

Calibration and fitness-linked correlates of personality in Conambo, Ecuador

Aaron W. Lukaszewski^{a,b,*}, John Q. Patton^{a,c}, Patrick K. Durkee^{a,d,e}, James G. Zerbe^{a,f}, Brenda J. Bowser^{a,g}

^a Center for the Study of Human Nature, California State University, Fullerton, USA

^b Department of Psychology, California State University, Fullerton, USA

^c Evolutionary Anthropology Program, Division of Anthropology, California State University, Fullerton, USA

^d Institute for Advanced Study, Toulouse, FR, USA

^e Department of Psychology, California State University, Fresno, USA

^f School of Human Evolution and Social Change and Institute for Human Origins, Arizona State University, USA

^g Archaeology Program, Division of Anthropology, California State University, Fullerton, USA

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ABSTRACT

We present a study testing the existence and correlates of personality concepts in the village of Conambo, Ecuador, which is home to horticultural-foragers located in the Sápara Territory of the Ecuadorian Amazon. Lexical terms to describe the three focal personality concepts from the HEXACO taxonomy—Sociability, Immodesty, and Un-emotionality—were interpreted from Spanish into the Indigenous languages of Achuar and Quichua. These terms were employed in a photo ranking task wherein 76 adult community members ranked the relative standing of same-sex others on each personality concept. Inter-ranker agreement was high for Sociability and Immodesty, but low for Un-emotionality. We tested the associations among individual differences in (i) Sociability and Immodesty, (ii) hierarchical status and fertility, which are hypothesized fitness-linked benefits of high Sociability and Immodesty, and (iii) physical strength, which is a hypothesized calibrator of status-oriented personality strategies. Using Bayesian models and psychological networks including age controls, we found good evidence that men's physical strength associated positively with Sociability, Immodesty, and status. Among both sexes, Sociability and Immodesty exhibited strong positive correlations with status, but evidence was weaker that the personality traits associated with fertility. Status associated positively with fertility among both sexes. We conclude that two personality concepts imported from the HEXACO and Big Five taxonomies, Sociability and Immodesty, exist with common meaning in the minds of Conambo villagers and appear adaptively patterned in relation to physical strength and fitness-linked outcomes. We argue that the photo ranking task employed in this research produces personality assessments with high validity and should therefore be adopted in future studies of individual differences in face-to-face groups.

1. Overview: personality concepts and individual differences

Within populations of organisms, individuals differ in their stable patterns of cognitive and behavioral outputs—i.e., in their personalities. The field of personality psychology has long sought to identify the phenotypic dimensions along which human individual differences exist and understand the causes and consequences of this variation. Much research on human personality and individual differences derives from the “lexical hypothesis,” which holds that languages tend to accumulate words and phrases that function to communicate about conceptual

aspects of people's behavior that are relevant for social decision-making (Buss, 1991; Buss & Hawley, 2010; Goldberg, 1990; Saucier & Goldberg, 1996; Wood, 2015); for example, if it is functionally important to know whether others are likely to defect in social exchanges (Cosmides, Barrett, & Tooby, 2010), languages will tend to accumulate lexical concepts such as “trustworthy” and “cheater” (Fiddick et al., 2016). Personality psychologists have examined the correlations among ratings of such lexical personality items to identify broad structural dimensions of human behavioral description. This is the approach that was used to derive the Big Five (John, Naumann, & Soto, 2008; McCrae & John,

* Corresponding author at: Center for the Study of Human Nature, California State University, Fullerton, USA.

E-mail address: aalukas.1859@gmail.com (A.W. Lukaszewski).

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1992; Saucier & Goldberg, 1996) and HEXACO (i.e., Big Six; Ashton & Lee, 2007; Thalmayer & Saucier, 2014) factor structures, whose resultant lexical dimensions (e.g., Extraversion, Neuroticism) have been employed as the units of analysis in vast amounts research on human personality and individual differences.

In recent decades, evolutionary and adaptationist frameworks have been developed to study the ultimate and proximate origins of personality variation—addressing the related questions of why natural selection maintains variation within populations and why individual differences come to be patterned as they are in ontogeny. These frameworks have most frequently been applied to explain phenotypic variation captured descriptively by the lexically derived Big Five or HEXACO dimensions (Ashton & Lee, 2007; Buss, 1991, 2009; Buss & Hawley, 2010; de Vries, Tybur, Pollet, & Van Vugt, 2016; Lukaszewski et al., 2020; Nettle, 2006; Penke, Denissen, & Miller, 2007; Tooby & Cosmides, 1990). One tenet common to these frameworks is that natural selection can create mechanisms that produce individual differences when there are cost-benefit tradeoffs that modulate optimal trait levels along phenotypic continua. Consistent with this, extant research has demonstrated that personality variation is often adaptively patterned in relation to (i) phenotypic (e.g., physical strength) or ecological (e.g., pathogen prevalence) variables that modulate optimal trait levels (e.g., Kerry & Murray, 2021; Lukaszewski & Roney, 2011; Rodriguez & Lukaszewski, 2020; Schaller & Murray, 2008; Sell, Tooby, & Cosmides, 2009; von Rueden, Lukaszewski, & Gurven, 2015), as well as (ii) life outcomes linked to fitness costs and benefits (e.g., Alvergne, Jokela, & Lummaa, 2010; Cheng, Tracy, & Henrich, 2010; Gurven, von Rueden, Stieglitz, Kaplan, & Rodriguez, 2014; Nettle, 2005; Penke & Jokela, 2016; Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007).

A major limitation of extant research on personality and its evolution, however, is that nearly all of it has been conducted on humans living in ecologies that are relatively WEIRD (Western, Educated, Industrialized, Rich, Democratic; Henrich, Heine, & Norenzayan, 2010)—and hence unrepresentative of the smaller-scale ecologies inhabited by most humans who have ever existed (Apicella, Norenzayan, and Henrich, 2020; Barrett, 2020a, 2020b; Gurven, von Rueden, Massenkoff, Kaplan, & Lero Vie, 2013). As such, it is presently unclear whether, in societies with little or no exposure to WEIRD cultures, (i) specific personality concepts are universally represented in the minds and lexicons of humans, with similar meaning; and, if so, (ii) personality trait levels exhibit theoretically predicted associations with fitness-linked costs and benefits. Notably, as reviewed below, the few etic and emic studies that have examined personality concepts in culturally distant Indigenous societies or languages provide some support for both propositions.

In the present investigation, we test for the existence and functional significance of WEIRD-imported personality concepts among Amazonian horticultural-foragers of Conambo, Ecuador. We focus on personality dimensions from three of the HEXACO (i.e., Big Six) trait dimensions: Sociability, Modesty, and Emotionality (Ashton & Lee, 2007). As explained below, we focused on these dimensions because there are theoretical and empirical reasons to expect them to associate with anthropometric and fitness-linked outcomes. Before describing the empirical study, we will situate our hypotheses and research questions within an adaptationist framework for the study of personality, and within the extant literature.

2. An adaptationist framework for the study of personality concepts and variation

Across our evolutionary history, humans invaded a niche defined in part by obligate dependence upon participation in multiple cross-cutting types of social relationships with both kin and non-kin individuals (Kaplan, Hill, Lancaster, & Hurtado, 2000; Tooby & DeVore, 1987), including friendships grounded in alliance and social exchange (Jaeggi & Gurven, 2013; Patton, 2005), mating relationships (Buss & Schmitt,

1993), collective actions (Tooby, Cosmides, & Price, 2006), coalitions (Pietraszewski, 2016), hierarchies (von Rueden, Gurven, & Kaplan, 2008), parent-child relationships (Kaplan et al., 2000), and enemies (Chagnon, 1983). The human niche therefore presented many adaptive problems related to making decisions about specific others that depended in part on their behavioral tendencies: Can this person be counted on to complete a critical task on time? Is this person (un)trustworthy in social exchange? To what extent is this person likely to prioritize immediate self-interest over creating benefits for others (or for me specifically)? Will this person freeze up in the face of danger? Will this person try to furtively copulate with my spouse? What type of parental support will be most effective in helping this specific child of mine overcome a developmental obstacle? Does this person pose a threat of violence? Who would be effective in organizing political action at the community level? Can this person keep a secret? And so on. In order to make such decisions in a fitness-positive manner, it is necessary to be able to detect, represent, and communicate about differences between people in their cognitive and behavioral tendencies—that is, in their personalities. It has been theorized that natural selection crafted a *personality assessment system* for these very purposes (Buss, 1996, 2011; Fiddick et al., 2016; Lukaszewski et al., 2020).

The personality assessment system's primary evolved function is to compute and store better-than-chance estimates regarding how a specific individual, including oneself, is likely to behave in future situations (Buss, 2011; Lukaszewski et al., 2020). The most basic computational requirement of this system is the existence of concepts that specify the fitness-relevant content of a given aspect of behavior. For example, the concept SOCIABLE might specify the extent to which one is likely to proactively approach and spend time talking with many others (Buss & Craik, 1983); the concept AGGRESSIVE might specify the extent to which one is likely to bargain for better treatment by inflicting physical costs on others (Sell et al., 2009); and the concept CHEATER might specify the extent to which one is likely to intentionally defect on social contracts (Cosmides et al., 2010; Fiddick et al., 2016). By hypothesis, such personality concepts are grounded in conceptual primitives that come equipped with human nature, such as COST-BENEFIT, APPROACH-AVOID, DOMINATE-DEFER, GIVE-TAKE, HELP-HARM, INTENT, BELIEF, and DESIRE (e.g., Boyer & Barrett, 2015; Tatone, Geraci, & Csibra, 2015; Thomas, Thomsen, Lukowski, Abramyan, & Sarnecka, 2018; Thomsen, 2020; Ting, Dawkins, Stavans, & Baillargeon, 2019). These (and other) conceptual primitives provide building blocks that can then be combined and elaborated across ontogeny into more complex concepts via fitness-relevant experience interacting with and communicating about others (Boyer & Barrett, 2015; Delton & Sell, 2014; Thalmayer, Saucier, & Rotzinger, 2022). Once personality concepts exist in the mind, they may be employed either to interpret an individual behavioral act (e.g., “that person is behaving in an ASSERTIVE manner”) or, by tracking patterns of act frequencies over time, to estimate an individual's relative standing on a given aspect of personality (e.g., “that person tends to be more ASSERTIVE than others”) (Buss & Craik, 1983; Fleenor, 2001).

Within and between human communities, people acquire information about how others (tend to) behave not only from direct experience interacting with others, but also via channels of gossip and reputation (Dunbar, 2004; Hess & Hagen, 2021, 2023; Rucas et al., 2006). In order for the personality assessment system to enable communication about the behavior of self and others, it requires lexical items that refer to internal personality concepts. According to the lexical hypothesis, words and phrases tend to accumulate in human languages as people collectively invent them to communicate about aspects of behavior that are regarded as functionally consequential in a given society—that is, conceptual aspects of behavior that people want to know about each other (Goldberg, 1990; Saucier & Goldberg, 1996; Thalmayer et al., 2022; Wood, 2015). The lexical hypothesis is eminently compatible with theories positing that the evolution of human grammatical language was driven substantially by an increasing imperative to communicate in

precise and situationally-tailored ways about the beliefs, motivations, values, behaviors, and relationships of other people (Dunbar, 2004; Pinker, 1994, 2010; Qi & Vul, 2022; Scott-Phillips & Kirby, 2010; Tooby & DeVore, 1987). Consistent with these distinct strands of theory from personality psychology and the evolutionary sciences, all human languages that have been studied contain many hundreds (or, more frequently, thousands) of behavioral adjectives (e.g., “assertive”) and type-nouns (e.g., “slacker”) (Brown, 1991; Goldberg, 1990). Additionally, the combinatorial human linguistic grammar (Pinker, 1994) affords an effectively unlimited set of sentence-level phrases that can be constructed to describe behavior and the mental states that are inferred to drive it (e.g., “She knew it would hurt me to sleep with him, but she did it anyway”; “He always does the right thing, even when this makes things harder for himself”).

According to a recently characterized adaptationist framework for personality science (Lukaszewski et al., 2020), critical ontological distinctions exist between (i) variation in the psychological mechanisms that generate manifest behavioral variation (e.g., in motivation or emotion systems), (ii) personality concepts that function to detect, interpret, and represent behavioral variation, and (iii) lexical personality items that enable people to communicate about the behavior of self and others with reference to personality concepts (see Fig. 1). For example, within- and between-person variation on the lexical personality dimension labeled “Agreeableness”—and implicitly on the internal personality concepts to which the lexical items of Agreeableness refer—has been shown to closely track variation in the activation of the well-characterized emotion program called anger (Lukaszewski et al., 2020), which is an evolved mechanism designed to motivate bargaining for greater valuation of the self when undervalued by others (Sell et al., 2009; Sznycer, Sell, & Dumont, 2022). However, it is important to note that the lexical items that define Agreeableness can also be used to refer to behavioral outputs that were not generated by the anger program. Thus, although the relationships between variation in behavior-regulating mechanisms, personality concepts, and lexical descriptions of personality are often fuzzy and misleading regarding the identities of mechanisms generating the behavior being described (Condon et al., 2020; Lukaszewski et al., 2020; Möttus et al., 2020), lexical personality concepts can be expected to probabilistically track functionally significant dimensions of cognitive and behavioral variation with appreciable

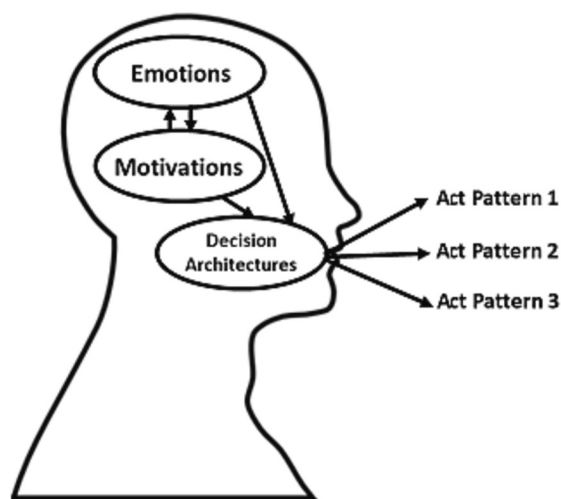
frequency (Fiddick et al., 2016). Indeed, confirming a key premise of the lexical hypothesis, the words and phrases within personality lexicons tend to cluster around aspects of behavior perceived to have high impact in human relationships (Wood, 2015).

2.1. Personality concepts as candidate cognitive universals

The adaptationist framework implies that personality concepts—or at least the developmental mechanisms to build them—come equipped with human nature and may therefore qualify as cognitive universals. Indeed, Brown (1991) included the use of personality concepts to interpret and explain behavior in his list of candidate human universals, as well a variety of specific mental and behavioral concepts (e.g., dominance-submission, expressions of envy, gossip, sexual modesty, intention). More than a decade prior, White (1980) identified many individual behavioral concepts in human language that he argued were abstractly universal, including concepts such as sociable, humble, afraid, intimidating, kind, lazy, jealous—and dozens more. More recent studies of mutually isolated languages have likewise identified dozens of specific personality descriptors that appear to be ubiquitous (Saucier, Thalmayer, & Bel-Bahar, 2014; Wood, Gurven, & Goldberg, 2020).

Several etic studies have imported lexical items used to assess the Big Five and Big Six personality traits in WEIRD societies into small-scale Indigenous communities. These studies support three main conclusions. First, nearly all specific personality items on psychometric questionnaires can be interpreted into Indigenous languages (e.g., Gurven et al., 2013). Second, the multivariate factor structures observed in Indigenous societies tend not to look much like the Big Five and Big Six factor structures found in WEIRD societies; this is likely due to the dependency of behavioral covariance patterns on socioecological variation (Lukaszewski et al., 2017; Smaldino, Lukaszewski, von Rueden, & Gurven, 2019). Third, as reviewed below, the individual differences described by personality concepts in small-scale societies often exhibit coherent links with external criteria. For example, Gurven et al. (2014) administered a survey assessing the Big Five dimensions to Tsimane horticultural-foragers of Bolivia and found that a Prosociality factor containing items from Extraversion and Agreeableness associated positively with the amount of time men spent socializing. Similarly, men who scored higher on Conscientiousness and Industriousness spent more

Behavior-Regulating Mechanisms



Personality Assessment System

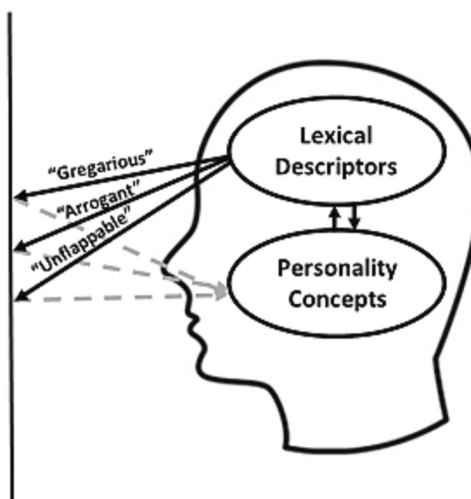


Fig. 1. An adaptationist framework for personality science that makes a clear distinction between (1) the psychological mechanisms that regulate behavioral decisions and (2) the personality assessment system and its concepts that function to detect, interpret, and communicate about the behavior of self and others (after Lukaszewski et al., 2020). Dotted lines represent ambiguous behavioral information that is to be detected and interpreted by the personality assessment system.

time working. Such findings bolster the construct validity of WEIRD-imported personality concepts in Indigenous societies and lexicons.

The very translatability of lexical items across vast cultural and linguistic distances suggests that many personality concepts may indeed qualify as human cognitive universals. However, this general conclusion—as well as its application to any specific personality concept—remains tentative, as it rests upon a relatively small set of empirical investigations in ecologies that are culturally distant from (more frequently studied) WEIRD societies (Thalmayer et al., 2022). More data from Indigenous societies and languages are needed.

3. Cost-benefit tradeoffs and the adaptive patterning of individual differences in personality

Natural selection would not have built a personality assessment system into the human mind if functionally consequential individual differences in the behavioral tendencies of self and others did not reliably exist within ancestral populations. But why do individual differences persist over evolutionary time in the first place and what causes them to be patterned as they are? Over the past several decades, evolutionary frameworks have been developed to explain the ultimate and proximate causes of individual differences in personality. Some individual differences in motivational and behavioral traits are likely fundamentally noisy (e.g., the result of low-frequency genetic mutations; Keller & Miller, 2006; Penke et al., 2007; Tooby & Cosmides, 1990). Other individual differences, however, are adaptively patterned in relation to factors that influence the fitness costs and benefits of being higher or lower on a given dimension of variation (Ashton & Lee, 2007; Buss, 1991, 2009; Buss & Hawley, 2010; de Vries et al., 2016; Del Giudice, 2018; Dingemanse, Kazem, Réale, & Wright, 2010; Lewis & Buss, 2021; Lukaszewski et al., 2020; Nettle, 2006; Penke et al., 2007; Tooby & Cosmides, 1990).

Cost-benefit tradeoffs along a phenotypic continuum can generate and maintain individual differences through multiple ultimate and proximate mechanisms. A regime of fluctuating selection—which occurs when optimal trait levels vary across individuals, time, or space—can maintain genetic variation that causes individual differences within a population (Keller & Miller, 2006; Penke et al., 2007; Penke & Jokela, 2016; Verweij et al., 2012). Natural selection can also create universal psychological mechanisms whose variable settings are facultatively calibrated (i.e., contingently adjusted) in ontogeny in response to cues that predict the magnitude of costs and benefits along a phenotypic continuum (Buss, 2009; Del Giudice, 2018; Lukaszewski & Roney, 2011; Penke, 2010; Tooby & Cosmides, 1990). The facultative calibration of psychological mechanisms—for instance, setting the activation threshold of an emotion program—can occur on vastly different time-scales and with radically different degrees of behavioral flexibility (Buss, 2009; Frankenhuys & Panchanathan, 2011; Lukaszewski, 2021; Penke, 2010). At one extreme, exposure to cues early in development can theoretically cause calibrational changes in the settings of a mechanism that persist throughout the lifespan. At the other extreme, a psychological mechanism can be designed to calibrate its settings fluidly in response to cues that predict the costs and benefits of different output levels across moments and immediate situations. Under any of these scenarios of proximate causation, individual differences are expected to be adaptively patterned in relation to fitness-linked costs and benefits.

3.1. Adaptive patterning of individual differences described by HEXACO personality dimensions

Most evolutionarily-informed research on the origins of human personality variation has focused on explaining individual differences that are described by the lexical dimensions of the Big Five and HEXACO (i.e., Big Six) factor structures (e.g., Buss & Hawley, 2010; de Vries et al., 2016; Lukaszewski & Roney, 2011; Nettle, 2005, 2006; Penke et al., 2007; Penke & Jokela, 2016; Rodriguez & Lukaszewski, 2020). This

research has proceeded according to an approach termed *dimensional cost-benefit analysis* (Lukaszewski, 2021), which involves inspecting the conceptual aspects of psychological and behavioral variation captured by a lexical dimension and considering the fitness-linked costs and benefits that may be associated with higher and lower levels on the dimension. Here, we focus on three personality dimensions from the HEXACO model (Ashton & Lee, 2007): Extraversion, Honesty-Humility, and Emotionality. In what follows, we describe the fitness-linked costs and benefits theorized to underlie individual differences on these dimensions, with specific reference to variables that will be relevant for the present study: physical strength (as a calibrator of variation), social status (as a benefit of certain aspects of variation), and fertility (as a benefit of certain aspects of variation).

3.1.1. Extraversion (sociability component)

The Extraversion continuum captures individual differences described by inter-correlated lexical concepts of “Sociability,” “Social Boldness,” “Social Self-Esteem,” and “Liveliness” (Ashton & Lee, 2007; Lee & Ashton, 2008). People who score high on the Sociability component, which we focus on here, tend to enjoy interacting with many others, having conversation, and attending social gatherings. People who score low on Sociability generally prefer more solitary activities and to spend less time interacting with and conversing with others. Note that, although there are some differences between Big Five and HEXACO personality dimensions, HEXACO Extraversion is nearly identical to Big Five Extraversion (John et al., 2008; McCrae & John, 1992).

Individual differences in sociable behavioral strategies have been hypothesized to associate with a specific set of cost-benefit tradeoffs (Ashton & Lee, 2007; de Vries et al., 2016; Lukaszewski & von Rueden, 2015; Nettle, 2005, 2006). Approaching and conversing with many others in a gregarious fashion facilitates the formation and maintenance of social exchange relationships and alliances (Kyl-Heku & Buss, 1996; Patton, 2005; Redhead & von Rueden, 2021; von Rueden et al., 2008; von Rueden, Redhead, O’Gorman, Kaplan, & Gurven, 2019). In turn, having more exchange partners and allies is a crucial determinant of an individual’s social network centrality (Redhead & von Rueden, 2021) and hierarchical status within communities (Anderson, John, Keltner, & Kring, 2001; Patton, 1996; von Rueden et al., 2008, 2019). Given that greater fertility is one of the principal fitness-linked benefits of high status (Chagnon, 1983; von Rueden, Gurven, & Kaplan, 2011; von Rueden & Jaeggi, 2016), it makes good sense that measures of Extraversion have been found to predict (especially men’s) fertility in both WEIRD (Berg et al., 2013; Jokela et al., 2011) and small-scale (Alvergne et al., 2010; Bailey et al., 2013; Gurven et al., 2014) societies (for a review, see Penke & Jokela, 2016). Despite these fitness benefits, high Sociability also carries costs, for example, opportunity costs in the currencies of time and energy (Lukaszewski & von Rueden, 2015; Nettle, 2005), and increased exposure to pathogen vectors (Christakis & Fowler, 2010; Schaller & Murray, 2008) and social conflict (von Rueden et al., 2008). Given these cost-benefit tradeoffs, the optimal level of Sociability for an individual depends on one’s relative probability of reaping the benefits (e.g., high status), and of paying the costs, of pursuing the behavioral tactics described by this dimension.

It has been hypothesized that behavioral strategies captured descriptively by Extraversion are facultatively calibrated in response to an individual’s level of physical strength relative to others (Lukaszewski, 2013; Lukaszewski & Roney, 2011). Relative to weaker people, stronger people are more likely to prevail in interpersonal conflicts (Hess, Helfrecht, Hagen, Sell, & Hewlett, 2010; Sell et al., 2009; Sell, Hone, & Pound, 2012; von Rueden et al., 2008, 2019), and are valued more as allies (Eisenbruch, Grillot, Maestripieri, & Roney, 2016), mates (Sell, Lukaszewski, & Townsley, 2017), and leaders (Lukaszewski, Simmons, Anderson, & Roney, 2016; von Rueden et al., 2008; von Rueden et al., 2014). As such, physically stronger people are, all else equal, better equipped than weaker people to cost-effectively attain the fitness-linked benefits of high Sociability, such as successful alliance formation (von

Rueden et al., 2008, 2019), high social status (Chagnon, 1983; Patton, 2000; von Rueden et al., 2008, 2019), and high fertility (Chagnon, 1983; von Rueden et al., 2011). As physically strong people are better able to elicit deference from others, they are also less likely to pay some of the costs of high Sociability, such as those related to losing in conflicts with others (Hess et al., 2010; Sell et al., 2009; Sell et al., 2012; von Rueden et al., 2008, 2019). Consistent with this facultative calibration model, physical strength has been found to associate positively with levels of Extraversion (and Sociability) in WEIRD societies (Fink, Weege, Pham, & Shackelford, 2016; Lukaszewski, 2013; Lukaszewski & Roney, 2011; Rodriguez & Lukaszewski, 2020; but see Kerry & Murray, 2018)—an association that has been observed more consistently among men than women. Moreover, von Rueden et al. (2015) found that, among Tsimane horticultural-foragers of Bolivia, physical strength associated positively with both Extraversion and a broader Sociability-saturated dimension labeled “Prosociality”.

The overall pattern of findings reviewed above implies positive associations among physical strength, Sociability, status, and fertility. However, no previous datasets have contained all the necessary information to provide an integrative test all of these hypothesized linkages.

3.1.2. Honesty-humility (modesty component)

The HEXACO Honesty-Humility dimension, whose content has low representation in Big Five factor space, captures individual differences described by inter-correlated lexical concepts of “Modesty,” “Fairness,” “Sincerity,” and “Greed Avoidance” (Ashton & Lee, 2007; Lee & Ashton, 2008). We focus here on the Modesty component, which captures the tendency to behave in ways perceived as unassuming and *not* to view oneself as superior and entitled to special treatment. People who score high on Honesty-Humility tend to follow rules, conform with social norms, and cooperate with others for mutual benefit (Ashton & Lee, 2007). People who score low on Honesty-Humility are likely to seek personal material gain by breaking rules, manipulating others, defecting on social contracts, and demanding special treatment (Ashton & Lee, 2007; Hilbig & Zettler, 2009; Hilbig, Zettler, Leist, & Heydasch, 2013).

It has been hypothesized that individual differences in Modesty reflect a specific set of cost-benefit tradeoffs (Ashton & Lee, 2007; de Vries et al., 2016). Benefits of low Honesty-Humility, including low Modesty, come in the currency of immediate personal profits, for example material resources acquired by exploiting or defecting on others, as well successful demands for special treatment and status. Research using economic games has demonstrated that Honesty-Humility scores are the key personality predictor of making selfish (and strategically calculating) decisions that maximize personal gain at a cost to others (Hilbig et al., 2013; Hilbig & Zettler, 2009; Hilbig, Zettler, & Heydasch, 2012). However, low Modesty also has potential costs, including the loss of social value in the minds of other people that result from being seen to believe that one is better than others believe them to be, and gaining a reputation for selfishness, defection, and entitlement (Anderson, Ames, & Gosling, 2008; Anderson, Srivastava, Beer, Spataro, & Chatman, 2006; Boehm, 2009; Wiessner, 2005). Some research suggests that people lower in Modesty tend to attain higher status, but are not better liked, than their peers (de Vries, Pronk, Olthof, & Goossens, 2020)—which is consistent with the idea that low Modesty does indeed have potential benefits that may (for some individuals) outweigh its costs.

Individual differences in the tactics described by Modesty may be facultatively calibrated to physical strength, for many (but not all) of the same reasons as for Sociability. Formal models predict that animals will resolve conflicts in part on the basis of relative physical formidability—a prediction that has been confirmed across many species (Huntingford & Turner, 1987), including humans (Hess et al., 2010; Sell et al., 2009; Sell et al., 2012; von Rueden et al., 2008). As such, relative to weaker people, physically stronger people are often able to elicit greater deference and better treatment from others by demanding more than they are seen to deserve on the basis of the benefits they generate for others. Consistent

with this, the anger program, whose activation threshold is set based on one’s felt entitlement to preferential treatment, is facultatively calibrated to physical strength, such that stronger people are quicker to become angry across a range of offenses (Sell et al., 2009). In a multi-sample analysis of young adults in the USA, Rodriguez and Lukaszewski (2020) found some evidence indicating that physical strength was negatively associated with components of Honesty-Humility, including Modesty (although this association was small and only statistically significant among women).

Although prior emic research has documented the existence of Modesty-related concepts (e.g., arrogant, pompous, grandiose) in small-scale societies and marginal lexicons (Thalmayer, Job, Shino, Robinson, & Saucier, 2021; Thalmayer, Saucier, Ole-Kotikash, & Payne, 2020), we are not aware of any studies that have tested for the adaptive patterning of Honesty-Humility or its components in a non-WEIRD context or small-scale society. In sum, there are some theoretical and empirical reasons to predict that psychological variation described by Modesty is calibrated to physical strength, and that Modesty may be negatively associated with social status and fertility. However, there is a paucity of extant data with which to evaluate these links.

3.1.3. Emotionality (overall factor)

HEXACO Emotionality, which partly overlaps with Neuroticism from the Big Five, captures individual differences described by inter-correlated lexical concepts of “Fearfulness,” “Anxiety,” “Dependence,” and “Sentimentality” (Ashton & Lee, 2007; Lee & Ashton, 2008). The core of Emotionality appears to reflect individual differences in the activation thresholds of phylogenetically ancient fear and anxiety programs, whose neurobiological and computational architectures have been well characterized (Montag & Panksepp, 2017; Moscarello & Hartley, 2017; Nesse, 2005). Both emotion programs activate in response to cues of potential threats, are experienced as aversive, and motivate threat mitigation tactics.

Given that physical strength influences a person’s ability to proactively mitigate a range of physical threats, from being attacked to trapped under a fallen log, it has been hypothesized that the fear and anxiety programs are facultatively calibrated to physical strength (Kerry & Murray, 2018; Kerry & Murray, 2021; Manson et al., 2022; Rodriguez & Lukaszewski, 2020). Relative to physically stronger people, weaker people estimate many physical threats to be less controllable, and therefore exhibit a more intense and prototypically fearful response. Consistent with this, studies of young adults in the USA have consistently found that physical strength associates negatively with levels of Emotionality (especially the Fearfulness component) among both men and women (Lukaszewski, 2013; Rodriguez & Lukaszewski, 2020). Moreover, recent studies have found that physical strength mediates the large sex differences in levels of Fearfulness (Manson et al., 2022) and Anxiety (Kerry & Murray, 2016; Kerry & Murray, 2021).

As reviewed above, cognitive and lexical concepts of fear and anxiety appear to be common across cultures. Several studies at field sites in small-scale societies have tested correlates of Big Five Neuroticism (Alvergne et al., 2010; Bailey et al., 2013; Gurven et al., 2014), which has substantial overlap with the Emotionality factor. In general, results have been mixed in these studies, as well as in studies in WEIRD societies, regarding the sex-specific associations of Neuroticism with age-specific fertility (for a review, see Penke & Jokela, 2016). We are not aware of any study that has tested the association of Emotionality or Neuroticism with status in a small-scale society. Given that courage and bravery (including in warfare) are among the most status-promoting traits across many cultures (Chagnon, 1983; Durkee, Lukaszewski, & Buss, 2019, 2020; Patton, 2000, this issue), especially among men (Buss et al., 2020), our general expectation is that Emotionality will associate negatively with (men’s) status and fertility.

4. The present study: testing the existence, calibration, and fitness-linked correlates of HEXACO personality concepts in Conambo, Ecuador

In the present study, we test the existence and fitness-linked correlates of HEXACO personality concepts—Sociability, Immodesty, and Un-emotionality—in the village of Conambo, which is located in the Sápara Territory of the Ecuadorian Amazon. The people of Conambo are Achuar, Quichua, and Sápara ethnicities, which are Indigenous to the region. Conambo has a number of attractive features as a study site for the current purposes. First, generally, the inhabitants of Conambo know each other well, and adults have a long history of repeated interactions and relationships with other members of the village; as such, each person's mind should contain a vast reservoir of information about how they and others tend to behave in daily life. Second, the people of Conambo maintain a traditional lifeway as self-sufficient horticultural-foragers. Although villagers regularly interact with people from other Indigenous villages nearby, the village is remote and difficult to access from outside the Indigenous territory; as such, their most frequent and fitness-relevant interactions and relationships are with others in the village of Conambo and nearby Indigenous communities. Third, previous research in Conambo has demonstrated the existence of clearly-defined status hierarchies among both men and women, and that people tend to strongly agree when they rank the status of self and others in the village (Bowser & Patton, 2004, 2010; Escasa, Gray, & Patton, 2010; Patton, 1996, 2000). Fourth, Conambo is a natural fertility population with a high fertility rate (Patton, 2005), making age-specific fertility a potentially good fitness proxy in this ecology. Finally, Spanish is spoken by the people of Conambo only as a second or third language, while the Indigenous languages of Achuar and Quichua are spoken as first and second languages, which arguably makes possible an indirect test of whether specific lexical personality concepts pre-existed contact with Spanish-speaking outsiders.

Conambo's status as a face-to-face community of self-sufficient horticultural-foragers with a long history of repeated interaction and interdependence is especially compatible with the method we use to assess personality traits and relative status. As described below (and in Conroy Beam et al., this issue), to assess personality traits and status, we use a photo ranking task wherein most adults in Conambo used photographs of others in the village to rank each other (and themselves) on the focal dimensions. We take the level of inter-ranker agreement for a given dimension as evidence that a given personality or social concept exists in the minds of people in Conambo—if people agree on others' standing on a given dimension, they must be using a similar internal concept to make their assessments. To assess individual differences in personality traits, we average the rankings of each target person for each dimension. As such, each person's personality score or level of relative status contains relevant information from the minds of most other same-sex villagers.

Using these methods, we first test inter-ranker agreement for each of the focal personality concepts, conceptualized here as Sociability, Immodesty (the low pole of Modesty), and Un-emotionality (the low pole of Emotionality). Next, we test zero-order and age-controlled pairwise associations among physical strength, Sociability, Immodesty, Un-emotionality, status, and fertility. Based on the hypotheses and prior literature reviewed above, we expected physical strength—as a hypothesized calibrator of individual differences—to associate positively with Sociability, Immodesty, Un-emotionality, status, and fertility. In turn, we expected status and fertility, respectively, to associate positively with Sociability, Immodesty, and Un-emotionality. We also expected status to associate positively with fertility. Finally, we employ network analyses to model unique and indirect associations among the focal variables in the study. Given inconsistency across prior studies in the sex-specificity of the predicted associations, there was little reason to make sex-differentiated predictions.

5. Methods

5.1. Participants and ethnographic context: Conambo, Ecuador

Conambo is home to approximately 180 people of Achuar, Quichua, and Sápara ethnicities, which are Indigenous to this region of Amazonia. Conambo is located in the Sápara Territory of Ecuador where corporate land rights have been formally recognized. Residents live in approximately 33 households, most of which are headed by a monogamous couple or, less frequently, a widowed woman or a polygynous husband and wives. Ost-marital residence is customarily matrilineal. Conambo is a natural fertility population; Western forms of birth control (e.g., hormonal contraceptives, condoms) are not available and rarely practiced, although interest in birth control is increasing among couples with small children due to the costs of school attendance. The village is remote, without easy access to towns or markets, and typically only accessible from outside the territory by small plane. The people are self-sufficient horticultural-foragers, as the great majority of their calories are produced by manioc horticulture, hunting, fishing, and gathering forest products (Patton, 1996). Food sharing among households is widespread and based on relationships of kinship, reciprocity, status, alliance, and residential propinquity (Patton, 2005). Achuar, Quichua, and Sápara are not only Indigenous ethnolinguistic auto-denominators based generally on first language and recent ancestry, but also constitute distinct political coalitions within Conambo (Bowser, 2000; Patton, 2000). The community is divided politically and spatially into two coalitions, known widely throughout the region as the Achuar and the Quichua, although in recent years, since the recognition of the Sápara land title, many people refer to the Quichua faction as Sápara. The Achuar-Quichua political divide has been the source of coalitional competition, conflict, and violence since the founding of the community in the 1970s (Patton, 1996). However, throughout the Indigenous territories, coalitional tensions result in lethal violence less frequently in recent decades than in the past.

Of particular relevance to the current investigation of lexical personality concepts, Conambo is a multilingual community. Many people speak some Spanish, although not equally well across age cohorts, everyone speaks one or both of the Indigenous languages of Achuar and Quichua, and one woman speaks Sápara, as well, though not fluently. Most people of middle age and younger speak some Spanish; however, everyone communicates primarily in the Indigenous languages.

Participants in the current study who were ranked by others were 76 adults (33 men; 43 women) who live in Conambo, 46 of whom (22 men; 24 women) also completed at least one of the photo ranking tasks described below. Male participants ranged in age from 18 to 77 with a mean of 40.24 ($SD = 15.71$), and female participants ranged in age from 19 to 88 with a mean of 40.92 ($SD = 18.02$). Finally, 41 participants (22 men) identified as Achuar and 26 (11 men) identified as Quichua or Sápara (ethnicity data are missing for 9 women). Sápara is a language with no surviving fluent speakers today, and individuals who identify as Sápara in Conambo speak Quichua as a first language and sometimes identify as, and are identified by others as, Quichua. Data on personality, status, and physical strength presented in the current article were collected in the summer of 2018. Age, fertility, kinship, household composition, and ethnic affiliation data have been collected in the territory since 1992, and we draw from that database for this study, as well.

5.2. Translations for lexical personality concepts and status

Terms to describe the focal personality concepts—Sociability, Immodesty, and Un-emotionality—were elicited using the standard back-translation method. Multiple researchers who were fluent in Spanish discussed each operational definition, including Indigenous researchers and multiple villagers who were fluent in Spanish, Achuar, and Quichua. Through these discussions, the best translations were identified via consensus and back-translation to match the targeted

theoretical concept in Spanish and English. The same process was used to identify the operational definition for status that has long been used in research in Conambo (e.g., [Patton, 1996, 2000](#)). [Table 1](#) presents the final operational definitions for the focal personality concepts and status in Spanish, Achuar, Quichua, and English.

5.3. Photo ranking task

To assess inter-ranker agreement and individual differences in personality and status, we employ a photo ranking task that has long been used in Conambo by Patton ([Bowser, 2000](#); [Bowser & Patton, 2004](#); [Bowser & Patton, 2008, 2010](#); [Conroy-Beam, Patton, Goetz, Lukaszewski, & Bowser, 2023](#), this issue; [Escasa et al., 2010](#); [Patton, 1996, 2000, 2004, 2005](#)). The task is administered in a private location, with only the participant and researchers present. In the task, the research assistant first verbally presents the operational definition of the focal attribute (e.g., Sociability) to the participant. Operational definitions were presented in all three languages to each participant: Achuar, Quichua, and Spanish (see [Table 1](#)). Then, the participant (“ranker”) physically arranges photographs of participating adults (“targets”), including themselves, according to their relative ranking on the focal dimension. This proceeds as follows: Initially, the research assistant draws two photographs at random, and asks the ranker whether the two targets are equal on the attribute, or whether one is higher than the other. The photos are then arranged accordingly on a tabletop, such that a target who is ranked as having more of the attribute is placed above the target ranked as having relatively less, whereas two targets perceived to have the same amount of the attribute are placed next to each other in the same ‘tier.’ This process is then repeated for the remaining photographs until a complete rank ordering of targets on the attribute has been constructed by the ranker. The research assistant records the final rank ordering of target photographs based on the ID numbers written on the back of each photograph.

Because rankers can decide that targets are equal on the focal attribute, they can effectively create as many ranking tiers as they wish—from splitting all the targets into two tiers of “higher” and “lower” to assigning a unique relative ranking tier to each target. To deal with this, rankings are placed on a standardized scale as follows: If targets were ranked on the highest tier, then they were given a score of 1. The targets on the lowest tier were assigned a rank value of 0. The targets ranked on tiers in-between the highest and lowest tier were given scores that were scaled between 1 and 0 depending on the number of tiers made by the participant ([Escasa et al., 2010](#)). [Fig. 2](#) provides a visual depiction of a mapping between a physical rank ordering of targets and the assignment of standardized ranking values. Finally, when appropriate given observed levels of inter-ranker agreement, personality scores are created for each target by averaging standardized rankings of them across all rankers.

In the current study, the 33 male targets were ranked by 20 male rankers (who were also targets in the photoset) on Sociability, 23 rankers on Immodesty, 21 rankers on Emotionality, and 22 rankers on status. The 43 female targets were ranked by 22 female rankers (who were also targets in the photoset) on Sociability, 23 rankers on Immodesty, 20 rankers on Emotionality, and 24 rankers on status. There were fewer rankers than targets because the field team was unable to schedule appointments to complete ranking tasks with some of the targets in the photoset, for various reasons (e.g., some residents were away

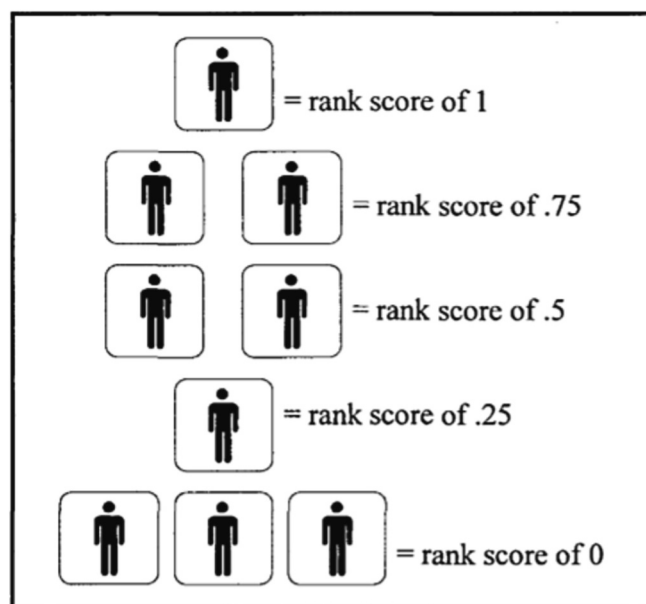


Fig. 2. Example of a mapping between a hypothetical ranker's physical rank ordering of nine target individuals' photographs on a given attribute and standardized ranking scores.

from the village at the time of data collection).

5.4. Grip strength

Grip strength was measured for both arms using a Baseline® electronic dynamometer (model 12–0286). The protocol was very similar to that used in previous research testing associations of physical strength with individual differences (e.g., [Kerry & Murray, 2021](#); [Lukaszewski & Roney, 2011](#); [Sell et al., 2009](#); [von Rueden et al., 2008](#)). For each arm, the participant is instructed to hold the dynamometer at their side, then squeeze with all their strength. The maximum pressure applied is then displayed on the digital screen and recorded by the research assistant. Right and left grip strength were highly correlated, $r = 0.809$. As such, we computed an average of grip strength measures from both sides to use for our operational definition of physical strength. The mean grip strength for men was 33.53 kg ($SD = 6.79$) and the mean for women was 20.85 kg ($SD = 6.23$). Grip strength data was missing for seven of 33 men and 10 of 43 women; our analyses address this missingness (see Results).

5.5. Demographic data from the Conambo census: fertility and age

Fertility and age were taken from the household census and genealogy database that has been established and updated across many field seasons since 1992 for Conambo and associated communities, based on standard ethnographic methods. Fertility was operationalized as the number of offspring each participant has ever given live birth to (for women) or fathered to their knowledge (for men). Given high levels of monogamy (and, in a few marriages, polygyny) in Conambo, a man's fertility typically matches his wife's (or wives') fertility ([Patton, 2005](#)). Fertility in Conambo is high: the number of offspring ranges from 0 to 13

Table 1
Translations of lexical concepts from Spanish to Quichua and Achuar.

Concept	Spanish	Quichua	Achuar	English (not used in study)
Sociability	Sociable	Asisiki	Yushimwuaasau	Sociable
Immodesty	cree mas que el/ella es mejor resto	Valirik	Nekapnuikei	believes he/she is better than the rest
Un-emotionality	Tranquilo	Kungailla	Nindinsup	unflappable, calm, or peaceful
Status	estatus/lider	Llaktaamu	Juun	important person/leader

for both men ($M = 5.47, SD = 3.95$) and women ($M = 5.26, SD = 3.70$). Offspring data are missing for 3 men and 5 women in 2018; our analyses address this missingness (see Results).

6. Results

All data and code to reproduce the analyses presented here are available on the OSF, along with the supplemental materials: https://osf.io/uf2cb/?view_only=44150726a8874d9e9ff3559f4a2a20d9

6.1. Inter-ranker agreement for personality concepts and status

We take the very translatability of our operational definitions of personality concepts and status, respectively, from Spanish into the indigenous languages as indirect evidence that these concepts exist in the minds of people in Conambo, have similar meaning as they do in WEIRD populations, and existed prior to exposure to Spanish-speaking people.

A more compelling test of whether these concepts exist and have consensual meaning across minds, however, is the extent to which rankers tend to agree in their relative rankings of targets—if people generally agree regarding who is higher or lower on a given behavioral attribute, they must be employing a similar internal concept to make their assessments. The most appropriate inter-ranker reliability index for our data is the two-way mixed effects intraclass correlation coefficient for absolute agreement because (i) the sample comprises most of the adult population (so we treat raters as fixed rather than generalize to a larger population), and (ii) we will be using mean ratings on each focal dimension in subsequent analyses (ICC3k; Koo & Li, 2016; McGraw & Wong, 1996; Shrout & Fleiss, 1979). Table 2 shows the ICC3k for each of the ranked dimensions across the 33 male targets and 43 female targets, respectively, which was computed using the ICC function in the psych package (Revelle, 2022) in R (R Core Team, 2022). For targets of both sexes, inter-ranker reliability was high for Status, Sociability, and Immodesty, but low for Un-emotionality. Given the lack of reliability for Un-emotionality and uncertainty about what the construct means in the minds of rankers, we dropped it from further analyses. For the other three concepts exhibiting high reliability, we computed the mean and standard error of rankings for each trait for each target based on all rankers' relative rankings.

6.2. Associations among grip strength, personality concepts, status, and fertility

6.2.1. Pairwise correlations

We took a Bayesian approach to estimating the pairwise correlations among all focal variables. We used the brms package (Bürkner, 2017) to specify three multivariate regression models for each sex with individuals' mean social-trait rankings, grip strength, and offspring count as outcomes. First, we modeled the residual correlations among these variables in a model with no predictors to estimate the zero-order

correlations. Second, we included linear age as the sole predictor to partial out any age effects. Third, we included both linear age and age-squared as predictors to partial out potential quadratic age effects. In models with continuous variables, we accounted for uncertainty around each person's peer-ranked trait by including their standard errors in the model (McElreath, 2020). In all models, we used Student's t likelihood distribution rather than Gaussian because the former is more robust to outliers and deviations from non-normality (Baez-Ortega, 2018; Kurz, 2021). We set the LKJ regularizing prior to 2, reflecting the conservative assumption that extreme correlations should be relatively less likely than moderate to small correlations (Nalborczyk, Batailler, Lævenbruck, Vilain, & Bürkner, 2019). Age trends were modeled using weakly-informative priors. The offspring variable was modeled as a count outcome with a Poisson distribution.

Data were missing for offspring (12%), grip strength (22%), and age (0.04%). Little's MCAR tests failed to reject the null hypothesis that missingness in the data was not completely random ($ps > 0.449$), indicating that listwise deletion could be appropriate. However, because this would further reduce our already small sample, we opted to handle missing data by creating 20 multiply imputed datasets using the mice package (Van Buuren & Groothuis-Oudshoorn, 2011), running the specified models on each imputed dataset, and combining the posterior draws across models (Zhou & Reiter, 2010). This allows us to maximize our analytic sample size and incorporate uncertainty about the missing data values (McElreath, 2020). All model Rhats converged on 1 and none exceeded 1.01, suggesting no issues with the model convergence (Vehtari, Gelman, Simpson, Carpenter, & Bürkner, 2021). Fig. 3 depicts the estimated pairwise zero-order and partial correlations among the focal variables for men and women, along with the 89% and 95% credible intervals (CI), and the full posterior probability distributions. Note that the Bayesian framework allows for evidence to be interpreted continuously, taking the full posterior probability distribution into account, rather than relying on dichotomous significance cutoffs (McElreath, 2020). The credible intervals are intended to aid in interpreting the range of effect sizes that we can be sure are compatible with our data at a given probability.

At the level of zero-order correlations, there was strong evidence that grip strength positively predicted men's Sociability. There was also some evidence for a positive association between grip strength and Immodesty, and a negative association between grip strength and offspring-indexed fertility at the zero-order level. The posterior probabilities are centered around zero for the relationship between grip strength and status at the zero-order level.

However, when conditioning on linear and quadratic age effects, there was stronger evidence that strength was positively related to both Immodesty and status in men. There was some evidence that strength was associated with men's or women's fertility in this sample after accounting for age effects, but a portion of the posterior distribution was still consistent with null and negative associations. Among women, the posterior distribution was largely consistent with grip strength being positively associated with Sociability and Immodesty at the zero-order level, but not when controlling for age effects.

Finally, as predicted, there was strong evidence that men's status was strongly positively associated with fertility—both with and without age controls. Among women, the majority of the posterior distributions supported positive associations between status and fertility, but the evidence was somewhat weaker when controlling for effects of quadratic age.

6.2.2. Repeating all analyses using only self-rankings of personality and status

In the supplemental materials, we repeated the above analyses using only self-rankings for personality traits and status (see Section 6.2). The effects are generally trending in the same directions for each focal association, but the posterior distributions are much wider, reflecting greater uncertainty about associations when the ratings are based on

Table 2
Inter-ranker agreement for personality concepts and status.

Ranking Task	Ranker N	ICC3k	Lower 95% CI	Upper 95% CI
Male Targets				
Sociability	20	0.869	0.808	0.918
Immodesty	23	0.716	0.586	0.823
Emotionality	21	0.426	0.160	0.643
Status	22	0.846	0.775	0.904
Female Targets				
Sociability	22	0.871	0.808	0.921
Immodesty	23	0.874	0.812	0.923
Emotionality	21	0.577	0.369	0.740
Status	24	0.752	0.631	0.848

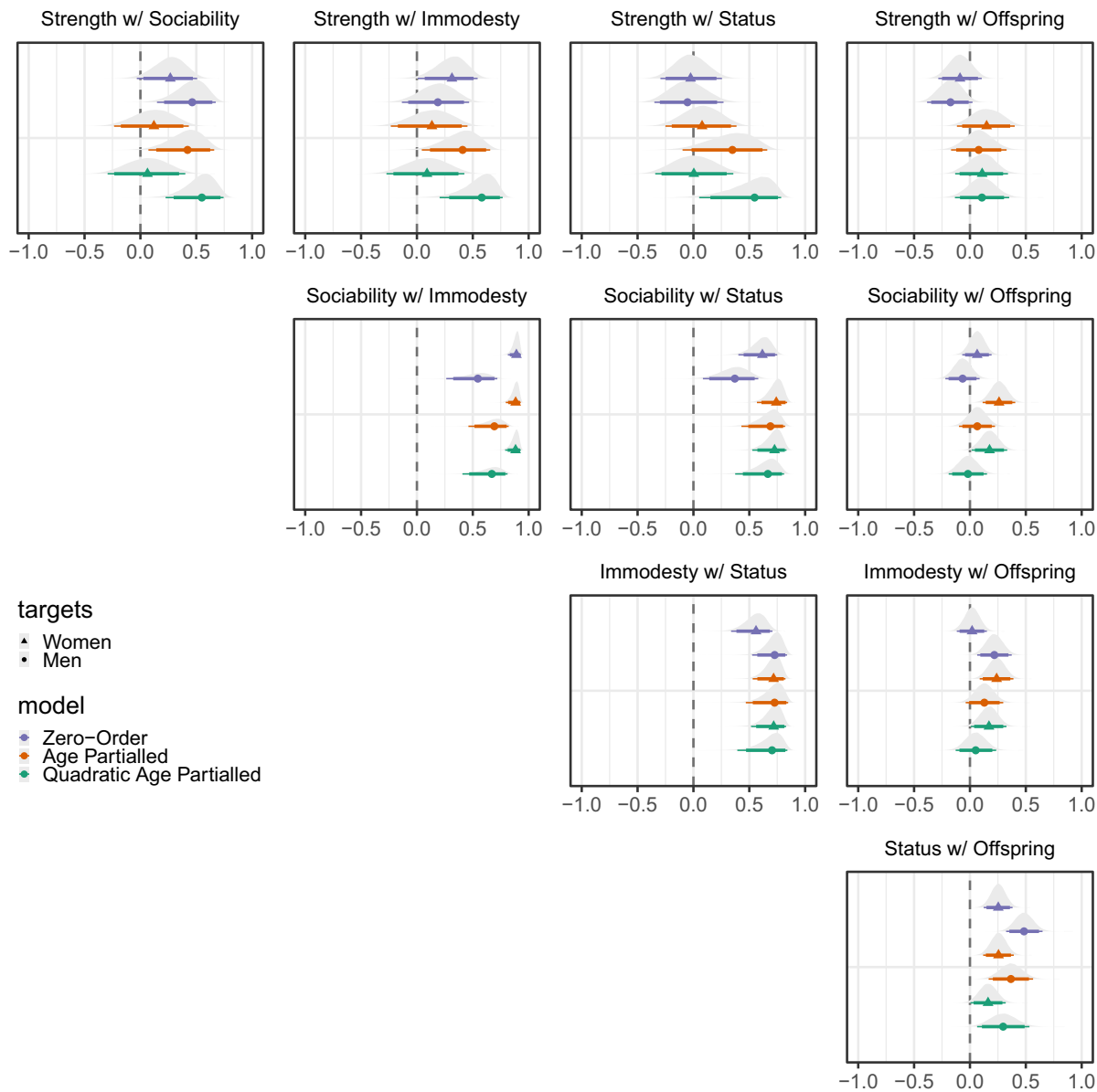


Fig. 3. Matrix of plots depicting the sex-specific pairwise associations among focal variables for models with and without age controls. The gray density distributions depict the full posterior probabilities, and the points mark the median of the probability distributions. The shape of the median point estimates corresponds to women (triangle) and men (circle), and the associated horizontal bars capture the 89% (thicker bar) and 95% (thinner bar) credible intervals for each association. Offspring is modeled as a count variable with a Poisson distribution.

only self-ratings.

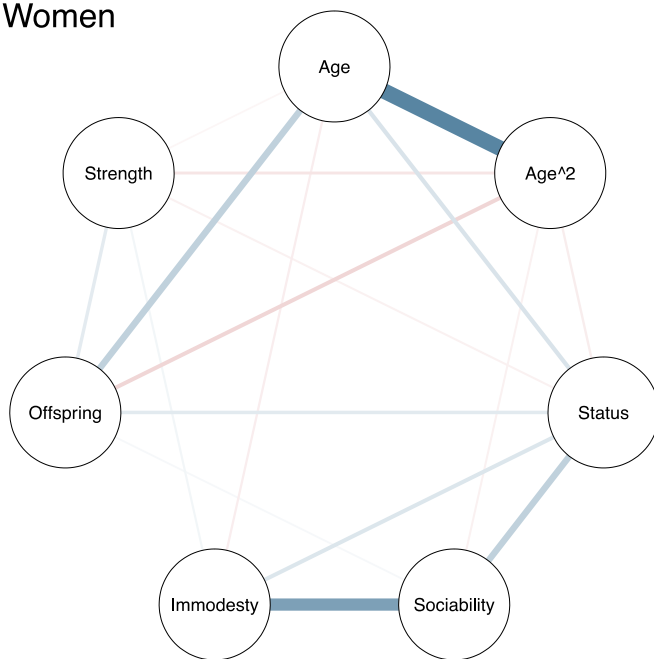
6.2.3. Network analysis

We also examined the associations among the focal individual difference constructs using a psychological network approach (Schmittmann et al., 2013). In psychological network terminology, constructs of interest are referred to as nodes. The estimated associations between the nodes are referred to as edges. Edges in psychological network analysis are typically constructed from partial correlations among nodes. This partial correlation approach is generally favored over zero-order networks because the latter are more likely to contain spurious connections between nodes (Costantini et al., 2015). Additionally, partial correlation networks provide insight into unique associations and potential indirect associations between variables by essentially linking all possible multiple regression models, without imposing assumptions of directionality as in path analysis (Epskamp & Fried, 2018).

We used the estimateNetwork function in the bootnet package (Epskamp, Borsboom, & Fried, 2018) to estimate a regularized partial correlation network using least absolute shrinkage parameter estimation regularization (LASSO; Tibshirani, 1996) with extended Bayesian information criterion (EBIC) optimization (Chen & Chen, 2008). This approach creates a sparse network that reduces the number of spurious edges and effectively recovers network structures in small sizes (Epskamp, Kruis, & Marsman, 2017). We set the tuning parameter to 0.5, as recommended by Foygel and Drton (2010). To address missingness, we used full-information maximum likelihood estimation (Burger et al., 2022).

Figure 4 depicts the sex-specific networks with each node represented by a circle. The strength of the unique associations between the nodes is depicted by the width of the path, and the direction of the association is indicated by the color (blue = positive; red = negative). Because of the regularization procedure, nodes with connecting paths

Women



Men

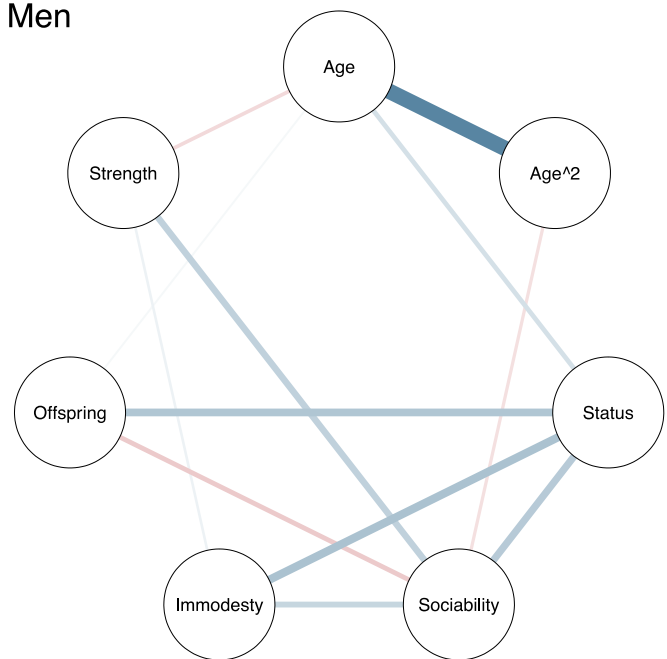


Fig. 4. Sex-specific network plots depicting regularized partial correlations (edges) among focal traits (nodes). The color and thickness of the edges respectively correspond to the direction and strength of the conditional associations (blue = positive, red = negative). Nodes are arranged arbitrarily in a circle. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

are likely to indeed have a non-zero unique association in the population when controlling for all other nodes in the network (Epskamp & Fried, 2018); however, we note that the relative magnitude of the associations should be interpreted with caution because bootstrapped analyses of network stability show a large amount of variation in the relative magnitude of the edge weights (see section 7 of the supplemental materials). This is to be expected, given the relatively small sample.

When considered alongside the pairwise associations among focal variables reported above, the networks provide several insights. Although men's age-controlled grip strength exhibited positive pairwise associations with Sociability, Immodesty, and status after controlling for quadratic age, men's grip strength was only connected to Sociability and Immodesty in the network and the residual associations for men's Sociability and Immodesty with Fertility are negative. These differences are consistent with the possibility that, holding age effects constant, any associations of men's strength with status or fertility occur indirectly via personality variation. Similarly, in the network, men's status—but not Sociability or Immodesty—exhibited a unique positive association with fertility, suggesting that any links between personality and fertility may occur via status. Additionally, among both men and women, Sociability and Immodesty—which are highly correlated—each exhibited unique associations with status in the networks, suggesting that the observed pairwise correlations of status with Sociability and Immodesty, respectively, do not simply reflect the overlapping variance between Sociability and Immodesty.

We note that, because Sociability and Immodesty were so strongly correlated that they could obscure each other's relationships to other variables, parallel network analyses were conducted that were identical to those presented above except that they included only one of these traits, rather than both. The patterns in these networks were qualitatively the same as those in the network presented above that included both personality variables (see section 7 of the supplemental materials).

6.2.4. Within-ranker associations

Finally, we examined how the traits assessed via the ranking task are associated within the minds of individual rankers. While the associations of the mean rankings across targets may align with the associations at

the within-ranker level, it could also be that status, Immodesty, and Sociability exhibit different associations within the minds of individual raters. For example, Sociability could be correlated with status at the target level because people who rank someone as high status also tend to rank that person as being sociable; but the target-level association could also arise because some people perceive a target as being high Status, while others perceive them as being Sociable. That is, at the within-ranker level, people who rank a person as having high status may not necessarily perceive them as Sociable.

We examined within-ranker associations by constructing sex-specific multivariate Bayesian cross-classified multilevel models with random intercepts for raters and targets. As with the pairwise associations at the target level, we ran three models: a zero-order model, a model controlling for linear age effects, and a model controlling for quadratic age effects. We modeled missing data in the rankings as estimated parameters within the model itself to reflect the multilevel data structure more accurately (McElreath, 2020). We used the same priors as in the between-target models.

Figure 5 shows the median point estimates, 89% and 95% credible intervals, and full posterior distributions for the within-ranker associations. The associations between status, Immodesty, and Sociability rankings are all small, but reliably positive for both men and women raters. This suggests that the patterns at the within-ranker level do generally mirror the target-level patterns, although the associations between the focal traits are less strong within the minds of individual rankers than when aggregating rankings at the target level.

7. Discussion

This study of personality in Conambo, Ecuador yielded several findings. At the most fundamental level, we found evidence that specific lexical personality concepts imported from the HEXACO framework exist in the minds of Achuar and Quichua speakers in Conambo, despite their variable exposure to Western cultures and Spanish language. One piece of evidence supporting this conclusion is that lexical terms referring to each of the three focal personality concepts—Sociability, Immodesty, and Un-emotionality—were readily interpreted from

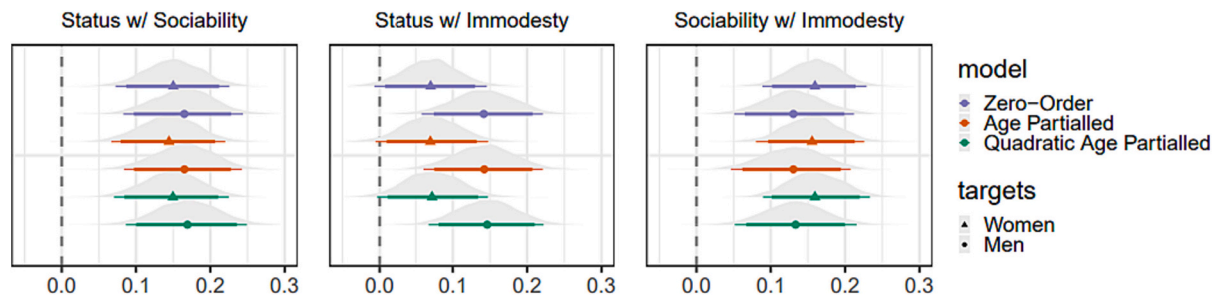


Fig. 5. Matrix of plots depicting the point estimates for sex-specific, within-ranker pairwise associations among focal variables for models with and without age controls, along with 89% (thicker bar) and 95% (thinner bar) credible intervals for each association.

Spanish and corresponding terms were identified and back-translated in the Indigenous languages of Achuar and Quichua through extended discussion among the field researchers experienced in language documentation, including Indigenous field participants fluent in Spanish and one or both Indigenous languages. Moreover, there was high inter-ranker agreement for Sociability and Immodesty (but not Unemotionality), which suggests that people's rankings of others in the village on two of the three focal dimensions were based on common internal concepts. Taken together, these findings, along with those of other etic (Bailey et al., 2013; Gurven et al., 2014; Saucier et al., 2014; Thalmayer et al., 2020) and emic (Saucier, Thalmayer, & Bel-Bahar, 2014; Thalmayer et al., 2020; White, 1980; Wood et al., 2020) studies of non-WEIRD societies and languages, underscore the likely status of some specific personality concepts as human cognitive and lexical universals (*sensu* Brown, 1991).

Findings also supported multiple predictions regarding the calibration and fitness-linked correlates of individual differences in Sociability and Immodesty. Consistent with hypotheses about how variation in physical strength modulates the cost-benefit tradeoffs along phenotypic dimensions related to status motivation (Lukaszewski & Roney, 2011; Rodriguez & Lukaszewski, 2020; Sell et al., 2009; von Rueden et al., 2015), men's (but not women's) age-corrected grip strength associated positively with Sociability and Immodesty. The network analyses tentatively suggested that grip strength exhibited a stronger unique association with Sociability than Immodesty, which parallels the stronger associations observed of strength with HEXACO Extraversion than Honesty-Humility in WEIRD samples of young adults (Rodriguez & Lukaszewski, 2020). The finding that grip strength's association with personality variation was restricted to men contributes to a larger pattern of cross-cultural variation in the sex-specificity of these links. Specifically, strength has been found to associate with Extraversion- and entitlement-related personality variables among both men and women in some studies of small-scale (Hess et al., 2010; von Rueden et al., 2015) and WEIRD (Rodriguez & Lukaszewski, 2020) societies. Other studies of WEIRD populations, however, have reported results that align with the current study, such that strength only associated with personality variation among men (e.g., Lukaszewski & Roney, 2011; Sell et al., 2009). Future research could fruitfully investigate whether cross-cultural variation in the sex-specificity of the strength-Sociability link tracks cross-cultural variation in the sex-specific relevance of physical strength for determining the costs and benefits of pursuing a gregarious social strategy. In any case, the current findings support the conclusion that, within the Conambo ecology, men's physical strength may be functionally coordinated with individual differences in Sociability and Immodesty.

Our findings also support the hypotheses that high status is among the fitness-linked benefits of high Sociability and Immodesty, respectively, among both sexes (Anderson et al., 2001; Anderson, Hildreth, & Howland, 2015; Cheng et al., 2010; de Vries et al., 2016; Lukaszewski & von Rueden, 2015; Nettle, 2005; Penke et al., 2007; von Rueden et al., 2015). We observed strong positive pairwise correlations of Sociability

and Immodesty with status rankings at the target level, and these associations were also robust, although weaker in magnitude, at the within-ranker level. The network analysis further indicated that Sociability and Immodesty exhibited unique associations with status, even though the two personality variables were highly correlated. Studies of WEIRD samples have likewise found that attained status in face-to-face groups is well predicted by Extraversion-related trait constructs (e.g., Anderson et al., 2001; Cheng et al., 2010; Ensari, Riggio, Christian, & Carslaw, 2011). Indeed, we are unaware of any study that has failed to find a positive association of Sociability (or the broader Extraversion factor) with status in face-to-face groups in any culture. Moreover, this conclusion is bolstered by studies of status determinants in Tsimane horticultural-foragers of Amazonian Bolivia, where men's number of allies—which would presumably be linked tightly with Sociability rankings—positively predicts attained community-wide status (von Rueden et al., 2008), network centrality (von Rueden et al., 2019), and provisioning of effective leadership (Glowacki & von Rueden, 2015). Similarly, Garfield and Hagen (2020) found that peer-reported number of allies/friends was strongly positively associated with social respect and leader status among Chabu hunter-gatherers of Ethiopia. Bowser and Patton (2010) reported similar findings from prior field seasons in Conambo. At this point in research history, it is tempting to conclude that the association of sociable and gregarious strategies with attained social rank is a candidate human universal—which, if correct, would validate some of the cost-benefit tradeoffs according to which Extraversion-related variation is theoretically adaptively patterned.

In Conambo, men's Status associated positively with their fertility, whether controlling for age or not. This finding fits nicely with meta-analytic phylogenetic evidence that male rank is a consistent predictor of fitness proxies (including age-specific fertility) across primate species and types of traditional human populations (von Rueden & Jaeggi, 2016). Specifically, across human small-scale societies, von Rueden and Jaeggi's analysis estimated that the aggregate effect size for the status-fertility association among men is approximately ~ 0.25 . Given that the posterior distributions for the status-fertility associations among men in Conambo were centered around ~ 0.50 , it may be that Conambo men's fitness is more status-dependent than in many natural fertility populations.

We found good evidence that women's status was associated with fertility at the zero-order level and when controlling for age, but the evidence was weaker when controlling for quadratic age. We note, however, that the age-controlled effect size estimates for status-fertility associations among women still centered around ~ 0.20 – 0.40 , which is very similar to the aggregate effect size across human societies estimated by von Rueden and Jaeggi (2016) for men. Previously, based on data collected in Conambo between in 1993, Bowser and Patton (2010) found that women's age-controlled Status was a strong positive predictor of their fertility in 1993, with an effect size of ~ 0.70 . It is unclear why women's status is less predictive of fertility in recent years (the current data were collected in 2018), but we tentatively conclude that status indeed tends to associate positively with women's fertility in Conambo.

We also found good evidence that men's grip strength was associated with status, at least indirectly. The direct association was strongest and most robust when controlling for quadratic age, but there was more variability in the posterior probabilities when controlling for linear age. In the network analysis, men's grip strength was uniquely associated with Sociability, but not directly with status; this is consistent with strong men attaining higher status via sociable behavioral strategies. von Rueden et al. (2008) observed similar patterns among the Tsimane: men's physical strength predicted their number of allies and community-wide status (~ 0.50), but strength did not uniquely predict status when controlling for number of allies.

Similarly, we found tentative evidence that men's grip strength, Sociability, and Immodesty associated positively with fertility. Although the posterior distributions for these associations were consistent with a range of null and negative effects, we note that medians of the posterior probability distributions are consistent with the existence of small positive associations in the ~ 20 – 0.30 range. In the network analysis, only men's status exhibited a unique positive association with Fertility, which—taken together with the associations among grip strength, Sociability, and status discussed above—is consistent with the possibility of a chain of indirect associations linking strength to fertility via personality and status. Future research aggregating across data from different field seasons in Conambo may be able to address these propositions in analyses with greater statistical precision.

7.1. Prospects of photo ranking for valid personality assessment in face-to-face groups

Our study employed the photo ranking task developed and validated by Patton and colleagues for use in Conambo (Bowser, 2000; Bowser & Patton, 2004, 2008, 2010; Conroy-Beam et al., 2023; Escasa et al., 2010; Henrich et al., 2005; Patton, 1996, 2000, 2004, 2005) to assess individual differences in personality traits and relative status. The associations we observed of Sociability and Immodesty with status, as well as with variables measured via other methods (e.g., grip strength), were quite large by comparison to those previously observed in WEIRD samples using typical self-report survey methods to assess personality traits. There are at least two reasons why the photo ranking task may lead to more valid and stronger estimations of focal associations than typical methods in WEIRD samples. First, most residents of a village such as Conambo have had many years of experience interacting with and being around each other, so each ranker's judgements of a target contain much information about their past behavior. Second, because each target is ranked by many others in the village, each target's aggregated score on a given attribute contains information from multiple peer perspectives across contexts and averages out biases of individual rankers. Third, the relative assessments made by rankers in the task map on well to the discriminations the personality assessment system is designed to produce—determining whether persons A, B, C, etc. are more or less likely to behave in a given way relative to each other. This is unlike the assessments made in typical psychometric instruments that require participants to assign abstract trait magnitudes to themselves or others (e.g., with Likert-type scales).

The results from this study support the claim that the photo ranking task produces more valid assessments than the self-ratings that are typically used in individual differences research. In our supplementary analyses that repeated all analyses using only self-rankings (see section 6.2), all associations of personality and status with other variables were much less precisely estimated, and smaller in magnitude, than when using the aggregated rankings. Moreover, other research using some version of the task has, like the current study, yielded associations (e.g., of behavioral attributes with status) that are larger than those typically obtained with other methods of assessment. This is the case for both lab-based studies in which people have only interacted with each other in a group for ~ 15 min (e.g., Anderson et al., 2006; Anderson et al., 2008) and field studies of communities where most people have known each

other, or known of each other, throughout their lives, as well as their parents, siblings, and children, extending back for generations (see, e.g., Bowser & Patton, 2004, 2010; Garfield & Hagen, 2020; Garfield et al., 2020; Patton, 2000; von Rueden et al., 2008).

It could be suspected that the large associations we observed among Sociability, Immodesty, and status are partly an artifact of the ranking method. What if people simply tend to rank others the same way, regardless of which attribute is being ranked? Our data speak against this in two ways. First, we found high inter-ranker reliability for Sociability, Immodesty, and status—but not Un-emotionality. It is unclear why this is so, but we should have found similarly high reliability for all variables if peoples' rankings do not depend on the content of the prompt. Second, although the within-ranker correlations among Sociability, Immodesty, and status directionally mirrored those at the target level, they were much weaker in magnitude—for example, a given participant who ranked a target person as being high in Sociability did not necessarily also rank the same target as being high in status. The much larger effect sizes at the between-target than within-ranker level are consistent with the idea that aggregation from multiple informants leads to more valid estimation of traits: A person whose past behavior is regarded as highly sociable by fifteen other people in the village will score higher on Sociability than a person regarded as highly sociable only by the four people with whom they regularly interact.

In sum, we believe that adoption of the photo ranking task in future research has much potential to increase the validity with which personality concepts and other social variables are assessed in face-to-face groups. It can be employed in any participant sample wherein people can recognize each other by photograph and have some experience interacting with each other—whether briefly in a laboratory task or more extensively in organizational settings or face-to-face communities.

7.2. Concluding remarks

Our study of personality concepts among the Achuar, Quichua, and Sápara people in the Amazonian village of Conambo, Ecuador supports several main conclusions. We conclude first that two lexical personality concepts imported from the HEXACO (and Big Five) factor models, Sociability and Immodesty, exist with common meaning in the minds and Indigenous languages of Conambo villagers. We also conclude that associations among the focal individual difference constructs appear adaptively patterned in relation to cost-benefit tradeoffs. In particular, the patterns suggest that, in Conambo, (i) men's physical strength associates positively with their Sociability and Immodesty; (ii) Sociability and Immodesty are associated with higher status among both sexes; and (iii) men's fertility associates positively with their status, which in turn associates with strength-related personality variation. Taken together, these findings are supportive of hypotheses regarding the calibration (e.g., Lukaszewski & Roney, 2011) and fitness-linked costs and benefits (e.g., de Vries et al., 2016; Gurven et al., 2014; Nettle, 2006; Penke & Jokela, 2016) of personality variation, as well as the existence of an evolved personality assessment system equipped with concepts that enable detection of, and communication about, phenotypic variation that is functionally relevant in the local ecology (Buss, 2011; Fiddick et al., 2016; Lukaszewski et al., 2020).

Finally, we note that the current study's methods, including the photo ranking task to assess personality concepts and status with high validity, can be readily implemented at field sites within communities around the globe. Such studies could further establish the human-universality of specific personality concepts and examine the extent to which their content is pre-programmed by natural selection or built from evolved conceptual primitives across ontogenies. Future research could also provide further tests of hypotheses regarding the adaptive patterning of personality variation in relation to fitness-linked outcomes and proposed calibrators of behavior-regulating systems. A multi-site research program that accomplished these goals could help fulfill the promise of evolutionary personality science to explain the origins of

individual differences and the cognitive foundations of personality perception and description.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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