# The Adapa Tablets and the Tuxtla Glyphs: Coevolution between Human and Nonhuman Animals

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## The Adapa Tablets and the Tuxtla Glyphs:

## Coevolution between Human and Nonhuman Animals


### Abstract

The purpose of this study was to examine how attitudes toward different nonhuman animal species (including emotional empathy, cognitive empathy, and harm avoidance) are shaped by the coevolutionary histories between the ancestors of contemporary humans and these different nonhuman animal species. We compared the explanatory power of alternative categorization frameworks for classifying attitudes towards animals across several cross-cultural samples (Arizona, California, Costa Rica, Spain, and Mexico). Analytical Approach 1 directly compared two alternative frameworks. *Adapa* categories were generated as purely *functional* ones based upon the ecological niches occupied by each species within the biotic community generated by human-nonhuman animal relations; and *Tuxtla* categories were generated as *cognitive* ones based upon the degrees of consciousness commonly ascribed to the constituent species. Analytical Approach 2 tested the alternative hypothesis that both categories were part of a general scheme organized into three superordinate categories reflecting concentric circles around our own, consistent with fitness interdependence theory. Results supported this alternative hypothesis. The concentric circles model (Kith & Kin Animals, Domesticated Animals, and Wild Animals) better explained empathy and harm avoidance scores, suggesting that attitudes toward specific animal species are partly shaped by which circles they fall into, the product of the coevolutionary relationship shared between them and humans.



**Keywords**: Symbiotic Portmanteau Assemblages; Cognitive Empathy; Emotional Empathy; Harm Avoidance; Human-Animal Interactions


### Introduction

We present the results of a cross-cultural survey whose purpose was to examine the possible cognitive schemata underlying people’s current attitudes toward different nonhuman animal species (including emotional empathy, cognitive empathy, and harm avoidance). To accomplish this objective, we compared the explanatory power of alternative categorization frameworks for classifying attitudes towards animals across several cross-cultural samples (Arizona, California, Costa Rica, Spain, and Mexico). The two alternative frameworks for categorization initially hypothesized were: (1) a purely *functional* one based upon the ecological niches occupied by each species within the biotic community generated by human-nonhuman animal relations; and (2) a *cognitive* one based upon the degrees of cognition, consciousness, or sentience commonly ascribed to the constituent species by popular beliefs. A third alternative, to be described further below, was derived *post hoc* from these results and tested in a subsequent set of analyses.

The main goal of the present analysis was to determine which of these schemata was more *ancestral* in an evolutionary sense by assessing the results of this survey for cross-cultural generalizability. The criterion of using currently shared traits as a basis for inferring its ancestrality was based on assumptions generally made in the well-developed fields of cladistics and phylogenetic analysis, in which shared traits are attributed to common ancestry, consistent with the principle of parsimony. As microevolutionary processes leading to descent with modification are dependent on the existence of common ancestry (Okasha, 2009), phylogenetic comparative methods have been frequently used in fields such as evolutionary anthropology and human behavioral ecology to examine the evolution of human phenotypes after accounting for any underlying shared biocultural ancestry among human groups (Straffon, 2016). Thus, the persistence and modification of biocultural traits are not only a product of ecological variation but also of the phylogenetic inertia, as evidenced by the degree to which two or more biocultural groups share a common ethnolinguistic ancestor (Hoppit & Laland, 2013).

### *Previous Descriptive Work on Attitudes towards Nonhuman Animals*

A number of researchers have previously explored people's attitudes toward animals across cultures. People’s feelings, thoughts, and behaviors toward nonhuman animals offer a unique opportunity for examining the evolution of human-animal interactions. Numerous publications have examined the various factors facilitating the rise of these attitudes (e.g., Hines, 2003; Signal and Taylor, 2007; Knight et al., 2009).

For instance, Wilson described the notion of *Biophilia* as “the innate tendency to focus on life and lifelike processes” (Wilson, 1984, p.1). Building on this, Kellert and colleagues (as described in Kellert and Wilson, 1993) proposed an evolutionary framework for classifying and understanding human attitudes toward nonhuman organisms, including animals, with their respective functions and presumed fitness consequences for humans. Kellert's summary of his extensive cross-cultural research on *Biophilia Values* (in Kellert & Wilson, 1993), includes *Utilitarian* attitudes toward nature (i.e., the practical exploitation of animals). Kellert (1993) also described Biophilia as being comprised of several other evolved attitudes, including *Negativistic* attitudes (e.g., fear and aversion) directed at harmful life forms, *Humanistic* attitudes (e.g., emotional attachment, strong affection) directed at valuable life forms due to their companionship or cooperation, and *Ecologistic-Scientific* attitudes directed at organisms known to generate intellectual and academic curiosity.

However, for others, attitudes towards animals are independent of usefulness, but are based rather on cognitive capacities. The most evident use of cognition as a method for classifying animals can be seen in animal rights debates. According to moral philosophers, the kinds of creatures that deserve moral consideration must have rationality-based cognitive capacities (e.g., Cohen, 1986, Cohen & Regan, 2001) or must be conscious, sentient beings, who can understand that their lives can go better and worse from their own point of view (Regan, 2003, Cohen & Regan, 2001). Further, Wise (2002), a philosopher and animal rights lawyer proposed an *autonomy scale* where species were rated according to cognitive abilities. Moreover, as summarized by Serpell (2004) and later found by Knight and colleagues (Knight et al., 2009) cognitive similarity to humans affects attitudes toward animals (e.g., animals that resemble us in intelligence incur more favorable attitudes).

Individuals also differ in their empathy towards different kinds of nonhuman animals (Herzog et al., 2001). Past research has identified significant differences in people's welfare concerns that depend on the type of nonhuman animal involved. For instance, while a majority of Americans eat chicken, beef, and pork, they are typically aghast at the practice of consuming dog meat seen in other cultures (Oh & Jackson, 2011; Podberscek, 2009). Herzog and colleagues (2001) synthesized the results of various large-scale examinations on attitudes and concerns regarding the welfare of nonhuman animals. The authors reported that relatively few people support primate or dog research involving pain or leading to the nonhuman animal's death. In contrast, a larger number of respondents endorsed using these types of procedures with rats and pigeons. Similarly, as per Herzog, a large percentage of respondents expressed concern for the general welfare of dogs, seals, whales, dolphins, horses, birds, and cats, compared to other species such as frogs, snakes, mice, hamsters, and pigs.

In addition to people varying in their concern and empathy towards different types of animals, past research has also found that some individuals may also act inconsistently toward the same species (Herzog, 2010). For example, over half of Western dog owners see their dogs as family members, yet many dispose of no-longer wanted dogs at shelters to be euthanized (Herzog, 2010). Consequently, the evidence suggests that although some individuals may act inconsistently toward the same species (e.g., dogs), they may still exhibit consistent preferences when asked about different types of animals (e.g., dogs relative to snakes).

The emotional responses elicited by nonhuman animal species may also vary according to their perceived utility to humans. Serpell's work, which has often been concentrated on pets or companion animals specifically, highlights two dimensions that shape attitudes toward nonhuman animals. These include *Affect*, or emotional responses, and *Utility*, or perception of their benefit or instrumental value to humans (Serpell, 2018). From this perspective, many pet species lack practical utility but may provide social support and stimulate an emotional response. Serpell and Paul (2011), in discussing pets as family members, also note the tendency for some individuals to view pets as children (similar to Herzog's misfiring of parental instinct), but also that their emotional connection to their pets may be fueled by the human inclination toward anthropomorphism. Thus pets can elicit strong positive emotional responses because they provide social/emotional support, satisfaction of parenting instinct, or , as Serpell and Paul (2011) also note, happy, healthy pets can advertise their human's nurturing or caregiving skill. So it is not surprising that attitudes toward many pet species are shaped by our emotional response while attitudes toward other species may be influenced more by utility (as food in the case of cattle or transport in the case of horses).

Other approaches to how we might categorize nonhuman animals with regard to our attitudes include Sevillano and Fiske's (2016; 2019) social cognition and stereotype approach, which looks at the roles the dimensions of perceived warmth and competence play in shaping attitudes toward different nonhuman animal species. The dimension of warmth includes intent, whether good or bad, or seen as part of one's in-group or out-group. The competence dimension captures the ability or capacity to achieve goals, including intelligence and cognitive abilities. Their research suggests four broad categories or stereotypes with associated attitudes or emotional reactions. They include subordination/indifference with high warmth and low competence (farm animals, rabbits, birds), threatening/awe with low warmth and high competence (wolves, lions, bears), contemptible/contempt with low warmth and low competence (rodents, reptiles, insects), and protective/fondness with high warmth and high competence (dogs, cats, horses, primates). Another way of labeling these categories is prey, predators, pests, and companions in terms of their social roles in our world.

Many researchers have focused on the role empathy plays in our reactions to nonhuman animals, falling into these different categories, particularly when it comes to how our attitudes influence behavior or our acceptance of the behavior of others. Empathy has been used to predict attitudes regarding our willingness to harm or not harm nonhuman animals. As mentioned previously, empathy has been connected to more positive or caring attitudes toward nonhuman animals generally. However, there are two forms of empathy, emotional and cognitive, where emotional empathy is *sharing* others' emotions, and cognitive empathy consists of *understanding* others' emotions (Abramson et al., 2020). The distinction between emotional and cognitive empathy is well recognized as being derived from distinct neural mechanisms, developmental trajectories, and variably manifest among animal species (Abramson et al., 2020). Emotional empathy, or emotional contagion, evolved as an automatic response to conspecifics or others in distress and leads to caregiving responses, including human caring for other animals. Cognitive empathy relies on cognitive processing (e.g., theory of mind) which may be affected by a person's developmental history and culture as well as possible genetic influences. This capacity enables one to evaluate and predict the needs and desires of another animal. However, much of the research examining empathy toward nonhuman animals and the measures created to do so (Paul, 2000; Tam, 2013) does not distinguish between these two types of empathy. In this study, we will separately address the roles of emotional empathy, cognitive empathy, and harm avoidance, as applied to different categories of nonhuman animals.

***Evolutionary approaches toward nonhuman animal interactions***

Thus, we believe that a truly evolutionary approach to human-nonhuman animal interactions should seek the origins of human attitudes towards animals, such as emotional empathy, cognitive empathy, and harm avoidance, in the coevolutionary dynamics that have characterized our various symbiotic relationships over the last ten to thirty thousand years. Evolutionary ethological approaches to determining the evolutionary origins of any behavioral traits consists of looking for evidence of *adaptive design*, meaning trying to determine whether the characteristics of the existing behavioral phenotypes reflect the design criteria that would be expected of the psychological mechanisms in serving their hypothesized adaptive functions.

We believe that these hypothesized adaptive functions are best understood within the framework of how nonhuman animals fit within the constructed human ecological niche. Alfred Crosby's *Ecological Imperialism* (2004) was among the first to deliver a comprehensive understanding of the role of geography, pathogens, and domesticates on human historical dynamics. Crosby developed the principle of *portmanteau assemblages* for understanding the matrices of coadapted ecological relations between human and nonhuman organisms (domesticated flora and fauna, pathogens, and so-called weeds). Per Crosby, portmanteau assemblages operated in unison and often competed with opposing assemblages soon after contact. Crosby (2004) also noted that Eurasian portmanteau biotas were frequently at the center of these ecological confrontations, in which the invasive assemblage of species often replaced the native flora and fauna and facilitated the expansion of human colonists. This observation suggested that this species assemblage featured a considerable competitive advantage relative to native networks, even when continued human intervention was neither necessary nor sufficient.

Consequently, Crosby concluded that many confrontations associated with European colonialism were not waged between natives and colonists but instead between the indigenous biota and the exotic biota introduced by Eurasian colonists, whether intentionally or otherwise. More importantly, the ecological conquest of exotic species over aboriginal taxa facilitated the subsequent European colonization. Crosby (1986), and later Diamond (1997) and Morris (2010) also acknowledged the fact that nonhuman animal and plant domestication generally originated in what has been referred to as *The Lucky Latitudes*, geographical regions featuring mild-temperate climate (such as portions of Mesoamerica and the South American Andes, the Fertile Crescent, Northern India, and China). Thus, it was not unexpected for the authors that the rise and spread of complex societies also occurred in these regions.

It is worth noting that, despite its merits, Crosby's concept of portmanteau assemblages also had its limitations. Hertler and colleagues (2018) noticed that, the notion of portmanteau (a large trunk or suitcase) rested on a semantically inherent anthropocentric foundation. These authors questioned the assumption that humans operated as the main facilitators of mutualistic relations among nonhuman organisms. Consequently, Hertler and colleagues, recommended instead the notion of *Symbiotic Portmanteau Assemblages* (SPAs) to denote the fact that mutualism between nonhuman species often occurs in the absence of human intervention such as invasive ungulates promoting the spread of foreign weeds or foreign weeds facilitating the establishment of exotic insects (Hertler et al., 2018). SPAs played an essential role in the rise and expansion of human societies across history. The spread of human populations, and consequently their sociopolitical borders, followed the maximal biogeographical ranges of their SPAs. Thus, biogeographic restrictions operating upon the viability of specific SPAs also imposed limits to human demographic dynamics. These patterns are especially evident when considering the biogeographic boundaries associated with the range of human biocultural groups (Hertler et al., 2020). It is worth mentioning that the variation in competitive ability between human societies is largely based on the relative robustness of their SPAs. Productive SPAs provide human groups with enough resources for establishing large-scale and stratified sociopolitical systems. Throughout human history, all Post-Neolithic societies coevolved with their local SPAs. Competition and the eventual replacement of SPAs may occur as long as the local ecology permits it. For instance, Eurasian SPAs introduced to the Americas successfully displaced the native SPAs in geographical areas that resembled the Eurasian ecological landscape (Crosby referred to these regions as *Neo-Europes*, locations found above the Tropic of Cancer and below the Tropic of Capricorn). Alternatively, Eurasian SPAs face considerable challenges invading more tropical areas, such as the Amazonian basin or the humid forests of lowland Mesoamerica.

In addition to biogeographic factors, Hertler and colleagues (2018) proposed that complex SPA networks could outcompete simpler SPA networks. The authors classified the SPA members of the various biogeographic regions by ecomorphic types into: food crops, such as maize, beans, squash, legumes, wheat, barley, rye, cassava, chili peppers, white potatoes, sweet potatoes, tomatoes, and quinoa; forage crops, such as grasses and legumes; artiodactyls, such as cows, pigs, sheep, goats, and camelids; perissodactyls, such as horses and donkeys; galliformes, such as chickens, turkeys, and araucanas; apids, such as stinging and stingless bees; domestic dogs; and humans. Based on this classification, the authors identified significant differences between the SPAs of Eurasia relative to that of pre-Columbian societies. For instance, the Native North American SPA included only: food crops; humans; and canids. Native Mesoamerican SPA entailed only: food crops; galliformes; humans; canids; and apids. Native South American SPA contained only: food crops; artiodactyls; galliformes; humans; and canids.

As evidenced by the species diversities of these *portmanteau biotas,* the Eurasian SPA was considerably more complex relative to the Native American SPA, not only in terms of brute numbers but also on the number of cross-linkages among its interrelated and interdependent members (e.g., artiodactyls and forage crops). Whereas the Eurasian SPA featured 15 of these linkages, all American SPAs were under six, with the North American SPA featuring only 2 linkages, the Mesoamerican SPA featuring only 5 linkages, and the South American SPA featuring only 4 linkages. The number of such linkages is an indicator of their relative systems complexity. The number of such linkages is relevant because the explanatory theory proposed by Hertler and colleagues (2018) was that more complex SPA systems could outcompete less complex ones.

### *The Present Study*

The purpose of the present study was to examine how people's current attitudes toward different nonhuman animal species (including emotional empathy, cognitive empathy, and harm avoidance) are shaped by the varying coevolutionary histories between their ancestors and these different nonhuman animal species. Thus, we tested and compared the explanatory power of alternative categorization frameworks for classifying attitudes towards animals. Analytical Approach 1 directly compared two alternative frameworks based on seemingly very different principles (Analytical Approach 1a and Analytical Approach 2a); Analytical Approach 2 proposed and tested a synthetic framework designed to integrate these two.

For Analytical Approach 1a, the first of these hypotheses was that attitudes towards different nonhuman animal species are based on their *ecomorphs* (Williams, 1983). Ecomorphs represent species that may not be closely related phylogenetically, but nevertheless have evolved similarities due to their occupying similar ecological niches. In the seminal book chapter on this topic, Williams (1983, p. 326) defines ecomorphs as follows:

> The concept is basically the familiar one of convergent evolution – a set of animals showing correlations among morphology, ecology, and behavior, but not lineage – a concept usually applied to widely divergent taxa (for example, the birds of different continents; Karr and James, 1975)…

One such example involving birds of different continents is that Old World and New World vultures are virtually indistinguishable from each other by non-specialists, yet Old World vultures are members of the raptor family (along with hawks and eagles) and New World vultures may actually be more phylogenetically related to the storks (e.g., Seibold & Helbig, 1995). Nevertheless, both Old World and New World vultures occupy similar ecological niches as scavengers.

In the case of the nonhuman animal species that are most closely associated with humans, these ecological niches may be defined by their positions within the different symbiotic portmanteau assemblages (SPAs) historically constructed by human societies (Hertler et al, 2018). This would reflect their different degrees as well as different kinds of evolved fitness interdependence with humans within our niche-constructed ecological hyperspace (Hutchinson, 1957). Based on SPA theory, we would therefore expect that the coevolutionary pressures that have shaped both human and nonhuman animals over the past thirty-thousand years or so have shaped the psychological characteristics of our symbioses (including any feelings we might harbor or beliefs that we might hold) to be governed primarily by the ancestral ecological relations among our species. This logic is based on the *Utility* reasoning detailed above.

For Analytical Approach 1b, the second of these hypotheses was that attitudes towards different nonhuman animal species are instead based on their degree of similarity to humans on dimensions such as cognitive ability or “sentience”. Thus, humans might have a more favorable attitude towards gorillas due to their relatively high degree of intelligence, even though gorilla intelligence is of no self-evident fitness value to humans. Based on this alternative hypothesis, we would expect that our evolved affective or cognitive adaptations were influenced very greatly by any folk psychology beliefs regarding the existence of a hierarchical phylogenetic scale (*scala naturae*) of presumed intellectual superiority of one species over another.

As experimental manipulations, we invented two purely fictional ancient civilizations, the Pre-Sumerian Adapa of Mesopotamia and the Pre-Olmec Tuxtla of Meso-America. Neither of these ancient civilizations ever actually existed, and they were invented for this study just to test two very different alternative hypotheses. Each of these ancient cultures was represented as having different ways in which to think of the relations among human and nonhuman animals: (Analytical Approach 1a) The Adapa categories for human and nonhuman animals were generated as purely *functional* ones based upon the ecological niches occupied by each species within the human SPA, which constitutes the assemblage of species integrated into biotic community generated by the system of human-nonhuman animal relations; and (Analytical Approach 1b) The Tuxtla categories were instead generated as *cognitive* ones based upon the hierarchical levels or degrees of consciousness commonly ascribed to the constituent species by folk-psychological belief.

To test these hypotheses, we used the same experimental manipulations in five cross-cultural sites: (1) Arizona; (2) California; (3) Costa Rica: (4) Spain; and (5) Mexico. We then planned our analyses under the assumption that degrees of cross-cultural generalizability should imply degrees of ancestrality. In phylogenetic comparative methodology, for example, a trait that is shared among various derived taxa is typically presumed to be ancestral (Nunn, 2011; Yang, 1996; Sober, 1983). Such an inference is based on the principle of parsimony, in that the explanation that a shared trait is ancestral is simpler than instead presuming that the same trait evolved independently multiple times in descendent taxa. Therefore, to the extent that the same traits governing human-nonhuman animal attitudes and interactions are generalizable across human biocultural groups, we reasoned that might justifiably infer that those traits were present in a common ancestor and thus were more ancestral rather than evolutionarily derived.

Thus, for example, if the Adapa (functional) hypothesis were the more ancestral principle describing the evolved human species-typical attitudes towards nonhuman animals, we would hypothesize that: (1) The Adapa category scores should generalize well across different cultural groups; and (2) The Tuxtla category scores should not generalize very well across different cultural groups. Conversely, of course, if the Tuxtla (cognitive) hypothesis were the more ancestral principle, then we would expect the opposite outcomes.

For Analytical Approach 2, a third hypothesis was developed and tested that combined elements of the Adapa and Tuxtla hypotheses and organized all the previously tested categories into three superordinate classifications. For Analytical Approach 2, we therefore tested the third alternative hypothesis that both the Adapa and Tuxtla categories could be subsumed under the more general scheme represented by three superordinate categories reflecting concentric circles around our own species: (1) Kith & Kin Animals, including pet or “companion” animals and close phylogenetic relatives like apes; (2) Domesticated Animals; and (3) Wild Animals.

If this third hypothesis instead reflects the more ancestral principle, we would expect that these concentric circles would generalize well both across the data from the fictional Adapa and Tuxtla civilization categories that were nested within them as well as across the data from the five contemporary biocultural groups sampled.

## General Method

### *Participants*

A total of 1121 respondents from 5 different cross-cultural study sites participated in this survey. Of these, 994 respondents self-reported their biological sex. The majority of respondents were female and this pattern was consistent across all locations. Table 1 shows a complete breakdown of the various sample sizes by respondent sex for each cross-cultural sample; Table 2 shows a complete breakdown of the various sample sizes by respondent biogeographical ancestry and cultural ethnic group for each cross-cultural sample.

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[Insert Tables 1 and 2 Here]

### *Measures*

Attitudes toward individual animal species were assessed with three measures. For these three measures, the questions were rated on a seven-point scale from *strongly disagree* to *strongly agree*. Two of these scales were designed to distinguish between the participants’ emotional responses to animals (Emotional Empathy) versus the participants’ understanding of nonhuman animal emotions and thoughts (Cognitive Empathy). The third was designed to assess the participants’ attitudes towards the avoidance of harm to different categories of nonhuman animal species (Harm Avoidance). For each category of species, a scale score was calculated for each of the three measures, based on the arithmetic mean of the nonmissing item values, a procedure called *multivariate imputation* (MVI; Figueredo, McKnight, McKnight, & Sidani, 2000; McKnight, McKnight, Sidani, & Figueredo, 2007).

*Emotional Empathy* consisted of six statements which focused on affective response to nonhuman animals with items such as “I often have tender, concerned feelings for the following animals when they are less fortunate than I” and “The misfortunes of the following animals do not usually disturb me a great deal.”

*Cognitive Empathy* consisted of four statements which focused on understanding of nonhuman animal emotions/thoughts including statements such as “The following animals are capable of a range of feelings and emotions (e.g. pain, fear, contentment, maternal affection)” and “The following animals are more like computer programs, i.e. mechanically responding to instinctive urges without awareness of what they are doing.” Note that this scale measured the human respondents’ thoughts regarding the degree of cognition possessed (or not) by nonhuman animals, not the possession of cognitive empathy by the nonhuman animals themselves, as this latter construct was not assessed in the present study.

*Harm Avoidance* consisted of eight questions assessing how likely participants were to harm or avoid harming different categories of nonhuman animal species. Examples of these questions include “How willing would you be to eat the following animals?” and “How willing would you be to wear clothes or ornaments made from the skin (hide) or fur of the following animals?”

### ***Statistical Analyses***

Generalizability Theory (GT) analysis operates as a mathematical extension of the fundamental theory underlying the Analysis of Variance (ANOVA; Fisher, 1925). An ANOVA is not only capable of estimating the effects' observed variance in the model (the *observed mean squares*) but it can also estimate the corresponding variance components (theoretical entities representing the *expected means squares*). Weighted linear functions connect the observed mean squares with the expected means squares. Just as in a chemical formula, the weighting coefficients operate akin to the chemical subscripts reflecting the number of atoms found associated with each molecule of a chemical compound. Following this analogy, expected mean squares are equivalent to the atomic components and the observed mean squares are equivalent to the molecular compounds thereof. It is worth noting that, as with chemical formulae, the equations must balance. In the case of an ANOVA expected mean squares (EMS) analysis, the equation is balanced based on the model's degrees of freedom, parameters specified as per the study's design, and derived from the number of levels found in each multilevel nominal variable. Variance component models solve the systems of linear equations by partitioning the overall observed variances into the various *variance components* and identifying the "unknown" terms (expected mean squares) from the "known" terms (the observed mean squares). These analytical strategies are implemented via alternative methods such as ordinary least squares (OLS) or maximum likelihood (ML) estimation (Figueredo & Olderbak, 2008).

Variance components can be reordered into either *reliability* or *generalizability* coefficients. Per Classical Test Theory (CTT), a reliability coefficient is operationalized as:

$$E^2 = \sigma^2_t / (\sigma^2_t + \sigma^2_e)$$

In this formula, the component $\sigma^2_t$ represents the *true score* variance, and $\sigma^2_e$ represents the *error* variance. Thus, the equation for the CTT Reliability coefficient can be considered the statistical ancestor of those used in the estimation of Generalizability Theory (GT) coefficients. This is because CTT "reliabilities" already represent a diverse array of different coefficients, including inter-item, inter-rater, test-retest reliability coefficients. These CTT coefficients tacitly aim at generalizing the true score across various dimensions, often referred to as different kinds of "error" (such as items, raters, and testing occasions). Consequently, GT analyses expand this logic to allow researchers to generalize across the various *random facets*, test the corresponding alternative hypotheses, and estimate parameters reflecting the relative magnitude of generalizations performed simultaneously across these multiple facets for comparison and contrast. For instance, a measure may exhibit a larger inter-item consistency than inter-rater reliability and larger inter-rater reliability relative to test-retest replicability. GT coefficients are calculated from the estimated variance components, based on the following formulae (Shavelson et al., 1989):

If r is *nested* within f: $E^2 = \sigma^2_f / (\sigma^2_f + \sigma^2_{r(f)})$

If r is *crossed* with f: $E^2 = \sigma^2_f / (\sigma^2_f + \sigma^2_{r*f})$

In these formulae, f corresponds to the *focal facet* that is being generalized, and r encompassing the *random facet*; thus, f generalizes across r. GT Coefficients are analytically equivalent to CTT Coefficients and are interpreted similarly, where $E^2 = 0$ reflects no generalizability, and $E^2 = 1$ suggests perfect generalizability. We used PROC VARCOMP statement in SAS version 9.4, with hierarchical ordinary least squares (TYPE1) and restricted maximum likelihood (REML) estimation to determine the various variance components in our models. Subsequently, GT Coefficients were computed in MS Excel.

In summary, these analyses used GT Coefficients to estimate the internal consistencies of items within scales as well as of scales within the hypothesized common factors. We do it this way to incorporate the psychometric analyses within the GT models and thus be able to assess the cross-cultural generalizability of these psychometric parameters. Similar applications of GT analysis have been detailed within previous publications in such diverse fields as comparative quantitative ethology (e.g., Figueredo, Cox, & Rhine, 1995) and experimental psycholinguistics (e.g., Figueredo & Olderbak, 2008).

### *Ethics Statement*

The proposal for this study was reviewed and approved by the pertinent Internal Review Boards (IRB). All survey respondents gave informed consent to participate in this study.

## Analytical Approach 1 Method

### *Procedures*

Questionnaire packets were administered online by means of Qualtrics Survey Software (Qualtrics, Provo, UT). Respondents were informed that evolutionary cognitive psychologists had theorized that ancestral categories dating from the first civilizations of which we have any record may form the basis for the folk categorization of animals in all subsequent civilizations that are culturally derived from them, and that, if those theories are valid, then we might expect the reactions and attitudes of modern humans to all reflect that same ancestral patterns.

As experimental manipulations, respondents were introduced to two purely fictional ancient civilizations, the Pre-Sumerian Adapa of Mesopotamia and the Pre-Olmec Tuxtla of Meso-America. Although neither of these ancient civilizations ever actually existed, and they were invented for this study just to test two very different alternative hypotheses, the respondents were not informed of this minor deception until the debriefing at the very end of the survey.

Each of these fictional ancient cultures was represented as having different ways in which to think of the relations among human and nonhuman animals: (1) The Adapa categories for human and nonhuman animals were generated as purely functional ones based upon the ecological niches occupied by each species within the human Symbiotic Portmanteau Assemblage (SPA), which constitutes the assemblage of species integrated into biotic community generated by the system of human-nonhuman animal relations; and (2) The Tuxtla categories were instead generated as cognitive ones based upon the hierarchical levels or degrees of consciousness commonly ascribed to the constituent species by folk-psychological belief.

The description of the Adapa Civilization presented to the respondents was as follows:

> Some ancient baked clay cuneiform tablets were recently discovered in Iraq by archaeologists that purportedly dated from a Pre-Sumerian Civilization, called the Adapa, which presumably existed before the Great Flood of Mesopotamian creation myths. The tablets claim to be a translation from Adapa to Sumerian of lists of animals arranged into ten functional categories, according to the ecological roles that they played in the Adapa world. Some Adapa words had no Sumerian equivalent, so the scribes simply substituted their translations in ancient Egyptian; the Sumerian words do not translate exactly into modern English, but the table below shows what kind of animal was meant by each Adapa category. Please note that these categories are alphabetized, as the Adapa categories were organized in no particular rank order.

Respondents were shown the graphic presented in Figure 1.

[Insert Figure 1 Here]

The description of the Tuxtla Civilization presented to the respondents was as follows:

> In stark contrast to the functional taxonomy used by the Adapa of Mesopotamia were those of the Tuxtla of Meso-America. The Tuxtla were a Pre-Olmec Civilization that, perhaps not coincidentally, was believed to have been swept away by the legendary Great Flood that presumably destroyed the “World of the Fourth Sun” according to the creation myths shared by most pre-Columbian Meso-American civilizations, in remarkable

parallel with those of ancient Mesopotamia. Mexican archaeologists have recently unearthed ancient stone inscriptions ("glyphs") documenting these intriguing differences in their belief systems as compared with those of the Mesopotamians. The glyphs purport to be translations from Tuxtla to Nahuatl (“Aztec”) of lists of animals arranged into quite different categories from those of the Adapa, according to the degree of spiritual development ascribed to them by the Tuxtla. Even among humans, the Tuxtla valued intellectual (“cognitive”) abilities above all other individual characteristics, and ascribed superior intelligence to higher concentrations of spiritual essence; The Nahuatl words do not translate exactly into modern English, but the table below shows what kind of animal was meant by each Tuxtla category. Please note that these categories are alphabetized rather than presented in the Tuxtla rank order to avoid biasing your responses.

Respondents were shown the graphic presented in Figure 2.

[Insert Figure 2 Here]

After the description of each fictional civilization and its categorizations of nonhuman animals, respondents were presented with the questionnaires for Emotional Empathy, Cognitive Empathy, and Harm Avoidance in relation to these categories, although these were not labeled as such. In all cross-cultural samples, the order of presentation of the Adapa and Tuxtla categories, and the associated questions, were counterbalanced. The following instructions were presented with each set of questionnaires:

> Please respond as you would to these categories and not as you believe that these ancient cultures would. For each item, indicate how well it describes you by circling the appropriate number on the scale. Use this table to help you keep the animal categories in mind as you answer each item, and give your best estimate for the entire category of animals rather than just one member.

***Statistical Analysis***

ANOVAs and GT analyses were performed to estimate and test the main effects and interactions of either Adapa or Tuxtla *Category*, *Scale* (Emotional Empathy, Cognitive Empathy, and Harm Avoidance), and *Sample* (Arizona, California, Costa Rica, Spain, and Mexico) for both the Adapa Tablets and the Tuxtla Glyphs data. The GT Coefficients were estimated for each of the following terms for both the Adapa Tablets and the Tuxtla Glyphs data: (1) Category across Scale*Category; (2) Category across Sample*Category; and (3) Category*Scale across Sample*Category*Scale.

## Analytical Approach 1 Results

All of the following models predict participant responses on the various Emotional Empathy, Cognitive Empathy, and Harm Avoidance items as a single dependent (criterion) variable. These were modeled as a function of various categorical variables, such as the Adapa or Tuxtla Categories; the Emotional Empathy, Cognitive Empathy, or Harm Avoidance Scales; and the five Cross-Cultural Samples.

[Insert Table 2 Here]

The General Linear Models (GLMs) indicated that the main effects and interactions of Category, Scale, and Sample were all statistically significant for both the Adapa Tablets and the Tuxtla Glyphs data. The analyses also estimated that these main effects and interactions accounted for 26% and 25% of the systematic variance, respectively, on the Adapa Tablets and the Tuxtla Glyphs data (see Table 2).

[Insert Table 3 Here]

The corresponding Generalizability Theory model estimated high GT coefficients for both the Adapa Tablets and the Tuxtla Glyphs (Table 3). In particular, Category generalized very well across Samples; Category generalized less well across Scales; and the Category by Scale interaction generalized very well across Samples. It is worth noting that the GT coefficients of both the Adapa Tablets and the Tuxtla Glyphs data were not considerably different from each other, as it was originally predicted that they might be.

## Analytical Approach 2 Method

### *Procedures*

Following the results of Analytical Approach 1, Analytical Approach 2 examined the alternative hypothesis that both the Adapa and Tuxtla Categories were part of a general scheme organized into three superordinate categories reflecting concentric circles around our own, consistent with *Fitness Interdependence Theory.* Analytical Approach 2 was thus a secondary reanalysis of the data collected for Analytical Approach 1. In Analytical Approach 2, we tested the alternative hypothesis that both the Adapa and Tuxtla Categories could be subsumed under the more general scheme represented by the following three superordinate categories reflecting hierarchically nested concentric circles around our own species and close associates: (1) *Kith & Kin Animals*; (2) *Domesticated Animals*; and (3) *Wild Animals*. Regarding the name of the first of these superordinate categories, the dictionary definitions of the words *kith* and *kin* refer to *friends* and *family*, respectively. Our usage of the composite category, *Kith & Kin,* was therefore similar to the common use of the synonymous composite “Friends and Family”. In the present application of this expression, it refers to species that are ecologically associated by symbiotic relationships (figuratively, *kith*) as well as those that are phylogenetically related (figuratively, *kin*) by common evolutionary ancestry.

Figure 3 displays these three hypothesized superordinate categories as concentric circles, with a few illustrative examples listed in parentheses for each circle:

[Insert Figure 3 Here]

Tables 4 and 5 represent how the Adapa and Tuxtla Categories were respectively nested within the same system of hypothesized concentric circles. These tables were not shown to study respondents, but were created afterwards by the researchers to test the Analytical Approach 2 alternative hypothesis regarding the three superordinate categories.

[Insert Tables 4 and 5 Here]

### ***Statistical Analyses***

ANOVAs and GT analyses were performed to estimate and test the main effects and interactions of *Circle* (Kith & Kin Animals, Domesticated Animals, and Wild Animals), either Adapa or Tuxtla *Category*, *Scale* (Emotional Empathy, Cognitive Empathy, and Harm Avoidance), and *Sample* (Arizona, California, Costa Rica, Spain, and Mexico) for both the Adapa Tablets and the Tuxtla Glyphs data. The GT coefficients were estimated for each of the following terms for both the Adapa Tablets and the Tuxtla Glyphs data: (1) Circle across Category, nested within Circle; (2) Circle across Scale*Circle; (3) Circle across Sample*Circle; and (4) Circle*Scale across Sample*Circle*Scale.

## **Analytical Approach 2 Results**

All of the following models predict participant responses on the various Emotional Empathy, Cognitive Empathy, and Harm Avoidance items as a single dependent (criterion) variable. These were modeled as a function of various categorical variables, such as the Concentric Circles; the Adapa or Tuxtla Categories nested within the Concentric Circles; the Emotional Empathy, Cognitive Empathy, or Harm Avoidance Scales; and the five Cross-Cultural Samples.

[Insert Table 6 Here]

The GLMs indicated that the main effects and interactions of Circle, Category, Scale, and Sample were all statistically significant for both the Adapa Tablets and the Tuxtla Glyphs data. The models accounted for 26% and 25% of the systematic variance respectively for both the Adapa Tablets and the Tuxtla Glyphs data (Table 6).

[Insert Table 7 Here]

The GT coefficients were relatively high for both Adapa Tablets and Tuxtla Glyphs data. Circles generalized extremely well across Categories within Circles; Circles also generalized very well across Samples and across the Samples*Scales interaction; but Circle generalized much less well across the main effect of Scales. Nevertheless, the GT coefficients of Circles across Categories, Scales, and Samples did not differ considerably between the Adapa Tablets and Tuxtla Glyphs. The Circles, however, provided a more adequate organization for both the Adapa and Tuxtla Categories under a single superordinate scheme. Based on these results we decided to collapse both Adapa and Tuxtla Categories within Circles and proceed to combine the two data sets for the corresponding GT analyses (see Table 7).

[Insert Table 8 Here]

The results of a GLM using the combined Adapa-Tuxtla data indicated that the main effects and interactions Circle, Category(Adapa versus Tuxtla), and Sample were all statistically significant. The model accounted for 23% of the systematic variance (see Table 8).

[Insert Table 9 Here]

The GT coefficients for the combined Adapa-Tuxtla data were all relatively high; The Circles generalized quite well across Categories, across Samples, and across the Category*Scale interaction; however, Circles once again generalized less well across the main effect of Scales. These results confirmed the prediction that the Circles organized the data for both the Adapa and Tuxtla Categories quite well under a single superordinate scheme that worked equally well across fictitious civilizations (see Table 9). Following these results, it was pertinent to conduct basic psychometric analyses to elucidate the latent structure of the data.

[Insert Tables 10 and 11 Here]

An in-depth psychometric evaluation concluded that the internal consistency reliability coefficients of the scales, nested within Scales and Circles, for both the Adapa Tablets and the Tuxtla Glyphs data were adequate. Likewise, the loadings of the scales from the unit-weighted common factors, representing each of the corresponding combination of Scales and Circles, were uniformly high and statistically significant for both the Adapa Tablets and the Tuxtla Glyphs data (see Tables 10 and 11). Overall, the factor loadings ranged from .80 to .97.

[Insert Table 12 Here]

The bivariate correlations among the corresponding Adapa and Tuxtla factor scales, for each combination of Scales and Circles were sizeable in magnitude and statistically significant (see Table 12). For Emotional Empathy, Adapa and Tuxtla Scales correlated above .70 across all three Circle categories. A similar pattern was found for Cognitive Empathy, wherein all correlations where above .60. Furthermore, the correlations between Adapa and Tuxtla Scales for Harm Avoidance were sizeable in magnitude, with these estimates ranging from .83 to .84. Based on the latter evidence, we decided to aggregate the corresponding Adapa and Tuxtla factor scales across Categories for each combination Scales and Circles.

[Insert Table 13 Here]

For the Combined Emotional Empathy Scales, the analyses revealed sizeable and significant bivariate correlations between KITHKIN and DOMESTIC and between DOMESTIC and WILD. In contrast, the correlation between KITHKIN and WILD, though statistically significant was considerably weaker in magnitude (.23). A similar pattern was found for the Combined Cognitive Empathy Scales, wherein KITHKIN and DOMESTIC, as well as DOMESTIC and

WILD, had strong and significant correlations. These findings supported the pattern that one might expect from the Concentric Circles Model (see Table 13).

For the Combined Harm Avoidance Scale, however, we detected strong and significant correlations, all above .80, between KITHKIN, DOMESTIC, and WILD. This finding for Harm Avoidance violated the pattern that one would expect from the Concentric Circles Model, in that the immediately adjacent Circles did not have higher correlations than the nonadjacent Circles (see Table 13).

## General Discussion

The purpose of Analytical Approach 1 was to test and compare the explanatory power of two alternative categorization frameworks for classifying attitudes towards animals. Our *a priori* hypotheses that the Adapa (functional) category scores should generalize well across different cultural groups whereas the Tuxtla (cognitive) category scores should *not* generalize very well across different cultural groups was empirically *disconfirmed*. The Tuxtla category scores generalized just as well across Emotional Empathy, Cognitive Empathy, Harm Avoidance, and across five cross-cultural samples (Arizona, California, Costa Rica, Spain, and Mexico) as the Adapa category scores. These findings suggest that *functional* categorizations of human and nonhuman animals might be no more ancestral than *cognitive* ones.

The purpose of Analytical Approach 2 was to test our alternative hypothesis that both the Adapa (functional) and Tuxtla (cognitive) categories could be subsumed under a more general scheme, represented by three superordinate categories (Kith & Kin Animals, Domesticated Animals, and Wild Animals). This hypothesis was empirically supported. These superordinate categories reflected a series of *concentric circles* around our own species, with greater empathy for species considered part of the inner circle of Kith and Kin. Further, our findings suggest that both Emotional and Cognitive Empathy are more ancestral for Kith & Kin Animals than for Domesticated Animals, and for Domesticated Animals than for Wild Animals, perhaps evolving radially outwards in that order. Harm Avoidance, however, appears to be equally ancestral for all three concentric circles.

Finally, the surprising degree of correspondence between the independently-derived Adapa (functional) and Tuxtla (cognitive) categories is worth contemplating: This finding suggests some degree of evolutionary influence of nonhuman animal ecological functions within human symbiotic portmanteau assemblages (SPAs) upon their selected cognitive abilities. Additionally, our explicit investigation of Emotional Empathy separate from Cognitive Empathy yielded a similar radiating pattern of correlation among the concentric circles: Both empathies showed a high correlation between Kith & Kin Animals and Domesticated Animals, and between Domesticated Animals and Wild Animals, with low correlation between Kith & Kin Animals and Wild Animals. This finding suggests these distinct empathy mechanisms may have coevolved in the service of symbioses within the SPAs and that, perhaps as a result, emotional and cognitive empathy are not very distinguishable when it comes to functional or sentient/cognitive categorization and associated affective attitudes.

### *Limitations and Future Directions*

Though the concentric circles framework of nonhuman animal attitudes appears to best explain the data from our multicultural sample, there are various limitations to our study. First, the sample population was mostly relatively young college students, which may be more homogeneous appearing than a more representative sample of the different populations. Second, females were overrepresented in the sample population, likely due to the sex ratio skew towards females found on most college campuses, as well as the general tendency for more females than males to respond to questionnaires whether they are college students or not. Given the sex differences in empathy toward nonhuman animals previously reported, our female-skewed sample may influence the relative levels of empathy for the species represented in the different concentric circles (e.g., higher for pets in Kith & Kin Animals, lower for Wild Animals) as well as the general female tendency to avoid harm of all nonhuman animals (Costa et al., 2001; Herzog, 2007; Taylor & Signal, 2005).

Another sampling limitation stems from the fact that the five cross-cultural sites selected for study were limited by our network of international contacts and the number of languages in which the authors of this study were proficient. More potential collaborators were also asked to participate during the planning stages of this project, but not all of them were either willing or able to do so. Two of the cross-cultural sites were mostly English-speaking and three of them were mostly Spanish-speaking; four of them were located in the Americas and one in Europe. We understand that this is not a comprehensive representation of the diversity of the world's biocultural groups; however, we wanted to make some attempt at cross-cultural data collection rather than restrict our survey to a single biocultural group, as is done so often.

In addition, a more idiographic approach to understanding attitudes toward nonhuman animals may be fruitful, as suggested by previous findings that take sex into consideration. In addition to sex, we have also collected a number of possibly relevant variables to consider in future analyses. These idiographic predictors include personal experiences with different species of nonhuman animals (such as growing up on a farm, with pets in the home, etc.), interpersonal relationship behavior, dark triad personality traits, and sibship birth order. In addition, we would also like to examine any effects of the zoogeographic regions of origin for individual respondents (i.e., country of birth categorized by zoogeographic region), which could indicate evolved genetic biases.

Finally, the similar performance of the Emotional Empathy and Cognitive Empathy scales is somewhat surprising. Further exploration of the similarities and differences in these forms of empathy in relation to nonhuman animals is needed.

***Conclusions***

While a wide range of researchers have explored the factors shaping people's attitudes toward animals, few have focused on a co-evolutionary approach, testing the relative impact functional versus cognitive categories of species have on emotional versus cognitive empathy as well as harm avoidance. The lack of difference between the functional and cognitive categories led to our concentric circles model (Kith & Kin Animals, Domesticated Animals, and Wild Animals) which better explained both empathy and the harm avoidance scores. This suggests that our attitudes toward specific animal species are partly shaped by which of these concentric circles they fall into and the type of co-evolutionary relationship shared between them and humans. Our results add to the evolutionarily informed animal attitudes literature as well as to the body of evidence that disaggregates attitudes toward a wide array of animal species into three main categories of animals.

***References***


Abramson, L., Uzefovsky, F., Toccaceli, V., & Knafo-Noam, A. (2020). The genetic and environmental origins of emotional and cognitive empathy: Review and meta-analyses of twin studies. *Neuroscience & Biobehavioral Reviews*, *114*, 113-133.

Borgi, M., & Cirulli, F. (2015). Attitudes toward animals among kindergarten children: species preferences. *Anthrozoös*, *28*(1), 45-59.

Cohen, C. (1986). The case for the use of animals in biomedical research. *The New England Journal of Medicine, 315*(14), 865–870.

Cohen, C., & Regan, T. (2001). *The animal rights debate*. Rowman & Littlefield.

Costa, P. T., Terracciano, A., & McCrae, R. R. (2001). Gender differences in personality traits across cultures: Robust and surprising findings. *Journal of Personality & Social Psychology, 81*, 322–331.

Crosby, A. W. (2004). *Ecological imperialism: the biological expansion of Europe, 900-1900*. Cambridge: Cambridge University Press.

Diamond, J. (2013). *Guns, germs, and steel: a short history of everybody for the last 13,000 years*. New York: Random House.

Figueredo, A. J., McKnight, P. E., McKnight, K. M., & Sidani, S. (2000). Multivariate modeling of missing data within and across assessment waves. *Addiction*, *95 (Supplement 3)*, S361-S380.

Figueredo, A.J. & Olderbak, S.G. (2008). Generalizability theory analysis for psycholinguistic applications. *Journal of Memory and Language*, *59*, 426–433.

Figueredo, A.J., Cox, R.L., & Rhine, R.J. (1995). A generalizability analysis of subjective personality assessments in the Stumptail macaque and the Zebra finch. *Multivariate Behavioral Research*, *30*(2), 67-197.

Gray, R. D., & Atkinson, Q. D. (2003). Language-tree divergence times support the Anatolian theory of Indo-European origin. *Nature*, *426*(6965), 435-439.

Hertler, S. C., Figueredo, A. J., & Peñaherrera-Aguirre, M. (2020). *Multilevel Selection: Theoretical Foundations, Historical Examples, and Empirical Evidence*. New York: Springer.

Hertler, S., Figueredo, A. J., Peñaherrera-Aguirre, M., Fernandes, H. B. F., & Woodley of Menie, M. A. (2018). *Life History Evolution: A Biological Meta-Theory for the Social Sciences*. New York, NY: Palgrave Macmillan.

Herzog Jr, H. A., Betchart, N. S., & Pittman, R. B. (1991). Gender, sex-role orientation, and attitudes toward animals. *Anthrozoös*, *4*(3), 184-191.

Herzog, H. (2010). *Some We Love, Some We Hate, Some We Eat: Why it's so Hard to Think Straight About Animals*. New York: Harper.

Herzog, H., Grayson, S., & McCord, D. (2015). Brief measures of the animal attitude scale. *Anthrozoös*, *28(1)*, 145-152.

Herzog, H., Rowan, A., & Kossow, D. (2001). Social attitudes and animals. In D.J. Salem & A.N. Rowan (Eds.). *The state of the animals 2001* (pp. 55-69). Washington, DC: Humane Society Press.

Hines, L. M. (2003). Historical perspectives on the human-animal bond. *American Behavioral Scientist*, 47(1), 7-15.

Hoppitt, W., & Laland, K. N. (2013). *Social learning*. Princeton University Press.

Hutchinson, G. E. (1957). Concluding Remarks. *Cold Spring Harbor Symposia on Quantitative Biology*, *22*, 415-427.

Jordan, F., & Mace, R. (2005). The evolution of human sex-ratio at birth: a bio-cultural analysis. In *The evolution of cultural diversity: a phylogenetic approach* (pp. 207-216). UCL Press.

Jordan, P., & Shennan, S. (2003). Cultural transmission, language, and basketry traditions amongst the California Indians. *Journal of Anthropological Archaeology*, *22*(1), 42-74.

Kellert, S. R., & Berry, J. K. (1987). Attitudes, knowledge, and behaviors toward wildlife as affected by gender. *Wildlife Society Bulletin (1973-2006)*, *15*(3), 363-371.

Kellert, S., & Wilson, E. O. (eds.) (1993). *The Biophilia Hypothesis*. Washington: Island Press.

Knight, S., Vrij, A., Bard, K., & Brandon, D. (2009). Science versus human welfare? Understanding attitudes toward animal use. *Journal of Social Issues*, 65(3), 463-483.

Knight, S., Vrij, A., Bard, K., & Brandon, D. (2009). Science versus human welfare? Understanding attitudes toward animal use. *J. Social Issues*, *65(3*), 463-483.

Knight, S., Vrij, A., Cherryman, J., & Nunkoosing, K. (2004). Attitudes towards animal use and belief in animal mind. *Anthrozoös*, *17*(1), 43-62.

Mace, R., Holden, C. J., Shennan, S., Clare, H., & Shennan, S. J. (Eds.). (2005). *The evolution of cultural diversity: a phylogenetic approach*. Psychology Press.

McKnight, P. E., McKnight, K. M., Sidani, S., & Figueredo, A. J. (2007). *Missing Data: A Gentle Introduction*. New York, NY: Guilford.

Morris, I. (2010). Why western science conquered the world. *New Scientist*, *208*(2784), 32-34.

Nunn, C. L. (2011). *The comparative approach in evolutionary anthropology and biology*. Chicago: University of Chicago Press.

O'Brien, M. J., Boulanger, M. T., Buchanan, B., Collard, M., Lyman, R. L., & Darwent, J. (2014). Innovation and cultural transmission in the American Paleolithic: phylogenetic analysis of eastern Paleoindian projectile-point classes. *Journal of Anthropological Archaeology*, *34*, 100-119.

Oh, M., & Jackson, J. (2011). Animal rights vs. cultural rights: Exploring the dog meat debate in South Korea from a world polity perspective. *Journal of intercultural studies*, *32*(1), 31-56.

Paul, E. S. (2000). Empathy with animals and with humans: Are they linked? *Anthrozoös 13,* 194–202.

Pifer, R., Shimizu, K., & Pifer, L. (1994). Public attitudes toward animal research: Some international comparisons. *Society & Animals*, *2*(2), 95-113.

Podberscek, A. L. (2009). Good to pet and eat: The keeping and consuming of dogs and cats in South Korea. *Journal of Social Issues, 65,* 615–632.

Regan. T. (2003). *Animal rights, human wrongs : an introduction to moral philosophy*. Rowman & Littlefield.

Seibold, I., & Helbig, A. (1995). Evolutionary History of New and Old World Vultures Inferred from Nucleotide Sequences of the Mitochondrial Cytochrome b Gene. *Philosophical Transactions: Biological Sciences, 350*(1332), 163-178.

Serpell, J. A. (2004). Factors influencing human attitudes to animals and their welfare. *Animal Welfare*, *13*, 145-151.

Serpell, J. A. (2018). Companion animals. In G. Hosey & V. Melfi (Eds.), *Anthrozoology: human-animal interactions in domesticated and wild animals* (pp. 17-31). New York: Oxford University Press.

Serpell, J. A., & Paul, E. S. (2011). Pets in the Family: An Evolutionary Perspective. In C.A. Salmon & T.K. Shackelford (Eds.), *The Oxford handbook of evolutionary family psychology* (pp. 297- 309). New York: Oxford University Press.

Sevillano, V., & Fiske, S. T. (2016). Warmth and competence in animals. *Journal of Applied Social Psychology*, *46(5)*, 276-293.

Sevillano, V., & Fiske, S. T. (2019). Animals as social groups: An intergroup relations analysis of human-animal conflicts. In K. Dhont & G. Hodson (Eds.), *Why We Love and Exploit Animals: Bridging Insights from Academia and Advocacy* (pp. 260-283). London: Routledge.

Signal, T. D., & Taylor, N. (2007). Attitude to animals and empathy: Comparing animal protection and general community samples. *Anthrozoos*, *20*, 125-130.

Sober, E. (1983). Parsimony in systematics: philosophical issues. *Annual Review of Ecology and Systematics*, *14(1)*, 335-357.

Straffon, L. M. (Ed.). (2016). *Cultural Phylogenetics: Concepts and Applications in Archaeology* (Vol. 4). Springer.

Tam, K. P. (2013). Dispositional empathy with nature. *Journal of Environmental Psychology*, *35*, 92–104. doi:10.1016/j.jenvp.2013.05.00434 V.

Tehrani, J., & Collard, M. (2002). Investigating cultural evolution through biological phylogenetic analyses of Turkmen textiles. *Journal of anthropological archaeology*, *21*(4), 443-463.

Williams, E. E. (1983). Ecomorphs, faunas, island size, and diverse end points in island radiations of *Anolis*. In R. B. Huey, E. R. Pianka, & T. W. Schoener, (Eds.) *Lizard Ecology: Studies of a Model Organism* (pp. 326-370). Cambridge, MA and London, England: Harvard University Press.

Wilson, E. O. (1984). *Biophilia*. Cambridge: Harvard University Press.

Wise, S. M. (2002). *Drawing the line : science and the case for animal rights*. Perseus Books.

Yang, Z. (1996). Phylogenetic analysis using parsimony and likelihood methods. *Journal of Molecular Evolution, 42(2),* 294-307.

**Table 1.** *Numbers of participants identifying as biologically female and male in each of our cross-cultural samples. Overall, more women than men participated in the study.*

| ***Sample*** | ***Women*** | ***Men*** | ***Other*** | ***Subtotal*** | ***Missing*** | ***Total*** |
|---|---|---|---|---|---|---|
| *Arizona* | 159 | 113 | 2 | 274 | 21 | 295 |
| *California* | 136 | 81 | 1 | 218 | 12 | 230 |
| *Costa Rica* | 62 | 36 | 1 | 99 | 53 | 152 |
| *Spain* | 169 | 18 | 1 | 188 | 22 | 210 |
| *Mexico* | 158 | 56 | 1 | 215 | 19 | 234 |
| *Total* | 684 | 304 | 6 | 994 | 127 | 1121 |

**Table 2.** *Proportions of participants in each of our cross-cultural samples, disaggregated by self-reported biogeographical ancestry and cultural ethnic group.*

| ***Biogeographical Ancestry*** | ***Arizona*** | ***California*** | ***Costa Rica*** | ***Spain*** | ***Mexico*** |
|---|---|---|---|---|---|
| *Australian Aborigine/ Papuan/Melanesian (ex. Fijian, Moluccans)* | .02 | .00 | .09 | .00 | .03 |
| *Caucasian/European (ex. English, French, German, Russian, Spanish)* | .56 | .65 | .36 | .88 | .35 |
| *Mashriqi/Maghrebi (ex. Moroccan, Egyptian, Syrian, Iraqi)* | .02 | .02 | .06 | .03 | .03 |
| *Native American/American Indian (ex. Cherokee, Hopi, Mayan, Navaho)* | .07 | .12 | .19 | .06 | .46 |
| *Northeast Asian (ex. Chinese, Japanese, Korean)* | .21 | .08 | .06 | .02 | .05 |
| *Polynesian/Pacific Islander (ex. Native Hawaiian, Maori, Samoan)* | .01 | .02 | .05 | .00 | .02 |
| *South/Central Asian (ex. Iranian, East Indian, Pakistani, Sri-Lankan)* | .03 | .02 | .06 | .00 | .03 |
| *Southeast Asian (ex. Malaysian, Filipino, Indonesian)* | .02 | .06 | .05 | .01 | .02 |
| *Sub-Saharan African (ex. Congolese, Kenyan, Nigerian, Rwandan)* | .05 | .04 | .07 | .01 | .02 |
| ***Cultural Ethnic Group*** | ***Arizona*** | ***California*** | ***Costa Rica*** | ***Spain*** | ***Mexico*** |
| *Afro-American Culture* | .12 | .09 | .19 | .05 | .09 |
| *Anglo-American Culture* | .31 | .37 | .18 | .54 | .14 |
| *Asian-American Culture* | .22 | .12 | .10 | .04 | .07 |
| *Hispanic-American/Latin-American Culture* | .27 | .34 | .35 | .32 | .62 |
| *Native American/First Nation Culture* | .06 | .06 | .11 | .03 | .05 |
| *Native Chamorro/Hawaiian/ Samoan Culture* | .00 | .02 | .07 | .01 | .03 |

**Table 3.** *General Linear Models for the Adapa Tablet and the Tuxtla Glyph Data.*

| **Source** | **DF** | **ADAPA $\eta^2$** | ***F-ratio*** | **TUXTLA $\eta^2$** | ***F-ratio*** |
|---|---|---|---|---|---|
| *Category* | 10 | .088* | 405.36 | .086* | 385.82 |
| *Scale* | 2 | .025* | 578.67 | .030* | 686.37 |
| *Category*Scale* | 20 | .035* | 80.28 | .033* | 75.13 |
| *Sample* | 4 | .046* | 526.39 | .047* | 532.3 |
| *Category*Sample* | 40 | .027* | 30.69 | .022* | 24.28 |
| *Scale*Sample* | 8 | .017* | 98.79 | .022* | 123.06 |
| *Category*Scale*Sample* | 80 | .011* | 6.56 | .011* | 5.98 |
| *Whole Model $R^2$* | 164 | .259* | 72.63 | .253* | 69.52 |

* $p < .05$

**Table 4.** *Generalizability Models for the Adapa Tablet and the Tuxtla Glyph Data.*

| **Variance Component** | **ADAPA REML** | **TUXTLA REML** |
|---|---|---|
| $\sigma^2$*(Category)* | .15521 | .15784 |
| $\sigma^2$*(Scale)* | .05988 | .07615 |
| $\sigma^2$*(Category*Scale)* | .11380 | .11022 |
| $\sigma^2$*(Sample)* | .08341 | .08268 |
| $\sigma^2$*(Category*Sample)* | .06047 | .04648 |
| $\sigma^2$*(Scale*Sample)* | .04943 | .06649 |
| $\sigma^2$*(Category*Scale*Sample)* | .03930 | .03704 |
| $\sigma^2$*(Error)* | 1.44418 | 1.50028 |
| **Generalizability Coefficients** | **ADAPA** | **TUXTLA** |
| *Category* across *Scale*Category* | *.577* | *.589* |
| *Category* across *Sample*Category* | *.720* | *.773* |
| *Category*Scale* across *Sample*Category*Scale* | *.743* | *.748* |

**Table 5.** *The Adapa Categories Nested within Three Concentric Circles (Kith & Kin Animals, Domesticated Animals, and Wild Animals).*

| Concentric Circle | Adapa Category | Examples in English |
|---|---|---|
| **Kith & Kin Animals** | KEE | monkeys, apes, lemurs |
| | MIW | cats |
| | NAMLUGALLU | humans ("civilized" people) |
| | UR | dogs |
| **Domesticated Animals** | ESSURU | chickens, turkeys, geese, ducks |
| | SAHU | cows, pigs, sheep, goats, llamas, alpacas |
| | SISU | horses, donkeys, camels |
| **Wild Animals** | BJ | honeybees, stingless bees |
| | KUA | catfish, carp |
| | SHITTU | snakes, spiders, scorpion |
| | UH | rats, mice |

**Table 6.** *The Tuxtla Categories Nested within Three Concentric Circles (Kith & Kin Animals, Domesticated Animals, and Wild Animals).*

| Concentric Circle | Tuxtla Category | Examples in English |
|---|---|---|
| **Kith & Kin Animals** | MITZCUINTLI | dogs, cats |
| | OZOMAHTLI | monkeys, apes, lemurs |
| | TOLTECATL | humans (“wise one”, “lord”) |
| **Domesticated Animals** | MAATL | cows, sheep |
| | PITZOTL | pigs, goats |
| | XUEHXOLOTL | chickens, turkeys, geese, ducks |
| | YAMA | horses, donkeys, llamas, alpacas, camels |
| **Wild Animals** | CAXTILLĀN | rats, mice |
| | COATL | snakes, spiders, scorpion |
| | MICHIN | catfish, carp |
| | XICOHTLI | honeybees, stingless bees |

**Table 7**. *General Linear Models for the Adapa Tablet and the Tuxtla Glyph Data, with Categories Nested Within Concentric Circles.*

| **Source** | **DF** | **ADAPA** $\eta^2$ | ***F-ratio*** | **TUXTLA** $\eta^2$ | ***F-ratio*** |
|---|---|---|---|---|---|
| *Circle* | 2 | .076* | 1745.41 | .078* | 1746.28 |
| *Category(Circle)* | 8 | .012* | 70.24 | .008* | 45.65 |
| *Scale* | 2 | .023* | 537.58 | .027* | 618.23 |
| *Scale*Circle* | 4 | .028* | 317.61 | .028* | 320.42 |
| *Scale*Category(Circle)* | 16 | .007* | 20.95 | .005* | 13.79 |
| *Sample* | 4 | .045* | 517.96 | .050* | 566.69 |
| *Sample*Circle* | 8 | .018* | 102.53 | .014* | 77.96 |
| *Sample*Category(Circle)* | 32 | .009* | 12.72 | .008* | 10.86 |
| *Sample*Scale* | 8 | .017* | 99.98 | .021* | 116.44 |
| *Sample*Scale*Circle* | 16 | .008* | 22.47 | .006* | 17.96 |
| *Sample*Scale*Category(Circle)* | 64 | .004* | 2.58 | .004* | 2.98 |
| *Whole Model* $R^2$ | 164 | .259* | 72.63 | .253* | 69.52 |

* $p < .05$

**Table 8**. *Generalizability Models for the Adapa Tablet and the Tuxtla Glyph Data, with Categories Nested Within Concentric Circles.*

| **Variance Component** | **ADAPA REML** | **TUXTLA REML** |
|---|---|---|
| $\sigma^2$*(Circle)* | .16769 | .21374 |
| $\sigma^2$*(Category(Circle)* | .02080 | .01366 |
| $\sigma^2$*(Scale)* | .02463 | .03309 |
| $\sigma^2$*(Scale*Circle* | .11033 | .12332 |
| $\sigma^2$*(Scale*Category(Circle)* | .02854 | .01694 |
| $\sigma^2$*(Sample* | .07014 | .08356 |
| $\sigma^2$*(Sample*Circle* | .04708 | .03855 |
| $\sigma^2$*(Sample*Category(Circle)* | .02399 | .01955 |
| $\sigma^2$*(Sample*Scale* | .04089 | .05490 |
| $\sigma^2$*(Sample*Scale*Circle* | .03732 | .03085 |
| $\sigma^2$*(Sample*Scale*Category(Circle)* | .01118 | .01476 |
| $\sigma^2$*(Error)* | 1.44415 | 1.50027 |
| **Generalizability Coefficients** | **ADAPA** | **TUXTLA** |
| *Circle* across *Category(Circle)* | *.890* | *.940* |
| *Circle* across *Scale*Circle* | *.603* | *.634* |
| *Circle* across *Sample*Circle* | *.781* | *.847* |
| *Circle*Scale* across *Sample*Circle*Scale* | *.747* | *.800* |

**Table 9**. *General Linear Models for the Combined Adapa Tablet and the Tuxtla Glyph Data, with Categories Nested Within Concentric Circles.*

| **Source** | **DF** | **COMBO $\eta^2$** | ***F-ratio*** |
|---|---|---|---|
| *Circle* | 2 | .076* | 3341.54 |
| *Scale* | 2 | .025* | 1076.41 |
| *Circle*Scale* | 4 | .027* | 600.09 |
| *Civilization* | 1 | .000* | 34.28 |
| *Civilization*Circle* | 2 | .000* | 15.5 |
| *Civilization*Scale* | 2 | .000* | 4.23 |
| *Civilization*Circle*Scale* | 4 | .000* | 3.75 |
| *Sample* | 4 | .048* | 1044.48 |
| *Circle*Sample* | 8 | .015* | 165.27 |
| *Scale*Sample* | 8 | .018* | 202.03 |
| *Circle*Scale*Sample* | 16 | .007* | 36.17 |
| *Civilization*Sample* | 4 | .000* | 6.06 |
| *Civilization*Circle*Sample* | 8 | .001* | 8.32 |
| *Civilization*Scale*Sample* | 8 | .000* | 4.37 |
| *Civilization*Circle*Scale*Sample* | 16 | .001* | 2.95 |
| *Whole Model* $R^2$ | 89 | .226* | 222.46 |

* $p < .05$

**Table 10**. *Generalizability Models for the Combined Adapa Tablet and the Tuxtla Glyph Data, with Categories Nested Within Concentric Circles.*

| **Variance Component** | **COMBO REML** |
|---|---|
| $\sigma^2$*(Circle)* | .19391 |
| $\sigma^2$*(Scale)* | .02860 |
| $\sigma^2$*(Circle*Scale)* | .12205 |
| $\sigma^2$*(Civilization)* | .00094 |
| $\sigma^2$*(Civilization*Circle)* | .00116 |
| $\sigma^2$*(Civilization*Scale)* | .00000 |
| $\sigma^2$*(Civilization*Circle*Scale)* | .00029 |
| $\sigma^2$*(Sample)* | .07849 |
| $\sigma^2$*(Circle*Sample)* | .04565 |
| $\sigma^2$*(Scale*Sample)* | .04641 |
| $\sigma^2$*(Circle*Scale*Sample)* | .03310 |
| $\sigma^2$*(Civilization*Sample)* | .00000 |
| $\sigma^2$*(Civilization*Circle*Sample)* | .00276 |
| $\sigma^2$*(Civilization*Scale*Sample)* | .00064 |
| $\sigma^2$*(Civilization*Circle*Scale*Sample)* | .00448 |
| $\sigma^2$*(Error)* | 1.52695 |
| **Generalizability Coefficients** | **COMBO** |
| *Circle* across *Scale*Circle* | *.614* |
| *Circle* across *Civilization*Circle* | *.994* |
| *Circle* across *Sample*Circle* | *.809* |
| *Circle*Scale* across *Civilization*Circle*Scale* | *.998* |
| *Circle*Scale* across *Sample*Circle*Scale* | *.787* |
| *Circle*Scale* across *Civilization*Sample*Circle*Scale* | *.965* |

**Table 11.** *Reliability Coefficients and Unit-Weighted Factor Loadings for the Adapa Tablet Data, with Categories Nested Within Concentric Circles.*

| Adapa Tablets | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Emotional Empathy** | | | **Cognitive Empathy** | | | **Harm Avoidance** | | |
| | **Alpha** | **Kithkin** | | **Alpha** | **Kithkin** | | **Alpha** | **Kithkin** |
| **KEE** | .86 | *.87** | **KEC** | .62 | *.94** | **KEH** | .86 | *.93** |
| **MWE** | .86 | *.83** | **MWC** | .62 | *.93** | **MWH** | .82 | *.96** |
| **NAE** | .84 | *.86** | **NAC** | .62 | *.87** | **NAH** | .85 | *.92** |
| **URE** | .84 | *.92** | **URC** | .63 | *.95** | **URH** | .81 | *.96** |
| | **Alpha** | **Domestic** | | **Alpha** | **Domestic** | | **Alpha** | **Domestic** |
| **ESE** | .88 | *.90** | **ESC** | .56 | *.90** | **ESH** | .78 | *.96** |
| **SAE** | .85 | *.89** | **SAC** | .59 | *.92** | **SAH** | .77 | *.96** |
| **SIE** | .87 | *.92** | **SIC** | .60 | *.93** | **SIH** | .84 | *.94** |
| | **Alpha** | **Wild** | | **Alpha** | **Wild** | | **Alpha** | **Wild** |
| **BJE** | .87 | *.82** | **BJC** | .60 | *.89** | **BJH** | .85 | *.96** |
| **KUE** | .86 | *.84** | **KUC** | .63 | *.89** | **KUH** | .79 | *.93** |
| **SHE** | .90 | *.80** | **SHC** | .70 | *.85** | **SHH** | .84 | *.93** |
| **UHE** | .89 | *.86** | **UHC** | .62 | *.80** | **UHH** | .80 | *.94** |

* $p < .05$

**Table 12**. *Reliability Coefficients and Unit-Weighted Factor Loadings for the Tuxtla Glyph Data, with Categories Nested Within Concentric Circles.*

| Tuxtla Glyphs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Emotional Empathy** | | | **Cognitive Empathy** | | | **Harm Avoidance** | | |
| | **Alpha** | **Kithkin** | | **Alpha** | **Kithkin** | | **Alpha** | **Kithkin** |
| **MZE** | .83 | *.91** | **MZC** | .62 | *.92** | **MZH** | .81 | *.96** |
| **OZE** | .83 | *.81** | **OZC** | .68 | *.87** | **OZH** | .87 | *.95** |
| **TOE** | .88 | *.80** | **TOC** | .73 | *.80** | **TOH** | .87 | *.92** |
| | **Alpha** | **Domestic** | | **Alpha** | **Domestic** | | **Alpha** | **Domestic** |
| **MAE** | .85 | *.93** | **MAC** | .62 | *.94** | **MAH** | .81 | *.95** |
| **PIE** | .85 | *.94** | **PIC** | .60 | *.94** | **PIH** | .79 | *.95** |
| **XUE** | .85 | *.85** | **XUC** | .61 | *.90** | **XUH** | .79 | *.97** |
| **YAE** | .84 | *.87** | **YAC** | .62 | *.93** | **YAH** | .84 | *.93** |
| | **Alpha** | **Wild** | | **Alpha** | **Wild** | | **Alpha** | **Wild** |
| **CAE** | .89 | *.86** | **CAC** | .64 | *.85** | **CAH** | .83 | *.95** |
| **COE** | .90 | *.91** | **COC** | .66 | *.94** | **COH** | .82 | *.96** |
| **MIE** | .86 | *.87** | **MIC** | .69 | *.93** | **MIH** | .80 | *.94** |
| **XIE** | .89 | *.85** | **XIC** | .69 | *.89** | **XIH** | .86 | *.95** |

* $p < .05$

**Table 13.** *Correlation Matrices for Corresponding Adapa Versus Tuxtla Common Factors, with Categories Nested Within Scales and Circles.*

| | | Adapa Emotional Empathy | | |
|---|---|---|---|---|
| | | **Kithkin** | **Domestic** | **Wild** |
| **Tuxtla Emotional** | **Kithkin** | ***.73**** | .61* | .12* |
| | **Domestic** | .65* | ***.72**** | .50* |
| | **Wild** | .27* | .43* | ***.79**** |
| | | **Adapa Cognitive Empathy** | | |
| | | **Kithkin** | **Domestic** | **Wild** |
| **Tuxtla Cognitive** | **Kithkin** | ***.68**** | .54* | .22* |
| | **Domestic** | .54* | ***.63**** | .53* |
| | **Wild** | .22* | .51* | ***.72**** |
| | | **Adapa Harm Avoidance** | | |
| | | **Kithkin** | **Domestic** | **Wild** |
| **Tuxtla Harm Avoidance** | **Kithkin** | ***.83**** | .74* | .73* |
| | **Domestic** | .74* | ***.86**** | .80* |
| | **Wild** | .75* | .82* | ***.84**** |

* $p < .05$

**Table 14.** *Correlation Matrices for Corresponding Adapa and Tuxtla Common Factors Combined, with Categories Nested Within Scales and Circles.*

| | | Combined Emotional Empathy | | |
|---|---|---|---|---|
| | | **Kithkin** | **Domestic** | **Wild** |
| **Combined Emotional** | **Kithkin** | 1.00 | ***.79**** | ***.23**** |
| | **Domestic** | .79* | 1.00 | ***.56**** |
| | **Wild** | .23* | .56* | 1.00 |
| | | **Combined Cognitive Empathy** | | |
| | | **Kithkin** | **Domestic** | **Wild** |
| **Combined Cognitive** | **Kithkin** | 1.00 | ***.78**** | ***.34**** |
| | **Domestic** | .78* | 1.00 | ***.73**** |
| | **Wild** | .34* | .73* | 1.00 |
| | | **Combined Harm Avoidance** | | |
| | | **Kithkin** | **Domestic** | **Wild** |
| **Combined Harm Avoidance** | **Kithkin** | 1.00 | ***.86**** | ***.87**** |
| | **Domestic** | .86* | 1.00 | ***.94**** |
| | **Wild** | .87* | .94* | 1.00 |

* $p < .05$

Figure

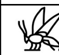
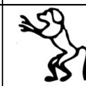
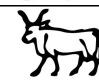
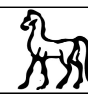
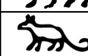
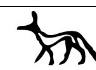
| Adapa Category | Examples in English | Hieroglyph |
|---|---|---|
| BJ | honeybees, stingless bees |  |
| ESSURU | chickens, turkeys, geese, ducks |  |
| KEE | monkeys, apes, lemurs |  |
| KUA | catfish, carp |  |
| MIW | cats |  |
| NAMLUGALLU | humans (“civilized” people) |  |
| SAHU | cows, pigs, sheep, goats, llamas, alpacas |  |
| SHITTU | snakes, spiders, scorpion |  |
| SISU | horses, donkeys, camels |  |
| UH | rats, mice |  |
| UR | dogs |  |

**Figure 1.** *The Adapa Categories.*

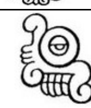
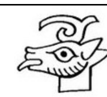
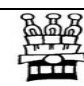
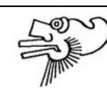
| **Tuxtla Category** | **Examples in English** | **Hieroglyph** |
|---|---|---|
| CAXTILLĀN | rats, mice |  |
| COATL | snakes, spiders, scorpion |  |
| MAATL | cows, sheep |  |
| MICHIN | catfish, carp |  |
| MITZCUINTLI | dogs, cats |  |
| OZOMAHTLI | monkeys, apes, lemurs |  |
| PITZOTL | pigs, goats |  |
| TOLTECATL | humans (“wise one”, “lord”) |  |
| XICOHTLI | honeybees, stingless bees |  |
| XUEHXOLOTL | chickens, turkeys, geese, ducks |  |
| YAMA | horses, donkeys, llamas, alpacas, camels |  |

**Figure 2.** *The Tuxtla Categories.*

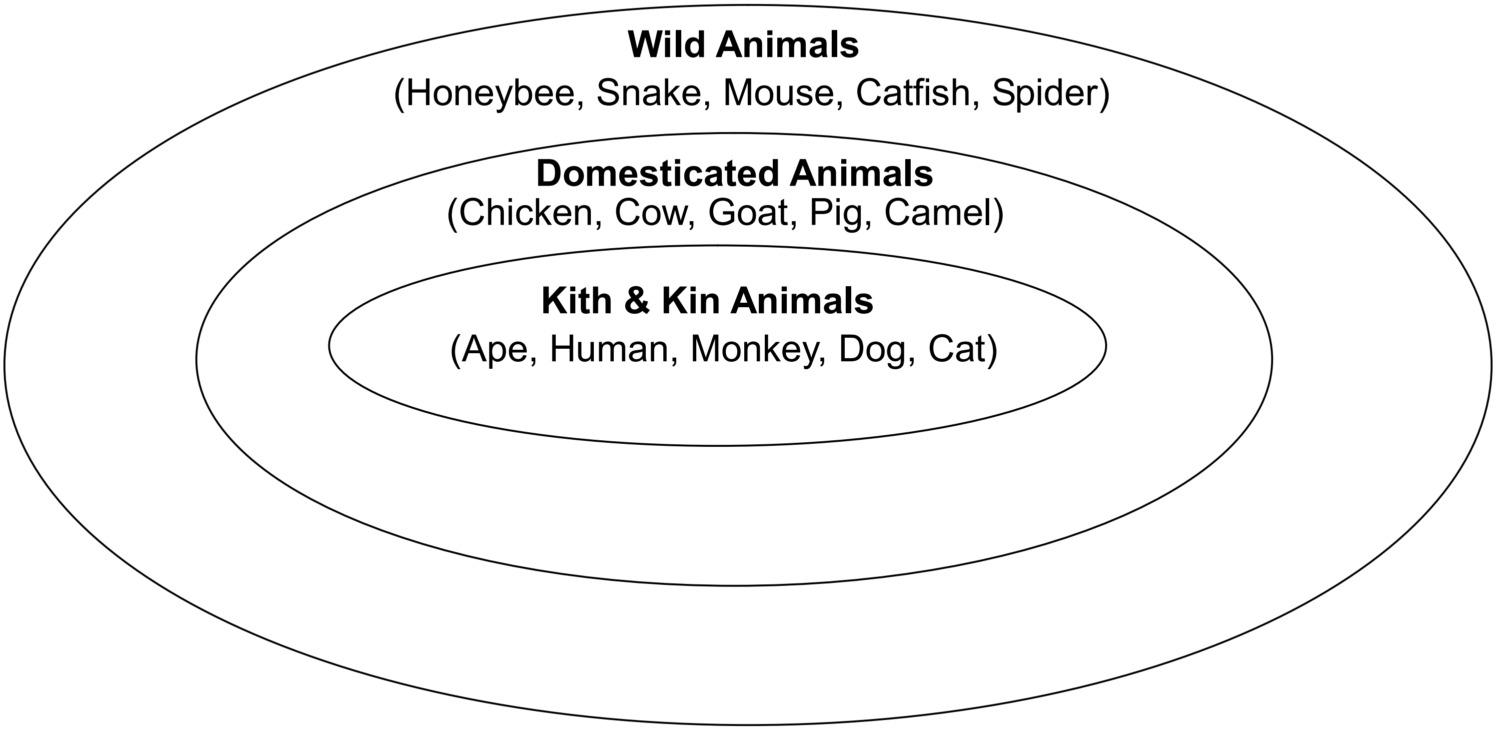



**Figure 3.** *Concentric Circles Model for the Adapa Tablets and the Tuxtla Glyphs.*