

**Personality assessment of three species of captive monkey
Macaca nigra, *Macaca sylvanus*, and *Saimiri sciureus*:
Cross-species comparisons of personality and implications
for captive management**

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Abstract

The study of animal personality, i.e. consistent individual differences in animal behaviour, is a rapidly growing research field. The construct of personality has been studied in many different scientific disciplines including ethology, behavioural ecology, psychology, animal management and physiology. Studying personality using a comparative framework is important for establishing whether phylogeny and/or ecology are a driving force in personality development. The applied use of personality assessments to aid captive animal management could also have far reaching ramifications, as recent studies have demonstrated that personality has relationships with variables such as health, welfare and breeding success. Within the animal personality literature three main methods of assessing personality have been developed: i) coding behavioural data under natural conditions, ii) coding animals' responses during novelty tests and iii) rating animals on sets of behaviourally defined traits.

In the current study personality was investigated in three primate species, Sulawesi black crested macaques (*Macaca nigra*), barbary macaques (*Macaca sylvanus*) and common squirrel monkeys (*Saimiri sciureus*). The two macaque species are closely related, being from the same genus, but show some differences in their ecology and behaviour while *S. sciureus* are phylogenetically distinct but exhibit some similarities to the two macaque species in certain aspects of their ecology and behaviour. The aims of the study were twofold: i) establish whether phylogeny or socioecology has an impact on the development of personality structure by comparing the study species with other primate species, and ii) evaluate the use of personality assessments as a tool for the management of the study species in captivity.

Personality was assessed using the trait rating method. Questionnaires consisting of 38 personality traits, with accompanying definitions, were sent to all European institutions holding any of the study species. Keepers were required to rate animals on each trait using a 1 – 7 interval scale. Personality assessments were tested for inter-observer reliability. For each species a Principal Components Analysis (PCA) was carried out using only traits that exhibited good inter-observer reliability and scores for animals on each of the resulting components (personality dimensions) were calculated. Construct validity of the personality dimensions was assessed by evaluating the relationships between personality dimension scores and, i) behaviour under natural conditions, and ii) behaviour during a novel object test. In order to assess the management implications of personality assessments further analyses were carried out using the personality dimension data, i) a MANOVA

was used to assess whether personality dimension scores were affected by Zoo, Age and Sex, ii) Generalised Linear Mixed Models (GLMMs) were used to assess which, if any, specific Zoo variables effect mean personality scores, iii) multiple regression and ANOVA analyses were carried out to establish whether personality dimension scores could predict breeding variables in *M. nigra*, iv) parent-offspring regressions were used to assess the heritability of personality dimensions in *M. nigra*, and v) correlation and General Linear Model (GLM) analyses were used to assess whether personality dimension scores effected behavioural measures of enrichment use in a *M. nigra* group.

Twenty four traits in *M. nigra* (N= 64), 25 traits in *M. sylvanus* (N= 62) and 18 traits in *S. sciureus* (N= 69) were rated reliably by human observers. When reliable traits were entered into a PCA for each species, results revealed three personality dimensions for *M. nigra*, Sociability, Dominance, and Emotionality; four personality dimensions for *M. sylvanus*, Sociability, Dominance, Emotionality and Human-Animal Sociability (HA-Sociability); and three personality dimensions for *S. sciureus*, Sociability, Dominance, and Cautiousness. Construct validity of each species personality ratings, in terms of relationships with observable behaviour, was demonstrated for each species. Validity was affected by contextual variables such as Zoo, Age and Sex, which, as personality can vary with the variables (see below) was to be expected.

MANOVA results showed that the variable 'Zoo' had significant effects on personality dimension scores in all three species. Further investigation using GLMMs revealed that i) in *M. nigra* mean Sociability scores were higher in groups with a lower mean age, ii) in *S. sciureus* mean Sociability scores were higher in groups where keepers had a high mean experience (months) working with the animals, and iii) again in *S. sciureus* mean Cautiousness scores were higher in groups with a small total group size. Multiple regression showed that personality dimension scores could not predict breeding success variables in either male or female *M. nigra* individuals. Of the three variables that could affect the breeding success of a male/female partnership, Male, Female and Zoo, only Male identity significantly affected breeding success but this could not be assessed against personality. Of the three *M. nigra* personality dimensions only one, Sociability, appears to have a heritable component. There were no significant correlations between personality dimension scores of individual *M. nigra* and measures of enrichment use across a range of enrichment devices. Repeated measures GLM revealed that while the individuals did spend significantly different amounts of time interacting with each of the enrichment devices this did not vary as a function of either repetition number or personality.

When comparing the three study species with other primate species, the Sociability and Dominance dimensions were comparable with previous research on non-human primates (NHP), except that

aggressive-type traits found in other studies were not present in the Dominance dimension in *M. nigra* and *M. sylvanus*. This may be attributed to data suggesting they have more tolerant social systems compared to other primate species. The Emotionality dimension was similar across the two macaque species and was comparable to analogous dimensions in other NHP species. The Cautiousness dimension in *S. sciureus* was found to be similar to dimensions such as fearfulness and bold/shy in other NHP species. The HA-Sociability dimension found in *M. sylvanus* could not be compared with other primate studies as, to date, there has been limited investigation of human-directed personality dimensions in captive primates. Quantitative analyses using partial Mantel tests were conducted to evaluate if either phylogenetic similarity or similarity in socioecological variables significantly correlated with similarities in personality structure for 11 primate species (including the three study species). The results of this analysis were inconclusive as neither phylogenetic similarity nor socioecological similarity had a significant correlation with personality similarity. However the effect of socioecology was approaching significance, indicating that, selection pressures related to socioecology may play an important role in shaping personality structure but further data collection on a wider range of species is needed to explore these relationships further.

In terms of the management of the study species in the current study, it was demonstrated that the captive environment, particularly the social environment and human-animal relationships (HARs), has a significant impact on personality and so personality could prove to be a valuable management tool. Breeding success of *M. nigra* could not be predicted by personality and this could be an indicator that *M. nigra* actually adapt to life in captivity relatively well compared to some other species. Knowledge of *M. nigra* individual's personality may not necessarily aid the design and formation of enrichment programmes for this species as personality was not a significant predictor of enrichment use. However the sample size may have limited the enrichment investigation and there were some general patterns in enrichment use between different personality types that may prove be significant with a larger dataset.

In conclusion, data collected in the current study reliably identified the personality structure of three previously unstudied NHP species. Further personality data, on a wider range of primate species that have more varied social systems and ecologies, is needed before any firm conclusions regarding the relative importance of phylogeny or socioecology in shaping personality structure can be drawn. Furthermore, personality assessment was demonstrated to be useful in animal management applications, such as the provision of environmental enrichment. It is therefore recommended that personality be more fully integrated into captive animal management.

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