



Capuchin monkeys with similar personalities have higher-quality relationships independent of age, sex, kinship and rank



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Social relationships vary in content, quality and patterning. Most researchers focus on whether and how nondispositional factors, including age, sex, kinship and rank, predict variance in the content, quality and patterning of relationships. However, within a species, these factors do not always predict partner choice. We examined whether similarity in any of five personality traits, Assertiveness, Openness, Neuroticism, Sociability and Attentiveness, independently contributed to variation in the affiliative and agonistic relationships of pairs of brown capuchin monkeys, *Sapajus* sp. Capuchins that were more similar in Neuroticism had higher affiliative relationship scores, while capuchins that were more similar in Sociability shared overall higher-quality relationships (i.e. the difference between the dyad's affiliative and agonistic scores). These effects were independent of age, sex, kinship and rank, suggesting that certain aspects of the psychology of these animals may contribute uniquely to the quality of their social relationships.

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Social relationships vary in content (e.g. sexual, parenting, affiliation or conflict), quality (e.g. the intensity of affiliation or aggression) and patterning (e.g. frequency and temporal stability) (Hinde, 1976). Studying how and why social relationships vary among interactants has implications for understanding theoretical and applied questions, such as gene flow (Morin et al., 1994; Pilot, Dahlheim, & Hoelzel, 2010), disease and information transfer (Allen, Weinrich, Hoppitt, & Rendell, 2013; Kuehl, Elzner, Moebius, Boesch, & Walsh, 2008; Zelner et al., 2012), health and wellbeing (Archie, Altmann, & Alberts, 2012; Kikusui, Winslow, & Mori, 2006), sexual selection (e.g. mate choice; DeVries, DeVries, Taymans, & Carter, 1995; Schülke, Bhagavatula, Vigilant, & Ostner, 2010), life history (Holt-Lunstad, Smith, & Layton, 2010; Seyfarth, Silk, & Cheney, 2012; Silk et al., 2010) and social decision making (e.g. cooperation versus conflict; Clutton-Brock, 2009; Clutton-Brock & Huchard, 2013).

Differences in nondispositional factors, including partners' age, sex, rank and kinship, are commonly used to explain why

relationships vary (e.g. Clutton-Brock & Huchard, 2013; MacCormick et al., 2012; Widdig, Nürnberg, Krawczak, Streich, & Bercovitch, 2001). This may be because such nondispositional factors reflect differences in partners' quality (e.g. health, fighting ability; Clutton-Brock & Huchard, 2013; Sapolsky, 2004), socio-ecological needs (e.g. food, sex, protection and/or parental investment; Clutton-Brock & Huchard, 2013; Isbell & Young, 2015; Trivers, 1972), physiology (e.g. stress and reproductive hormones; Sapolsky, 2004; Zimmerberg & Farley, 1993) and developmental trajectories (Hollén & Radford, 2009; Loretto, Fraser, & Bugnyar, 2012). Identifying nondispositional factors that contribute to social relationship variance has helped researchers understand why animals are selective in their choice of social partners. For instance, females usually seek higher-quality relationships (i.e. those that are more affiliative than agonistic) with alpha group members as this affords them better protection and access to high-quality food (Clutton-Brock & Huchard, 2013).

However, the explanatory power of nondispositional factors is not consistent across studies of social relationships. For example, in bottlenose dolphins, *Tursiops truncatus*, age and sex predict spatial affiliation in some populations (Lusseau & Newman, 2004), but not in others (Félix, 1997; Lusseau et al., 2006). In barnacle geese,

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Branta leucopsis, Kurvers et al. (2013) found that social rank was unrelated to social affiliation, whereas kinship had a significant effect. In brown (or 'tufted') capuchin monkeys, *Sapajus apella* (formerly *Cebus apella*; Alfaro, Silva, & Rylands, 2012), Tiddi, Aureli, Polizzi Di Sorrentino, Janson, and Schino (2011) reported that social tolerance was unrelated to kinship and rank, but weakly related to sex. Other factors may therefore contribute to social relationship variance beyond nondispositional factors.

Personality and Social Relationships

Personality is an umbrella term used to describe individual differences in behaviour, affect and cognition that are consistent across time and contexts (Dingemanse & Réale, 2005; Gosling, 2008; Koski, 2014; Weiss & Adams, 2010). Measures of personality are associated with individual differences in social decision making (Aplin, Farine, Mann, & Sheldon, 2014; Krause, James, & Croft, 2010), performance on cognitive and learning tasks (Carere & Locurto, 2011; Morton, Lee, & Buchanan-Smith, 2013; Sih & Del Giudice, 2012), risk taking (Dammhahn & Almeling, 2012), subjective wellbeing (Gartner & Weiss, 2013; King & Landau, 2003; Weiss et al., 2009; Weiss, King, & Perkins, 2006) and coping strategies (Coppens, de Boer, & Koolhaas, 2010; Martins et al., 2011). Personality traits are also heritable and reflect life history measures, including longevity and reproductive output (Biro & Stamps, 2008; van Oers, Drent, de Goede, & van Noordwijk, 2004; Silk et al., 2010; Weiss, Gartner, Gold, & Stoinski, 2013; Wolf, van Doorn, Leimar, & Weissing, 2007).

Despite the popular notion that 'opposites attract', individuals with similar personalities form stronger, more affiliative social bonds compared to other dyads. Such findings have been reported across a range of phylogenetically distant taxa, suggesting that similarities in personality may be a fundamental component of animal sociality. For example, pair bonding in eastern bluebirds, *Sialia sialis*, occurs more often between mates that are similar in aggressiveness (Harris & Siefferman, 2014). In rhesus macaques, *Macaca mulatta*, individuals are more affiliative with group members that are similar in Equability (e.g. calm/slow) and Adaptability (e.g. flexible/gentle) (Weinstein & Capitanio, 2008). Personality similarities may signal partner quality (e.g. fighting ability or genetic compatibility). In great tits, *Parus major*, and in zebra finches, *Taeniopygia guttata*, similarity in exploration and aggression are positive indicators of future offspring quality (e.g. body mass; Both, Dingemanse, Drent, & Tinbergen, 2005; Schuett, Dall, & Royle, 2011). In guppies, *Poecilia reticulata*, sexual partners that are similar in boldness have higher parturition success than more dissimilar partners (Ariyomo & Watt, 2013). Personality similarity may also reflect emotional or behavioural compatibility and predictability between potential social partners. In humans, perceived personality similarity promotes friendship intensity (Selfhout, Denissen, Branje, & Meeus, 2009) while couples in which both members have lower neuroticism (a measure of negative affect) report greater relationship satisfaction (e.g. Caughlin, Huston, & Houts, 2000; Heller, Watson, & Hies, 2004; Karney & Bradbury, 1997).

To date, most of what is known about associations between personality similarity and social relationship variance comes from studies of affiliative behaviour (e.g. Massen & Koski, 2014; Schuett et al., 2011; Seyfarth, Silk, & Cheney, 2014; Weinstein & Capitanio, 2008). Few data are available on the role that personality similarities play in agonistic relationships and overall social relationship quality (i.e. the intensity of affiliative versus agonistic behaviour between partners). Also, in many studies, nondispositional factors are usually not, or only partially, controlled for (e.g. Humbad, Donnellan, Iacono, McGue, & Burt, 2010; Massen & Koski, 2014;

Schuett et al., 2011; Seyfarth et al., 2014; Weinstein & Capitanio, 2008; but see Seyfarth et al., 2014). Controlling for nondispositional factors is critical for several reasons. For instance, partner similarities in bold or aggressive personality traits may reflect attraction towards individuals that are similar in rank (e.g. Dahlbom, Lagman, Lundstedt-Enkel, Sundström, & Winberg, 2011). Additionally, as these (and other) personality traits are heritable (Dochtermann, Schwab, Sih, & Dochtermann, 2015; Drent, van Oers, & van Noordwijk, 2003; Sinn, Apiolaza, & Moltchanivskyj, 2006), partner similarities in personality may be proxies for the degree of relatedness between pair members. Controlling for nondispositional factors therefore allows researchers to determine whether psychological factors other than those reflected by nondispositional factors contribute to variation in social relationships.

The Present Study

Studies of wild and captive brown capuchin monkeys often report mixed results with regard to the role of nondispositional factors in the social relationships of these animals. While Schino, Di Giuseppe, and Visalberghi (2009) and Tiddi, Aureli, and Schino (2012) found that brown capuchins preferentially give coalitionary support to kin, Ferreira, Izar, and Lee (2006) found no such preference within a different study population. Some studies report that brown capuchins groom 'down' the hierarchy (Parr, Matheson, Bernstein, & de Waal, 1997), while others report no significant association between grooming and rank (Schino et al., 2009), or report that their population grooms 'up' the hierarchy (Tiddi et al., 2012). Therefore, other factors like personality may contribute to capuchin social relationships.

Brown capuchins, and the closely related white-faced capuchin, *Cebus capucinus*, exhibit pronounced individual differences in personality (Manson & Perry, 2013; Morton, Lee, Buchanan-Smith, Brosnan, et al., 2013; Uher, Addessi, & Visalberghi, 2013). Ratings of capuchin personality are consistent across observers (Manson & Perry, 2013; Morton, Lee, Buchanan-Smith, Brosnan, et al., 2013), are associated with physiological measures (e.g. cortisol reactivity; Byrne & Suomi, 2002), and reflect behavioural codings (Manson & Perry, 2013; Morton, Lee, & Buchanan-Smith, 2013; Morton, Lee, Buchanan-Smith, Brosnan, et al., 2013; Uher et al., 2013).

In the present study, we investigated associations between personality similarities and the affiliative and agonistic components of brown capuchin social relationships. We predicted that, controlling for age, sex, kinship and rank, subjects with similar personalities would share higher-quality social relationships, defined here as relationships that were more affiliative than agonistic.

METHODS

Study Site and Subjects

Eighteen brown capuchin monkeys (*Sapajus* sp.) were studied at the Living Links to Human Evolution Research Centre (LL), located within the Royal Zoological Society of Scotland (RZSS), Edinburgh Zoo, U.K. (Macdonald & Whiten, 2011). Subjects were from two breeding groups. At the time of study, the 'East' group contained four adult males, three adult females, one juvenile male and five infants (following age–sex categories in Fragaszy, Visalberghi, & Fedigan, 2004). The 'West' group contained four adult males, three adult females, two juvenile males, one juvenile female and five infants. Infants dependent on their mothers (i.e. those less than a year old) were not included as study subjects. Subjects' ages ranged from 2 to 40 years for males (mean \pm SD = 10.79 \pm 8.55 years, $N = 11$) and 3 to 14 years for females

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