exceptionally playful (M645) while others (M473) were rated as not playful.

Discussion

Wild male African elephants have individual differences in reactivity and responses to others and their environment that shape their behavior and decision-making across their lifespan. As the number of observers and males were both limited in our study, the personality components derived in this study should be viewed with caution, despite highlighting individual differences; these differences may not yet be comprehensive descriptors of elephants in general. We focus on males here as their life history, sociability and reproductive success is distinct from that of elephant females (Lee et al., 2022) and we do not yet have an adequate sample to compare between the sexes.

The personality structures derived here require validation with behavior (e.g., Horback et al., 2013; O'Connell-Rodwell et al., 2024). We would also note, as is common when data reduction methods are used, that there are duplicate loadings on a number of components. Since behavior can support different functions, it might be expected to have loadings on several components. We provide these in Table 1 as exemplars of the kinds of dual loadings that might be predicted.

Prior studies of male personality based on captive elephants (Seltmann et al., 2018; Tetley & O'Hara, 2012) had male aggression as one significant and predominant descriptor, typically viewed by raters as including aggression towards humans. Since opportunities for male-male social engagement (positive or negative) are extremely limited in most captive contexts, we have no way of knowing whether what captive elephants perceive as aggressive in relation to other elephants is concordant with aggressive elephant-human interactions. Our criteria here were based on how elephant males responded to each other and not to humans. However, sociability was a key trait for working Asian elephants, along with aggression. Horback et al. (2013), by contrast, observed no overt aggression during their study and derived components of playful, curious and sociable for their small captive group with a high proportion of immatures.

The individuality of males seen here replicates the diversity of male responses derived from behavioral observations in Etosha (O'Connell-Rodwell et al., 2024), suggesting complementarity in components extracted here with the network structure and interactions seen at waterholes. Similar to the consistent behavioral traits of aggression and dominance that emerged in males using waterholes (O'Connell et al., 2024), in our ratings, one component (C3) contained irritability, aggression and tension. We labelled this as bellicosity rather than aggression per se, since males can indicate power and dominance through subtle signals (Poole, 1989b) rather than overt behavioral engagement with others, and escalated contests are very rare. Being an active, irritable and tense individual was associated with high perceived aggression and a lack of gentleness. Unlike "dominance", which we argue represents outcomes of interactions rather than the trait of an individual (e.g., Hinde & Datta, 1981), bellicosity in our view reflects a more rounded perspective on the exercise of power in male-male interactions outside of events of direct escalated competition during the heightened state of musth (Poole 1989a, b). Given the lack of an association between bellicosity and age, even though male elephant dominance is age-related (Poole, 1989b), this trait appears to reflect a more nuanced capacity to achieve a desired outcome. We suggest that aggressive / dominance interactions could emerge as paramount at waterholes because the individuals have motivations and needs (thirst) which temporarily over-ride sociability. The strongest component (C1) in the Amboseli males was best described as sociability or social awareness. Sociability highlights the dimension of being with other elephants, both male and female, in the absence of aggression or power. Sociability and Affiliation (*sensu* O'Connell-Rodwell et al., 2024) are linked in adjectives and their loadings as well as in our long-term observations of behavior.

Component 2, representing traits and states of being apprehensive, is orthogonal to C3 bellicosity and aligns with O'Connell-Rodwell et al. (2024) behavioral cluster termed anxiety. We again suggest that assessment of "dominance" often reflects traits of those who avoid or deflect threatening engagements – the anxious "subordinates" – rather than those of initiators. The age trends observed in C2 suggest that Apprehension may not represent a stable aspect of personality throughout the life of a male, but rather a characteristic shown at certain points in his life history or in associations with specific other male that tends to lessen with age, size and experience. Flexible responses to social contexts and experience are again highlighted by O'Connell-Rodwell et al. (2024). Greater apprehension on the part of younger individuals may be caused by social inexperience as well as by a clear distinction in size and relative rank. As males age, they become more firmly grounded in the male hierarchy (e.g., Poole, 1989b), and they thus may become less apprehensive, although even a few of the largest and oldest males were rated highly for deferential behaviors. The Amboseli population appears to contain both old deferential males and young pushy ones (see Figure 1), illustrating the mixture of individual traits in apprehension that constitute variability in wild male elephant behavior.

Component 4, Equable / relaxed, may be similar to the female trait of predictability and constancy and potentially related to the concept of conscientiousness. Similarity in component structure between the sexes suggests that personality is not segregated by sex in African elephants (see also Seltmann et al., 2019). The small sample of rated females, restricted to a single family, precludes the testing of males and females in a single analysis. However, both male and female elephants seem to display an element of conscientiousness, here described as equable and constant, which suggests that constancy may be an evolutionarily advantageous aspect of personality for highly social and group living animals. This equable component might also be similar to O'Connell-Rodwell et al. (2024) "social contentment" and the inverse of "socially anxious," Constant individuals are those who are equable, predictable and permissive, and these predictable males may be those specifically chosen by others as associates. Equability or constancy ultimately could be linked to the evolution of elephant group living (Lee & Moss, 2011). Animals within a social network need to be able to predict each other's actions and intentions in order to develop cooperative relationships (Koole et al., 2001). Older matriarchs, who often are the most constant and socially agreeable individuals within a family group (Lee & Moss, 2011), can remember individuals that they encountered briefly many years before. This extensive capacity for memory, combined with consistency in personality and behavior allows individuals in a leadership role to make decisions about the risks of a situation before it occurs (McComb et al., 2011; Mutinda et al., 2011). Males high in equability may thus play leadership

and social cohesion roles within the male social structure (e.g., Wilkie & Douglas-Hamilton, 2018). It will be interesting to overlap personality analysis with social network analysis in males as was done by O'Connell-Rodwell et al. (2024) to assess the effect, if any, of personality on rank and individual interactions in the Amboseli males. Are some males "Keystone" and highly sociable individuals; are some males poorly integrated and thus anxious; or are predictable, playful individuals central to male societies? Component 5, Playful, was also detected in wild females and a captive group with juveniles (Horback et al., 2013), and while there is a clear negative association with age in both males and females, it nonetheless represents a key and frequent social interaction between elephants. Previous studies in mammals (reviewed in Pellis et al., 2015), including elephants (Lee & Moss, 2014), emphasize the importance of play and exploration as tools for younger animals to learn appropriate behaviors as well as to hone combative strategies in a low-risk environment (Webber & Lee, 2020). Play sparring in adult elephants has been shown to produce a high state of arousal and allow for status assessment with minimal to no wounding to participants (Evans & Harris, 2008; Lee et al., 2011). Playfulness, which incorporates social interactions and curiosity, may be associated with knowledge acquisition about the strength, persistence and reliability of others outside of direct contests; as such playfulness could indicate both survival capacity (Lee & Moss, 2014) and reproductive success when play contexts translate to mating competition, or indeed relate to mating opportunities if females prefer familiar, non-threatening and predictable mates.

The importance of distinctive personalities in non-human animals for survival and reproductive success cannot be understated. Social animals have developed unique personalities to co-exist and cooperate in a group. Different personalities are evolutionarily adaptive as they facilitate the ability for a group to solve problems that one individual may be unable to solve or unwilling to approach (Bergmuller & Taborsky, 2010). Elephant sociality is multi-level, and multi-tiered both for females and males, over a lifespan of 60-70 years. Sociability rather than dominance appears to underlie elephant longevity and reproductive success (Lee et al., 2022). Our study, alongside that of O'Connell-Rodwell et al. (2024), provides novel insights into understanding the complexities of personality in male African elephants, as well as the far-reaching evolutionary and adaptive implications of personality differences in social animals (Réale et al. 2010).

Author Contributions: PCL and MW conceptualized the study, PCL developed initial questionnaires, NN and CS compiled responses with PCL, VF and CM. MW and PCL ran analyses. PCL, VF and CM wrote and edited the manuscript after initial drafting by MW.

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Conflict of Interest: Authors declare no conflicts of interest.

Data Availability: Individual adjective rankings for males and R code for EFA are available at www.elephanttrust.org/data-repository/

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Supplementary Materials

Table S1

Identity (Name and Code) and Characteristics of Males Rated in the Study (Date of Birth, Identity of Birth Family and Age at Rating or Last Known Observation)

Male	CODE	DOB	Family ID	Age at Rating / Last observation
Bad Bull	126	Jan-39	unknown	55
Masaku	7	Jan-45	unknown	50
Dionysus	22	Jan-41	unknown	50
Igor	105	Jan-58	IA	50
Ganesh	169	Jan-63	GB	48
Tim	234	Jan-69	TD	47
Sleepy	78	Jan-45	unknown	45
Beach Ball	150	Jan-51	unknown	45
Craig	221	Jan-72	CB	45
Adam	250	Jan-73	AA	44
Pizarro	273	Jan-74	PA	43
Vronsky	321	Dec-76	VA	41
Equinox	305	Jun-80	EA	37
Pascal	331	Jan-80	PC	37
Ramon	346	Apr-81	RA	36
Zelig	365	Oct-82	ZA	35
Bryn	373	Apr-83	BB	34
Calvin	375	Apr-83	CB	34
Finn	377	Mar-83	FD	34
Garth	378	May-83	GB	34
Icarus	380	Apr-83	IB	34
Conor	393	Oct-84	CB	33
Emmanuel	394	Oct-84	EA	33
LeRoy	398	Oct-84	LD	33
Elton	409	Dec-85	EA	32
Gordon	411	Jan-85	GB	32
Zvi	421	Apr-85	ZB	32
X003	X003	Jan-86	unknown	31
X078	X078	Jan-87	unknown	30
Barsaloi	433	Sep-87	BC	30
Gilgil	442	Dec-87	GB	30
Isuka	443	Mar-87	IB	30
Umoja	454	Aug-87	UA	30
Tee-Jay	469	May-88	TD	29
Bjorn	473	May-89	BB	28
Kristian	476	Mar-89	KB	28
Valde	481	Mar-89	VA	28
Arlus	458	Jan-88	AA	27
Esau	490	Dec-90	EB	27
Tor	502	Mar-90	TA	27
Michael	517	May-91	MA	26
X021	X021	Jan-92	unknown	25
Lengai	549	Dec-93	LC	24
Philip	567	Dec-94	PC	23
Palmer	568	Sep-94	PC	23
Townsend	571	Apr-94	TD	23
Titus	572	Jun-94	TD	23

X080	X080	Jan-97	unknown	20
Jafar	645	Apr-98	JA2	19
Imre	674	May-99	IA/IC	18
Jackson	719	Sep-00	JA	17
Google	753	Jun-01	GB	16
Esposito	797	May-03	EB	14
Jeremy	819	Jan-03	JA	14
Espresso	902	Feb-07	EB	11

Table S2

Adjectives and their Definitions as Provided to the Participating Research Staff at the Amboseli Trust for Elephants

Adjective	Definition
Active	Elephant moves around a lot, often at a fast pace and spends little time resting. Often vocal
Aggressive	Elephant causes harm or potential harm to other elephants: e.g., charges, bites, pokes, tusks or kicks
Apprehensive	Elephant seems to be anxious about everything; fears and avoids any kind of risk
Confident	Elephant behaves in a positive assured manner. Makes quick decisions and does not hesitate
Cooperative	Elephant works with others to attain goals
Curious	Elephant readily explores new situations, objects or animals / humans and tries to learn new things
Deferential	Elephant easily gives way to others
Distractible	Elephant easily loses focus and has a short attention span
Eccentric	Elephant displays unusual behaviors, mannerisms or vocalizations
Effective	Elephant successfully gets its own way, for example by influencing the actions of other elephants
Equable	Elephant reacts to others in an even, calm way
Excitable	Elephant overreacts to any change
Fearful	Elephant reacts to threatening objects / situations in an anxious or frightened manner; may grip the tip of their trunk to indicate nervousness or vocalize to signify distress
Gentle	Elephant is careful and caring towards others, not brusque
Insecure	Elephant hesitates to act alone; seeks reassurance from others
Intelligent	Elephant solves problems with intuition
Irritable	Elephant reacts negatively with little provocation
Paternal	Elephant provides a warm, receptive, secure base for others
Opportunistic	Elephant seizes a chance as soon as it arises
Permissive	Elephant could but does not interfere with the behavior of others
Playful	Elephant initiates play and joins in when play is solicited
Popular	Elephant is sought out as a companion by others
Predictable	Elephant's behavior can be predicted by others
Protective	Elephant shows concern for other elephants and often intervenes to protect others from harm or annoyance
Sensitive	Elephant is careful of the moods and movements of others
Slow	Elephant moves in a relaxed, deliberate manner; not hurried to complete tasks or activities
Social Other Males	Elephant likes to make friends and affiliate with other elephants of the same gender
Social All	Elephant likes to make friends with other elephants of the opposite gender
Solitary	Elephant prefers to spend time alone and does not seek out contact with other elephants
Strong	Elephant uses sturdiness and physical strength to achieve goals
Tense	Elephant shows rigidity and restraint in posture and movement; still and not relaxed

Table S3

Component score correlation matrix

Component	1	2	3	4	5
1		.143	-.306	.372	.385
2	.143		-.074	.025	.225
3	-.306	-.074		-.479	-.256
4	.372	.025	-.479		.106
5	.385	.225	-.256	.106	

Note. Extraction Method: Principal Component Analysis. Rotation Method: Promax with Kaiser Normalization.

Table S4

Exploratory Factor Analysis: Final Factor Loadings

	PA4	PA1	PA2	PA5	PA3
SS loadings	3.426	3.347	3.559	2.514	1.742
Proportion Var	.137	.134	.142	.101	.070
Cumulative Var	.137	.271	.413	.514	.584
Active		.790		.167	
Aggressive	-.139	.711	-.146	-.254	
Apprehensive	.176	.246	.839		
Confident	.226	.283	-.732	.155	.163
Curious			-.166	-.151	.818
Deferential	.104	-.277	.472		.330
Eccentric				-.796	.136
Effective	.189		-.599	-.221	
Equable	.500	-.175	.111	.328	.160
Excitable		.125	.237	-.687	.212
Fearful		-.262	.724	-.172	
Gentle	.333	-.394	.210	.394	.199
Insecure		.163	.847		
Irritable	-.138	.793			-.138
Permissive	.362	-.173		.541	
Playful	-.133	-.429	.191	-.225	.543
Popular	.751		-.157		
Predictable	.520	-.154		.447	
Protective	.583	-.213			
Sensitive	.753		.109		
Slow		-.378		.375	-.305
Social All	.433		.108		.554
Social Bull	.683		.101	-.181	
Solitary	-.560	.267	.177	.430	
Tense		.741	.427	-.170	-.168

Table S5

Scores for Individual Males (with Codes and Ages) on Each of the Separate Components (C1 to C5)

Code	Age	C1 Socially sensitive	C2 Apprehensive	C3 Bellicose	C4 Equable	C5 Playful
126	55	-1.68059	-0.37204	1.57012	-2.59906	.29192
22	50	.46682	-.71384	-1.13008	.04109	-.13992
7	50	-.94408	-.77355	-.80095	-.84329	-.44367
105	50	-1.13761	-.3033	-.87744	-.65968	-.24462
169	48	.69609	-1.20765	-.13211	.84767	-.99571
234	47	1.35485	-.4388	-.97706	1.26916	.46171
78	45	-1.29907	-.60146	-1.03183	-.88495	.33851
150	45	-1.39742	-.54345	-1.21737	-1.03004	-.16225
221	45	1.41176	-.6642	-.33484	1.60183	-.67393
250	44	1.66961	-1.2924	-.60438	.49638	-.77395
271	43	-2.37671	-.90415	-.77171	-.22023	-1.54264
321	41	.19105	-.49804	.24446	-1.47787	-.67744
331	37	-.13214	-.7423	.61816	.24679	-.75825
305	37	-.11821	-.59734	1.62695	-1.22075	-.68223
346	36	-1.18355	-.0503	.25734	1.13509	-.44041
365	35	.84265	-.64326	.59741	.123	-.59062
373	34	-1.72055	-.39502	1.8339	.62907	-1.2471
380	34	-1.56581	-.58493	.95796	.11562	-.94753
378	34	-1.66743	1.354	2.33789	-.65607	-1.41582
375	34	-1.00564	-.70402	-.73264	.41036	-1.28439
377	34	-.21962	.9296	1.21641	-.73095	.0756
394	33	-1.13023	-.96894	1.28855	.05408	-.67865
398	33	-.12927	1.776	.03791	-.28572	-1.64508
411	32	1.66012	1.35393	-.58934	.67118	.25601
421	32	.75078	-1.27931	-.41866	.09883	-.57399
409	32	.08301	-.86933	-.67762	1.31129	1.01122
X003	31	.66626	-.99407	.15984	.87676	.29812
442	30	-.56857	1.57017	.38177	-.69848	-1.03816
X078	30	.9119	-1.11932	-.4249	.21808	.91178
443	30	-1.68501	.0679	1.48353	-.21991	-1.32978
433	30	.85821	-.52588	1.41925	-.18551	-.83306
454	30	.55522	1.02536	-1.14525	.88211	.39403
469	29	1.18327	-.56325	-.93777	1.28806	.56674
476	28	1.33992	.93309	-.75115	1.06861	.88054
481	28	-.8738	-.38351	.5454	-.48499	-.0231
473	28	.06085	-.07192	-.84052	.29396	-1.92245
458	27	.83844	.78793	-.34411	1.5444	1.50062
502	27	.33541	.12237	-.87734	-1.43559	1.02689
490	27	.88727	-.32318	-.99123	1.17375	-.05817
X024	26	.85603	.52847	2.17265	-1.13471	1.37046
517	26	.20581	-.25038	-.8402	.71012	-.40221
X021	25	-.34528	-.44876	1.1746	-2.05406	-.05642
549	24	-.43039	-.38471	.04599	.89051	1.52237
568	23	1.38862	3.91574	-.55403	-.55698	.35219
567	23	.10216	1.50662	-.61335	.50971	.14945
572	23	.76294	-.32214	-.07037	-.03049	.68668
571	23	.06573	-.49261	1.28592	-.63957	-.06347
X080	20	.19139	-.87434	1.84011	-2.88537	.02213
645	19	.7134	.46786	-.57744	.02852	2.94615
674	18	.78438	1.34483	-.22214	.28755	1.05995
719	17	-.35292	.97471	-.09969	-.59826	2.01156
753	16	-.21849	.72926	-1.01364	.52862	.75411
819	14	.55595	.51245	-.56814	1.07045	1.8389
797	14	-.18777	.47949	-.97438	.04804	.77379
902	11	-.01975	1.52191	-.95443	1.06186	.14357