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Divergent Personality Structures of Brown and White-Faced Capuchins

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Abstract

One way to gain insights into personality evolution is by comparing the personality structures of related species. We compared the personality structure of 240 wild white-faced capuchin monkeys to the personality structure of 100 captive brown capuchin monkeys. An ancillary goal was to test the degree to which different personality questionnaires yielded similar personality dimensions. Both species were rated on a common set of 26 antonym pairs. The brown capuchin monkeys were also rated on the 54-item Hominoid Personality Questionnaire. Our cross-species comparisons revealed three personality dimensions---Assertiveness, Openness, and Neuroticism---shared by brown and white-faced capuchins, suggesting that these dimensions were present in the common ancestor of these species. Our comparison of the dimensions derived from the antonym pairs and the Hominoid Personality Questionnaire revealed that three common dimensions were identified by both questionnaires. In addition, the dimension Attentiveness was only identified using the Hominoid Personality Questionnaire. These results indicate that major features of capuchin personality are conserved and that the structure of some traits, such as those related to focus,

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persistence, and attention, diverged. Further work is needed to identify the evolutionary bases that led to the conservation of some dimensions but not others.

Keywords

Capuchin; *Cebus*; New World primates; personality; *Sapajus*

Approximately six million years ago, two populations of a now extinct species of neotropical primate faced selective pressures that led to the evolution of brown (*Sapajus apella*) and white-faced capuchins (*Cebus capucinus*). White-faced capuchins range from Honduras to the northern coast of Columbia and brown capuchins range throughout the southern Amazon (Fleagle, Mittermeier, & Skopec, 1981; International Union for Conservation of Nature, 2014; Rylands, Groves, Mittermeier, Cortés-Ortiz, & Hines, 2005). Despite the six million years of separation time and their different habitats, these species share many behavioral traits in common, including group living and communicative facial features (Defler, 1982). Both species are also known for coalitionary aggression and food sharing (Fragaszy, Visalberghi, & Fedigan, 2004).

There are also differences between these species. In terms of morphology, brown and white-faced capuchins differ in much the same way a gymnast and swimmer do; brown capuchins' bodies are stout, compact, and robust and white-faced capuchins' bodies are slender and gracile (Alfaro, Silva, & Rylands, 2012). Behaviorally, brown capuchin monkeys display more extensive tool use and advanced social learning skills than do white-faced capuchins (Custance, Whiten, & Fredman, 1999; Dindo, Thierry, & Whiten, 2008; Visalberghi, 1987; Visalberghi et al., 2009). In addition, white-faced capuchin are known for their male-male alliances (Perry, 1998) whereas brown capuchins are not. Finally, white-faced capuchins groom up the hierarchy (Perry, 1996) compared to brown capuchins, which are more flexible in their grooming (Parr, Matheson, Bernstein, & de Waal, 1997).

Given growing evidence of the interplay between personality and behavior, it is important to compare the personality structures of closely related species. We therefore examined the extent to which brown and white-faced capuchin personality structures diverged. Personality structures have been compared in other closely related primate species. Notably, studies of personality in humans and chimpanzees (*Pan troglodytes*), who shared a common ancestor approximately six million years age (Glazko & Nei, 2003), have demonstrated that this period of time is long enough for differences in how personality traits are organized into dimensions to emerge (King & Figueredo, 1997). Human personality structure is largely seen to consist of five broad, universal dimensions labeled Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness (Digman, 1990; McCrae, Terracciano, & 78 Members of the Personality Profiles of Cultures Project, 2005; Schmitt et al., 2007), though this view is not shared by all researchers (see, e.g., Gurven, von Rueden, Massenkoff, Kaplan, & Lero Vie, 2013; Saucier et al., 2013). Chimpanzee personality, on the other hand, is organized around five similar dimensions plus a sixth dimension, Dominance, that reflects a combination of assertiveness, low fear, competence, and intelligence (King & Figueredo, 1997). A study of bonobos (*Pan paniscus*) and chimpanzees

(Weiss et al., 2015) found similar personality dimensions with both sharing similar Agreeableness, Assertiveness, Conscientiousness, and Openness dimensions but differing in their presentation of Extraversion and Attentiveness. Finally, another study, this one focusing on the personalities of six macaque species, demonstrated that personality structure in macaques is related to phylogeny and species-specific social structures (Adams et al., 2015).

By comparing the personality structures of brown and white-faced capuchins we can gain insight into how their personalities diverged after their evolutionary split. Three studies, one on white-faced capuchins and two on brown capuchins, examined the structure of capuchin personality. The study of white-faced capuchins found personality dimensions labeled Extraversion, Openness, Neuroticism, Agreeableness, and Eccentricity (Manson & Perry, 2013). The first of the studies of the two studies of brown capuchins found personality dimensions labeled Assertiveness, Openness, Neuroticism, Sociability, and Attentiveness (Morton et al., 2013). The second study, which took a took a different approach to measuring personality, found five dimensions comparable to those identified in Morton et al.'s 2013 study (Uher, 2016).

These studies suggest that both capuchin species share personality dimensions related to competitive prowess (Assertiveness and Dominance), investigatory behavior and curiosity (Openness), and emotional instability and vigilance (Neuroticism). On the other hand, traits related to social behavior are divided into sociability (Extraversion) and affability (Agreeableness) in white-faced capuchins, whereas in brown capuchins they are both part of the Sociability dimension. Furthermore, a personality dimension related to focus and task persistence (Attentiveness) was found in brown capuchin monkeys but not white-faced capuchin monkeys, and a dimension related to eccentric or odd behavior (Eccentricity) was found in white-faced capuchin monkeys but not brown capuchin monkeys.

Morton, et al. (2013) and Manson and Perry (2013) reported that the personality dimensions of each species were related to behaviors. For instance, in brown capuchins, individual differences in Assertiveness and Openness were positively correlated with the amount of time subjects spent aggressing others and participating in cognitive testing, respectively. In white-faced capuchins, individual differences in Extraversion were positively correlated with the amount of time monkeys spent in close proximity with others. These findings demonstrate that the personality ratings of both species are not anthropomorphic impressions of raters, but rather reflect actual behavioral tendencies.

Two differences between the Morton et al.'s study and Manson and Perry's study prevent a clear comparison of the personality structures of these two species. The first difference is that each study used a different personality questionnaire. The second difference is that the white-faced capuchins studied by Manson and Perry lived in the wild whereas the brown capuchins studied by Morton et al. lived in captivity.

We sought to compare the personality structures of brown and white-faced capuchin monkeys. To do so we obtained ratings on captive brown capuchin monkeys using the same instrument that was used to rate the wild white-faced capuchin monkeys (Manson & Perry, 2013). Although this does not permit us to rule out any effects related to being captive-

housed or living in the wild, it does allows us to rule out the possibility that differences were caused by the use of different personality questionnaires. Finally, because the brown capuchin monkeys in the present study had been previously rated using the Hominoid Personality Questionnaire (HPQ; Weiss et al., 2009), we were able to determine whether the same dimensions were assessed in both questionnaires and the degree to which personality was stable over time.

Methods

Subjects

The brown capuchin monkeys were a subsample of 48 males and 52 females from an earlier study of 127 capuchins (Morton, et al., 2013). The monkeys lived in the Living Links to Human Evolution Research Centre at Edinburgh Zoo, Georgia State University Language Research Center, Yale University, Bucknell University, and the Eunice Kennedy Shriver National Institute of Child Health and Human Development. The age of subjects ranged from 2 to 40 years (mean = 10.1 years, $SD = 8.8$).

In addition to gathering new ratings on brown capuchin monkeys, we requested and were provided with personality structure matrices for the white-faced capuchin monkeys studied by Manson and Perry (2013). These monkeys included 129 males and 111 females who lived at the Lomas Barbudal Biological Reserve and on privately own land. The age of subjects ranged from 1.0 to 36.6 years (mean = 8.0 years, SD = 7.7; Manson & Perry, 2013).

This study was non-invasive and complied with the Association for the Study of Animal Behaviour's 2012 regulations and the American Psychological Association's guidelines for Ethical Conduct in the Care and Use of Nonhuman Animals in Research.

Instruments

The questionnaire used to rate white-faced capuchins (henceforth "MPQ") comprised 26 items that could be rated on a five point scale (Manson & Perry, 2013). Each item included a pair of antonyms, one of which was assigned a "1" and its antonym, which was assigned a "5": for example, "Creative (5) vs. unimaginative (1)". For 25 items, raters were instructed to "try to balance the distribution of your answers such that you assign about 40% of monkeys to a score of 3 for each dimension; about 20% should receive 2 or 4 for each measure, and 10% receive 1 or 5". Raters did not have to follow this rule for the item "Eccentric vs. normal".

The HPQ includes 54 items, each consisting of an adjective and one to three descriptive sentences (Weiss, et al., 2009).[1] For example, the item cautious is written as: "**CAUTIOUS**: Subject often seems attentive to possible harm or danger from its actions. Subject avoids risky behaviors." Ratings on each item are made on a seven-point scale with 1 indicating that the animal "displays either total absence or negligible amounts of the trait" and 7 indicating that the animal "displays extremely large amounts of the trait". Further details about the development, and content of the HPQ are presented in Weiss, et al. (2009).

[1]A copy of the HPQ can be obtained at: http://extras.springer.com/2011/978-1-4614-0175-9/weiss_monkey_personality.pdf

Ratings

Between March and July of 2013 14 researchers and care staff who had least one year of experience working with the brown capuchins rated 100 brown capuchins using the MPQ. Each capuchin was rated by one to five raters (mean = 2.43 raters per subject). Five capuchins were rated once, each time by the same person, on the MPQ. Of these capuchins, 83 were rated on the HPQ as part of an earlier study by 25 researchers and 3 care staff for a mean of 3.32 raters per subject (see Morton, et al., 2013 for further details). Three animals were rated only once, each by a different person, on the HPQ. The 240 white-faced capuchins were rated by 51 volunteers with each capuchin being rated by, on average, 17.4 raters (Manson & Perry, 2013).

For the MPQ ratings of the 100 brown capuchins there were 53 missing item ratings out of 5832 item ratings. For HPQ ratings of the 83 brown capuchins there were 504 missing item ratings out of 14742 item ratings. Missing item ratings were replaced with the overall mean for that item.

Analyses

All analyses were conducted using R, version 3.1.1. Principal components analyses and parallel analysis were conducted using the psych package (Revelle, 2011).

Interrater reliabilities of the MPQ items—We estimated item interrater reliabilities for the 95 subjects rated by multiple raters by calculating two intraclass correlations (Shrout & Fleiss, 1979). $ICC(3,1)$ indicates the reliability of individual ratings. $ICC(3,k)$, is a measure of the reliability of mean ratings across k raters.

Principal components analysis—We used principal components analyses to examine the structure of the MPQ ratings. To determine the number of components to extract we used parallel analysis (Dinno, 2012; Horn, 1965) and examined the scree plot. Because previous studies of capuchin monkeys found only modest correlations between components (Manson & Perry, 2013; Morton, et al., 2013), we rotated structures using the varimax procedure for this and all other analyses.

Cross-species comparison—We used two approaches to compare the personality structures of white-faced and brown capuchin monkeys. The first was described by Everett (1983) and involves finding the n-dimensional structure that most clearly replicates across samples. To do so we extracted two, three, four, and five components from the mean scores for the MPQ ratings in brown capuchins. We then asked Dr. Manson to provide the two, three, four, and five component structures from the mean trait ratings of the white-faced capuchin monkeys. We then used targeted orthogonal Procrustes rotations (McCrae, Zonderman, Bond, Costa, & Paunonen, 1996) to compare the brown capuchin monkey structures to the white-faced capuchin monkey structures. In these analyses, the white-faced capuchin structures served as the targets as the sample size was larger and thus these structures would be more stable. The structure that best captures the personality of both species in these analyses is the structure that has the highest ratio of replicated components and the highest number of components (Everett, 1983).

Our second approach entailed creating two sets of unit-weighted component scores (Gorsuch, 1983) for the brown capuchin monkeys. One set of unit-weighted component scores was computed using the MPQ ratings and based on definitions from the brown capuchin personality structure derived in this study. The second set was also computed using the MPQ ratings, but it was based on definitions derived from the white-faced capuchin structures, including the structure described by Manson and Perry (2013). We then obtained correlations between the two sets of scores.

Questionnaire comparisons—For the 83 brown capuchins rated using the MPQ and HPQ we conducted two analyses. We first correlated the unit-weighted scores based on the brown capuchin MPQ structure and unit-weighted component scores based on the published brown capuchin HPQ structure (Morton, et al., 2013). We then correlated the HPQ components and the MPQ items.

Results

Item Interrater Reliabilities

The interrater reliabilities for brown capuchin MPQ items are presented in Supplementary Table 1. The 54 brown capuchin HPQ items were found to be reliable in our previous analyses (see Table 4 in Morton, et al., 2013). Manson and Perry's (2013) questionnaire included 26 items, however two items (*permissive* and *understanding*) had low reliabilities (see Table 1 in Manson and Perry, 2013). These two items were not included our study. The mean *ICC*(3,1) for the MPQ was .39 (*SD* = .15, range =.04 to .69). The mean *ICC*(3,*k*) for the MPQ was .59 (*SD* = .16, range = .09 to .85). These estimates are comparable to previous studies (Freeman & Gosling, 2010).

Principal Components Analyses

A parallel analysis and scree plot of the MPQ items suggested that there were four components (see Table 1). The first included items related to dominance, such as *assertive, domineering*, and *aggressive*; we named this component Assertiveness. The second component included items related to exploratory and play behaviors, such as *curious, playful*, and *opportunistic*; we named this component Openness. The third component included items related to negative affect and vigilance, such as *reactive, alert, eccentric*, and *not relaxed*; we named this component Neuroticism. The fourth component included items related to prosocial behaviors, such as *reciprocating, solicitous*, and *attentive*; we named this component Agreeableness.

Cross-Species Comparisons

For brown capuchins, the two, three, and five component structures can be found in Table S2. For white-faced capuchins, the five component structure is presented in Table 3 of Manson and Perry (2013) and the two, three, and four component structures can be found in Supplementary Table 2. The three and four component structures had the highest overall congruences. However, at .84 and .83, respectively (see Table 2), they fell below the criteria needed to be considered "fairly similar" (Lorenzo-Seva & ten Berge, 2006). Both the three and four component solutions had one component that exceeded the cut-point of .85

(Lorenzo-Seva & ten Berge, 2006). However, two of the congruences for the four component solution fell below .82 and all three of the components for the three component solution had congruences close to .85. Thus, the three component structure best represented both species. The full results for the three component structure can be found in Table 3.

Component I of the brown and white-faced capuchin three component structure was related to Assertiveness/Extraversion and included items such as *assertive, meddling*, and (not) *fearful*. There were six items that loaded onto the first component for one species but not the other, as follows: (not) *tolerant, relaxed*, and *impulsive* in brown capuchins and *persistent, alert*, and *attentive to others* in white-faced capuchins. The second component of both species was related to Openness and included items such as *curious, opportunistic*, and *creative*. There were three items, *persistent* for brown capuchins and *impulsive* and (not) *neophobic* in white-faced capuchins that loaded onto the second component for one species but not the other. The third component for both species was related to Neuroticism. We multiplied the brown capuchin Neuroticism by −1 to make it easier to interpret and found that both species included items such as *reactive*, (not) *reciprocating*, and *alert*. There were three items that loaded onto the third component for one species but not the other, as follows: *eccentric* for brown capuchins and (not) *tolerant* and (not) *relaxed* for white-faced capuchins.

Correlations of component scores derived from the brown and white-faced capuchin structures using the MPQ revealed that the four brown capuchin dimensions of Assertiveness, Openness, Neuroticism, and Agreeableness were all highly correlated (rs ≥ 0.90) with their white-faced capuchin equivalents (see Table 4). However, brown capuchin Assertiveness was also positively correlated with white-faced capuchin Openness and negatively correlated with white-faced capuchin Eccentricity. Brown capuchin Neuroticism was also positively correlated with white-faced capuchin Eccentricity and negatively correlated with white-faced capuchin Extraversion.

When we correlated the brown capuchin HPQ component scores with their white-capuchin equivalents we found similar results (see Table 5). HPQ Assertiveness was positively correlated with MPQ Extraversion and negatively correlated with MPQ Eccentricity. HPQ Neuroticism again was positively correlated with MPQ Eccentricity but was not correlated with MPQ Extraversion. HPQ Sociability positively correlated with MPQ Extraversion and HPQ Openness was only positively correlated with its white-faced capuchin MPQ equivalent. Attentiveness did not correlate with any white-faced capuchin MPQ components.

Questionnaire Comparisons

The correlation of the brown capuchin monkey HPQ and MPQ component scores revealed that Attentiveness did not correlate with any components derived from the MPQ (see Table 6). The other four HPQ components were significantly correlated with similar MPQ components, though the HPQ Assertiveness and Sociability dimensions both correlated with MPQ Openness. These correlations were consistent across the two, three, and four component structures.

When we correlated the HPQ component scores with the MPQ items (see Table 7) we found that Assertiveness was positively correlated with items such as *assertiveness, aggressive, domineering*, and negatively with *fearful*. Openness was positively correlated with items such as *opportunistic, curious*, and *playful*. Neuroticism was positively correlated with *eccentric* and *reactive*. Sociability was positively correlated with *domineering, popular, socially intelligent*, and *sociable*. Attentiveness, as with the previous results, was not correlated with any MPQ items.

Discussion

We found that brown capuchin personality when measured using the MPQ was defined by four components. This structure included dimensions relating to Assertiveness, Openness, Neuroticism, and Agreeableness. These dimensions were significantly correlated with components based on the five white-faced capuchin components reported by Manson and Perry (2013). Targeted orthogonal Procrustes rotations suggested that Assertiveness, Openness, and Neuroticism were likely shared between the studied species and thus probably characterized the personality structure of the capuchins' common ancestor. These dimensions had medium to large correlations with similar personality dimensions derived using the HPQ. The correlations between the HPQ dimensions and the MPQ items were further evidence for the convergent validity of these dimensions.

Personality domains like Assertiveness and Neuroticism have been consistently found across nonhuman primate species (Freeman & Gosling, 2010). As such, these dimensions are likely variants of a personality dimension present in the common ancestor shared by all nonhuman primates. On the other hand, Openness has been found in several nonhuman primate species (Adams, et al., 2015; King & Figueredo, 1997; Morton, et al., 2013; Weiss, Adams, Widdig, & Gerald, 2011; Weiss, et al., 2015), but not in others, including closely-related species (Adams, et al., 2015; Weiss, King, & Perkins, 2006). Thus, Openness appears to have evolved independently several times and has also been 'lost' in some taxonomic groups.

The presence of an Attentiveness dimension in brown capuchins but not in white-faced capuchins is interesting and requires additional research. There are (at least) three possible explanations for this species difference. First, although capuchin species use tools defensively (Alfaro, et al., 2012) only brown capuchins use tools to access high protein foods (Ottoni & Mannu, 2001; Visalberghi, 1987). Access to these higher protein foods may have supported the development of larger brains and Attentiveness (MacLean et al., 2014). Second, a previous study found that, although brown capuchin monkeys who were higher in Attentiveness had better attention spans and were more vigilant, they were groomed less often by others (Morton, et al., 2013). Thus, the fitness benefits gained by higher Attentiveness scores may have been offset by social costs. To test this explanation would require behavioral studies of white-faced capuchins. Finding a similar trade-off between vigilance and social support would be evidence against this explanation. A final possibility is that the MPQ did not include enough traits related to Attentiveness. This is consistent with our inability to find any MPQ dimension resembling Attentiveness in brown capuchins.

We found that the MPQ and HPQ both measured Assertiveness, Openness, and Neuroticism. While Openness demonstrated convergent and divergent validity, Assertiveness and Sociability both correlated with the MPQ Extraversion component. Assertiveness and Sociability also correlated with four of the same MPQ items, suggesting that the MPQ cannot differentiate between Assertiveness and Sociability. Neuroticism correlated with its MPQ equivalent but to a lesser degree, and Neuroticism was only significantly correlated with two MPQ items. None of the MPQ components or items were correlated with HPQ Attentiveness. Together these findings suggest that the MPQ may require additional items to fully capture brown capuchin personality.

One limitation of our study is that there were more raters for the whited-faced capuchins than the brown capuchins and that two different groups of people rated the two different species. Future comparative studies should work to obtain ratings from the same pool of raters. Another limitation of this study is that we cannot rule out the effect of environment; we used structures based on wild white-faced capuchins but captive brown capuchins. It is, however, unlikely that environment would greatly alter personality structure for two reasons. First, brown capuchins remain undomesticated and thus, so long as they are housed in naturalistic conditions, they are likely to retain many natural behaviors. All of our brown capuchins were socially housed in stable, species typical groups. For example, the Living Links enclosure was designed to mimic the natural habitat of brown capuchin monkeys, going so far as to include a sympatric species (Macdonald & Whiten, 2011). Second, previous studies have found personality structure to be consistent across settings (King, Weiss, & Farmer, 2005; Weiss, et al., 2009; Weiss, King, & Hopkins, 2007). Still, to rule out the impact of environment requires measuring personality in captive and wild capuchin species.

One valuable direction for future research would be to compare different species of capuchins that live in the same geographic region. Specifically, *Cebus* and *Sapajus* species that live in overlapping habitats have more divergent morphologies than those living in non-overlapping habitats (Silva, 2001 cited in Alfaro, et al., 2012). This greater degree of speciation may function to enable two species to live within the same habitat as they would not compete for the same resources. We would predict that populations of different capuchin species living in overlapping habitats would also differ more in terms of their personality structures than those that live in non-overlapping habitats.

This study adds to the research showing that personality structure is an evolved trait that is shaped by the physical and social environment. Future studies of related species or different populations of the same species will add more to what we know about the origins of personality variation and covariation in not just primates, but other species, too.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Varimax rotated brown capuchin structure

Item	Assertiveness	Openness	Neuroticism	Agreeableness
Assertive	**0.92**	0.11	0.01	−0.16
Meddling	**0.90**	0.18	−0.01	−0.17
Aggressive	**0.88**	0.09	0.03	−0.26
Fearful	**0.85**	0.02	0.03	0.19
Domineering	**−0.82**	0.17	0.09	0.17
Popular	**0.77**	−0.08	−0.17	0.21
Sociable	**0.70**	0.32	−0.14	0.38
Tolerant	**−0.62**	−0.07	**−0.40**	0.36
Socially intelligent	**0.62**	0.07	−0.27	**0.51**
Relaxed	**0.49**	0.39	0.29	−0.29
Impulsive	0.20	**0.86**	0.06	0.03
Curious	0.15	**0.76**	−0.08	−0.18
Opportunistic	−0.22	**0.71**	−0.03	0.15
Creative	0.04	**0.70**	−0.15	0.10
Active	0.18	**0.68**	0.30	−0.02
Playful	−0.07	**0.66**	−0.04	−0.07
Persistent	0.09	0.05	**0.81**	0.00
Neophobic	0.00	−0.15	**0.76**	0.22
Reactive	**0.48**	0.07	**−0.55**	−0.11
Reciprocating	−0.38	0.10	**0.53**	−0.23
Eccentric	0.00	0.22	−0.10	**0.73**
Alert	−0.17	−0.15	0.05	**0.67**
Solicitous	0.11	0.02	0.38	**0.58**
Attentive to others	−0.14	−0.20	0.17	0.28
Proportion of variance	0.27	0.15	0.10	0.10

Note. N = 100. Salient loadings are in boldface.

Table 2

Congruence table of brown and white-faced capuchin structures

	Component					
Number of components	**I**	**II**	**III**	**IV**	**V**	**Total**
2	0.84	0.61	-	-	-	0.75
3	0.83	0.83	0.88	-	-	0.84
4	0.81	0.84	0.89	0.81	-	0.83
5	0.84	0.81	0.76	0.86	0.57	0.79

Note. N = 100.

Table 3

Targeted orthogonal Procrustes rotation of brown capuchin monkey three component structure to the white-faced capuchin monkey three component structure

Item	I	II	III	Congruences
Assertive	**0.88**	0.12	0.30	0.99
Meddling	**0.86**	0.18	0.29	0.99
Aggressive	**0.84**	0.09	0.37	0.94
Domineering	**0.83**	0.05	0.07	0.95
Fearful	**−0.82**	0.16	−0.20	0.89
Popular	**0.80**	−0.06	−0.11	0.90
Sociable	**0.72**	0.35	−0.19	0.94
Socially intelligent	**0.69**	0.11	**−0.40**	0.96
Relaxed	**0.59**	0.07	−0.22	0.74
Eccentric	**−0.50**	0.08	**0.46**	0.35
Tolerant	**−0.49**	−0.06	**−0.66**	0.94
Curious	0.17	**0.86**	0.10	0.98
Opportunistic	0.14	**0.75**	0.12	0.90
Creative	−0.21	**0.72**	−0.13	0.88
Playful	0.07	**0.71**	−0.14	0.99
Active	0.09	**0.68**	0.29	0.95
Persistent	−0.07	**0.65**	0.03	0.09
Reactive	−0.09	0.05	**0.60**	0.88
Reciprocating	0.05	0.26	**−0.54**	0.84
Impulsive	0.39	0.38	**0.51**	0.96
Solicitous	−0.13	−0.11	**−0.45**	0.77
Alert	−0.16	−0.14	**0.40**	0.44
Attentive to others	0.05	0.06	−0.09	0.62
Neophobic	−0.16	−0.18	−0.09	0.61
Overall	0.83	0.83	0.88	0.84

Note. N = 100. Salient loadings are in boldface.

Table 4

Pearson correlation of four components based on brown capuchin monkey structure and the published white-faced capuchin monkey structure

	Brown Capuchin Structure			
	Assertiveness	**Openness**	**Neuroticism**	**Agreeableness**
White-faced capuchin structure				
Extraversion	**0.97**	0.24	**−0.31**	0.08
Openness	**0.44**	**0.90**	−0.02	−0.08
Neuroticism	−0.18	−0.06	**0.93**	0.18
Agreeableness	−0.12	−0.01	0.02	**0.90**
Eccentricity	**−0.33**	0.03	**0.71**	−0.07

Note. N = 100. Boldface correlations are significant at $p < 0.05$.

Table 5

Pearson correlation of brown capuchin component scores based on HPQ and MPQ white-faced capuchin structure

	Ast	Opn	Neu	Soc	Att
White-faced capuchin structure					
Two components					
I	**0.68**	0.26	0.05	**0.39**	−0.06
II	0.21	**0.66**	0.11	**0.41**	0.02
Three components					
I	**0.72**	0.25	−0.08	**0.44**	−0.15
II	0.21	**0.71**	0.27	**0.35**	0.13
III	0.04	0.10	**0.53**	−0.23	0.22
Four components					
I	**0.73**	0.26	−0.11	**0.45**	−0.12
II	0.21	**0.71**	0.27	0.35	0.13
III	−0.02	0.08	**0.48**	−0.18	0.03
IV	0.19	0.04	**−0.43**	0.34	−0.30
Five components					
Ext	**0.73**	0.26	−0.11	**0.45**	−0.12
Opn	0.27	**0.68**	0.32	0.34	0.15
Neu	−0.20	0.03	**0.39**	−0.24	−0.02
Agr	−0.06	0.01	−0.26	0.18	−0.15
Ecc	**−0.41**	−0.05	**0.40**	−0.35	0.31

Note. N = 83. Ast = Assertiveness; Opn = Openness; Neu = Neuroticism; Soc = Sociability; Att = Attentiveness; Ext = Extraversion; Agr = Agreeableness; Ecc = Eccentricity. Boldface correlations are significant at $p < 0.05$.

Table 6

Pearson correlation of brown capuchin component scores based on HPQ and MPQ brown capuchin structure

	HPQ dimensions				
	Ast	**Opn**	**Neu**	**Soc**	**Att**
Brown capuchin MPQ structure					
Two components					
I	**0.71**	0.21	−0.10	**0.45**	−0.08
II	0.15	**0.70**	0.25	0.31	0.10
Three components					
I	**0.70**	0.21	−0.05	**0.43**	−0.05
II	0.15	**0.70**	0.25	0.31	0.10
III	0.29	0.11	**−0.52**	**0.38**	−0.12
Four components					
I – Assertiveness	**0.71**	0.24	−0.03	**0.43**	−0.05
II – Openness	0.15	**0.70**	0.25	0.31	0.10
III – Neuroticism	−0.32	0.00	**0.46**	−0.32	0.12
IV – Agreeableness	−0.06	0.03	−0.17	0.16	−0.19

Note. N = 83. Ast = Assertiveness; Opn = Openness; Neu = Neuroticism; Soc = Sociability; Att = Attentiveness. Boldface correlations are significant at $p < 0.05$.

Table 7

Pearson correlation of brown capuchin HPQ scores and MPQ items

Item	Ast	Opn	Neu	Soc	Att
Assertive	**0.67**	0.21	−0.02	0.33	0.04
Aggressive	**0.66**	0.20	0.02	0.33	0.02
Domineering	**0.64**	0.19	−0.10	**0.40**	−0.21
Popular	**0.63**	0.08	−0.21	**0.38**	−0.15
Meddling	**0.61**	0.23	0.00	0.35	0.02
Socially intelligent	**0.58**	0.19	−0.31	**0.47**	−0.30
Sociable	**0.48**	0.25	−0.03	**0.49**	−0.03
Fearful	**−0.64**	−0.11	0.25	−0.33	0.15
Eccentric	**−0.41**	−0.05	**0.40**	−0.35	0.31
Tolerant	−0.37	−0.13	−0.34	−0.06	−0.11
Relaxed	0.33	−0.10	−0.20	0.25	−0.02
Opportunistic	0.29	**0.59**	0.15	0.29	−0.02
Curious	0.21	**0.63**	0.27	0.33	0.15
Impulsive	0.19	0.27	0.34	0.18	0.26
Persistent	0.17	**0.38**	0.09	0.06	0.06
Reciprocating	0.13	0.21	−0.17	0.28	0.02
Active	0.07	**0.50**	0.27	0.28	−0.01
Attentive to others	−0.03	0.04	0.05	0.06	−0.17
Playful	−0.03	**0.65**	0.24	0.30	0.24
Creative	−0.04	**0.38**	0.06	0.09	0.00
Reactive	−0.05	0.05	**0.47**	−0.17	0.21
Alert	−0.06	−0.09	0.24	−0.12	−0.27
Solicitous	−0.22	−0.16	−0.26	0.04	−0.25
Neophobic	−0.26	−0.27	0.10	−0.15	0.03

Note. N = 83. Ast = Assertiveness; Opn = Openness; Neu = Neuroticism; Soc = Sociability; Att = Attentiveness. Boldface correlations are significant at $p < 0.05$.