



RESEARCH ARTICLE

Field evidence for two paths to cross-cultural competence: implications for cultural dynamics

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Abstract

Interaction between members of culturally distinct (ethnic) groups is an important driver of the evolutionary dynamics of human culture, yet relevant mechanisms remain underexplored. For example, cultural loss resulting from integration with culturally distinct immigrants or colonial majority populations remains a topic whose political salience exceeds our understanding of mechanisms that may drive or impede it. For such dynamics, one mediating factor is the ability to interact successfully across cultural boundaries (cross-cultural competence). However, measurement difficulties often hinder its investigation. Here, simple field methods in a uniquely suited Amazonian population and Bayesian item–response theory models are used to derive the first experience-level measure of cross-cultural competence, as well as evidence for two developmental paths: cross-cultural competence may emerge as a side effect of adopting out-group cultural norms, or it may be acquired while maintaining in-group norms. Ethnographic evidence suggests that the path taken is a likely consequence of power differences in inter- vs intra-group interaction. The former path, paralleling language extinction, may lead to cultural loss; the latter to cultural sustainability. Recognition of such path-dependent effects is vital to theory of cultural dynamics in humans and perhaps other species, and to effective policy promoting cultural diversity and constructive inter-ethnic interaction.

Keywords: Cultural evolution; cross-cultural competence; norms; ethnicity; Amazonia; item response theory

Media summary: Fieldwork suggests two paths to develop cross-cultural competence; one may promote cultural sustainability, the other loss.

The last 40,000 years of human evolutionary history are characterized by a diversity of behavior without precedent in nature (Foley and Lahr 2011). This behavioral diversity, often structured in symbolically marked groups (e.g. ethnic groups; Barth 1998), is a consequence of our evolved dependence on both individual and social learning for the acquisition of many skills and beliefs that have been, on balance, adaptive in the varying socioecological conditions encountered and created as our ancestors spread across the planet (Henrich and McElreath 2003; Richerson and Boyd 2005). Much of the richness of human history derives from interaction between members of such culturally distinct ethnic groups, be it mutually beneficial exchange, inter-marriage or exploitation and violence (Wolf 1982; Sahlins 1994). However, at present, we have only a rudimentary understanding of mechanisms underlying the cultural dynamics that often accompany such inter-ethnic interaction, entailing adoption of both adaptive and non-adaptive group-typical (i.e. cultural) behaviors and beliefs across group boundaries (Bunce and McElreath 2017). We thus require a more comprehensive theory of cultural dynamics at ethnic boundaries in order to better understand patterns in the linked genetic and cultural evolutionary history of our species (e.g. the spread of dairying culture and lactase persistence; Ségurel and

Bon 2017). Importantly, such theory may also shed light on the foundations of some contemporary societal problems.

For instance, fears of cultural loss or dilution as a consequence of inter-ethnic interaction form an important component of both domestic and international politics, and appear to be especially salient in recent discourse. They have motivated international protections for minority indigenous cultures undergoing social integration (United Nations General Assembly 2007), as well as nationalistic rhetoric decrying the influence of immigrants on host nation culture (Akkerman and Hagelund 2007; Betz and Meret 2009; Rydgren 2007; Golder 2016). The effect of such inter-ethnic interaction on cultural maintenance or change is likely to depend crucially on individuals who can interact successfully on both sides of an ethnic boundary. For instance, studies of language contact show that bilingual individuals can play a critical role in both the rate and direction of language change (Kandler *et al.* 2010; Fernando *et al.* 2010; Lambert 1981). However, current concern over cultural sustainability usually also involves perceived threats to valued non-linguistic culture-specific norms of coordination, such as beliefs about what constitutes appropriate behavior in a given context (Bunce and McElreath 2017). Politically salient examples of such perceived threats include conflicting norms of gender relations (Akkerman and Hagelund 2007), democratic participation (Betz and Meret 2009) and pedagogy (Trapnell 2003; United Nations General Assembly 2007). Interaction between members of groups with incompatible norms can result in costly failures (Sahlins 1994), as well as the eventual loss of one group's distinctive norms (Bunce and McElreath 2017, 2018). This perceived loss, when associated with group identity, can lead to both political backlash and harm to individual psychological health (Berry 1997).

As a generalization of the concept of bilingualism to include such non-linguistic cultural norms, I here use the term cross-cultural competence – the ability to interact successfully using both in-group and out-group norms. Knowledge of norms and values important to the out-group is a characteristic of peaceful multiethnic societies (Wise and Velayutham 2014), and is a potentially vital component of inter-group coordination to avoid violent conflict (Ginges *et al.* 2007). Cross-culturally competent individuals are expected to have the ability to consciously recognize and compare such out-group norms with the norms of their own group, i.e. they manifest a cultural metacognition that may entail cultural perspective-taking (Mor *et al.* 2013). Like bilingualism, general cross-cultural competence probably plays an important role in cultural maintenance and change. However, despite considerable attention in psychology (Hong *et al.* 2000; Berry 1997), medicine (Anand and Lahiri 2009), business (Johnson *et al.* 2006) and inter-cultural education (Trapnell 2003), and its importance in the historical record (Lamana 2008) and contemporary lived experience (Wise and Velayutham 2014; Kopenawa and Albert 2013), cross-cultural competence is conspicuously absent in all but a few (Kuran and Sandholm 2008; Carvalho 2017) studies of cultural dynamics (Bunce and McElreath 2018; Boyd and Richerson 2009; Creanza *et al.* 2017; Erten *et al.* 2018; Mesoudi 2018), primarily because it both complicates theoretical models and is notoriously difficult to operationalize and measure (Spitzberg and Changnon 2009; Fantini 2009).

Measuring cross-cultural competence

One of the difficulties of measuring cross-cultural competence is that, unlike bilingualism, it must account for uncertainty in individual norms. For instance, although all members of an ethnic group may be able to communicate using the same language (despite within-group speech variants: Labov *et al.* 2016), rarely do they all hold exactly the same norms in other domains (Bunce and McElreath 2017). Thus, when deciding how to behave with unfamiliar in-group and out-group members, a cross-culturally competent individual must employ heuristics about the probability distributions (commonness) of particular norms in the respective groups. Figure 1 shows how such heuristics, manifesting as guesses about the norms held by in-group and out-group members, can be used to derive an experience-level measure of cross-cultural competence. Different experiences

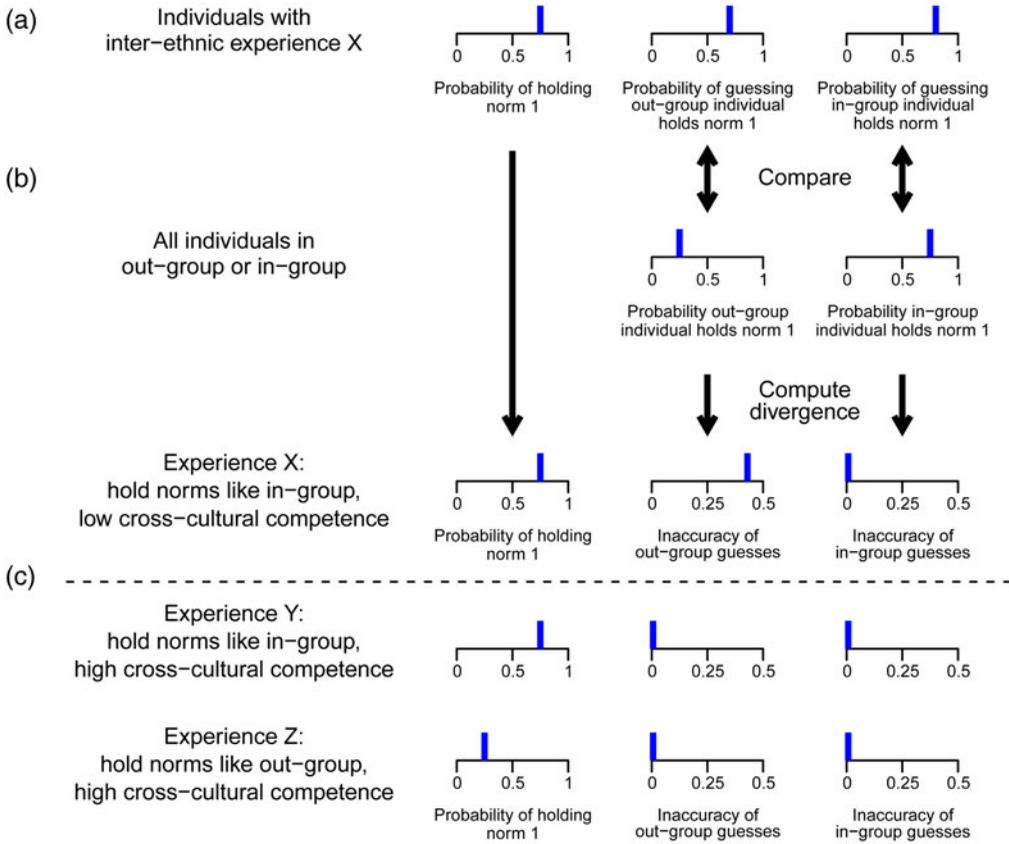


Figure 1. Derivation of experience-level cross-cultural competence. (a) Determine the probability that individuals with a given type of inter-ethnic experience hold a given norm, as well as their guesses about the norm held by an anonymous, randomly chosen out-group and in-group member. (b) Compare guess probabilities with the actual probabilities that out-group and in-group individuals hold the norm, and compute Kullback–Leibler divergence (Kullback and Leibler 1951) between these probability distributions as a measure of guess inaccuracy (in natural units of information entropy – see Materials and Methods). (c) Relative cross-cultural competence for an experience type is defined as less inaccurate out-group guesses and no more inaccurate in-group guesses than individuals with other types of experience. Two paths to cross-cultural competence (Y and Z) are distinguished by the norms that individuals hold.

with out-group norms may be associated with different degrees of relative cross-cultural competence, which is indicated by lower inaccuracy of out-group guesses and no greater inaccuracy of in-group guesses. Here, guess accuracy is used as a proxy (i.e. a necessary but not sufficient condition) for the ability to interact successfully using those norms.

Figure 1 also shows that this measure distinguishes between two forms of cross-cultural competence, which differ in whether an individual personally holds norms typical of the in-group (Experience Y) or typical of the out-group (Experience Z). As discussed below, these two forms appear to have profoundly different implications for the sustainability of valued cultural traits within a multi-ethnic society. A norm that is personally held is here defined as that which an individual would prefer to employ when interacting with a(nother) cross-culturally competent individual capable of employing either norm. This preference could be associated with an internalized injunctive norm or with a pragmatic descriptive norm (Morris *et al.* 2015; Bicchieri 2006) contingent on the contextual cues present during an individual’s most frequent or most important coordination interactions in that domain.

Measuring cross-cultural competence in this way requires several additional assumptions. First, we must assume that an individual’s personally held norms can be investigated through her/his responses

to ethnographically informed interview questions. Care must be taken in interpretation of such data, as the norms people express in response to interview questions may, as a result of perceived social pressure, not necessarily correspond to their actual behavior (Cronk 1991). Furthermore, people's perceptions of which norms are widely distributed within their own society, and, therefore, the norms it behooves them to follow in public, may bear little resemblance to the actual distributions of the norms that people in the society personally hold. In the extreme case, known as pluralistic ignorance (Katz and Allport 1931; Miller and McFarland 1987; Prentice and Miller 1993), the norm believed to be widely held, and followed, by most members of a society conflicts with the norm that those same individuals hold. Cultural competence in such a context would require knowledge of the norms that people in a society believe to be widespread (intersubjective cultural knowledge: Chiu *et al.* 2010), rather than knowledge of the commonness of people's personally held norms. The measure of relative cross-cultural competence described here is applicable only under the assumption that knowing a person's personally held norm provides information about how they are likely to behave. When most people's guesses of in-group norms are highly inaccurate, pluralistic ignorance is possible and this assumption may not hold. In such cases, the measure described here should be used with caution.

The goal of the present exploratory study is to demonstrate the applicability of the above measure by using it to characterize patterns of cross-cultural competence in an indigenous Matsigenka community and neighboring communities of Mestizo colonists in Amazonian Peru. Results of the quantitative analysis are checked against ethnographic observations in these communities, and discussed in light of long-term consequences for the maintenance or loss of group-typical cultural norms. This empirical examination of cross-cultural competence sheds light on the understudied, and important, role it may play in human cultural dynamics, and perhaps those of other cultural species.

Methods

Overview

An interview comprising fourteen ethnographically informed vignette questions (Table 1) measured personally held cultural norms across a range of interaction domains among adult residents of a Matsigenka community and neighboring Mestizo communities. A subset of these interviewees was then asked to guess the most common personally held norm (i.e. the response of a randomly chosen member) in their own ethnic group (in-group) and in the other ethnic group (out-group) for each vignette question, similar to previous methods for measuring inter-group perceptions (Medin *et al.* 2007; Gurven *et al.* 2008). Based on ethnographic observations collected over a year (Matsigenka) and five months (Mestizos) of participation in community life, domains of salient inter-ethnic interaction (e.g. education, labor) were identified and interviewees' self-reported experience in each domain was recorded. To distinguish among the associations between these inter-ethnic experiences and cross-cultural competence, data were analyzed using Bayesian estimation of item-response theory (IRT) models (Bunce and McElreath 2017), which resulted in posterior distributions (i.e. model estimates with associated uncertainties) of the probabilities of holding particular norms and guessing the most common norms held by in-group and out-group members, for each experience type. Using the procedure illustrated in Figure 1, the degree and form of cross-cultural competence associated with each inter-ethnic experience type were then compared.

Study population

The study was conducted among residents of the Matsigenka Native Community of Tayakome (adult population 79), located inside Manu National Park, in the department of Madre de Dios, in the lowland Amazonian region of southeastern Peru, and in the Mestizo towns of Boca Manu (adult population ~80) and Atalaya (adult population ~65), located just outside the boundary of the park, in the departments of Madre de Dios and Cusco, respectively (see Figure S1). Detailed

Table 1. Vignette questions administered in this study, and their respective social contexts. Column four contains the response arbitrarily coded as 1 (positive). An alternative response was coded as 0. The number of Matsigenka and Mestizo interviewees answering each question is indicated in column 5. The upper row corresponds to the number of Matsigenka responses with regard to personally held norms (ego, E), in-group guesses (I) and out-group guesses (O). The lower row contains analogous sample sizes for Mestizos. Further explanation, ethnographic validation, and translations of these questions are provided in Supplementary Appendix A.2

Number	Social context	Question	Positive	N (Mat, Mes)
1	Spousal relations	There is a married couple with no children. The woman hunts and fishes (Mestizo: has a job and makes more money). The man stays home and cooks, weaves (Mestizo: cleans), and washes clothes. Is this okay or not okay?	Okay	E, I, O 70, 57, 57, 80, 46, 46
2	Parent-offspring relations	After school, a 10-year-old daughter cannot go to a friend's house to play because she has to care for her two-year-old brother until their parents come home at night. Is this okay or not okay?	Okay	77, 57, 57, 78, 46, 46
3	Inheritance	A man always wears his favorite hat. After he dies, his son takes the hat and wears it. When he wears it he remembers his father. Is this okay or not okay?	Not okay	74, 57, 57, 79, 46, 46
4	Spousal relations	A woman wants to drink alcohol, but her husband doesn't want to drink. So the wife goes to drink without her husband. Is this okay or not okay?	Okay	73, 57, 57, 80, 46, 46
5	Education	A teacher hits students when they don't learn. Is this okay or not okay?	Okay	75, 57, 57, 74, 46, 46
6	Education	A student pays attention to the teacher and never asks any questions. Is this okay or not okay?	Okay	79, 57, 57, 81, 46, 46
7	Healthcare	If you get a respiratory illness (influenza), do you first go to the health post, first use home remedies, or first go to a shaman or curandero?	Health post	79, 57, 57, 81, 46, 46
8	Healthcare	You have chest pain (Mestizos: You wake up one day with chest pain). Do you first go to the health post, first use home remedies, or first go to a shaman or curandero?	Not health post	78, 57, 57, 79, 46, 46
9	Fairness	An old woman has two new pots and two adult daughters. One daughter has her own two pots, but wants her mother's pots. The other daughter has no pots, and also wants her mother's pots. When the mother dies, who should inherit the pots? Illustrated with a diagram. Options: one pot to each daughter, both pots to the daughter who has none.	Both pots to the daughter who has none	76, 57, 57, 82, 46, 46
10	Religion	A good person does not want to be baptized. Where does his or her soul	Hell or somewhere else	64, 56, 56, 60, 46, 46

(Continued)

Table 1. (Continued.)

Number	Social context	Question	Positive	N (Mat, Mes)
		go when they die? Options: up (heaven), down (hell), somewhere else.		
11	Wage labor	A man is hired to prepare an agricultural field. He stops work at noon in order to go visit a friend. He returns the next day to finish the job. Is this okay or not okay?	Okay	75, 57, 57, 77, 46, 46
12	Commerce	There are two stores. One is cheap with a mean owner. The other is expensive with a nice owner. Where would you buy?	Cheap store with mean owner	63, 57, 57, 77, 46, 46
13	Parent-offspring relations	Parents want their daughter to marry a certain man that she does not like. She wants to marry someone else. Should she obey her parents and marry him anyway or not?	Obey parents	63, 57, 57, 81, 46, 46
14	Wage labor	A man is hired to work two days: Monday and Tuesday. Monday night there is a party (Matsigenka: hosted by a Matsigenka). Should he go and get drunk or not? (Matsigenka: He goes and gets so drunk that he can't work on Tuesday. Is this okay or not okay?)	Okay to go and become drunk	67, 57, 57, 80, 46, 46

descriptions of these communities can be found in Bunce and McElreath (2017), Shepard et. al (2010), and Llosa Isenrich and Nieto Degregori (2003). As detailed in Supplementary Appendix A.2, there are salient norm differences between Matsigenka and Mestizos across many domains of life. This population is ideally suited to investigation of cross-cultural competence because, at the time of fieldwork, there was an almost complete absence of mass media exposure to the other ethnic group's cultural norms. This constrained the development of cross-cultural competence to: (a) contexts of personal inter-ethnic experience; and (b) intra-ethnic social learning from those with out-group experience. Such conditions contribute to substantial measurable variation in out-group norm exposure among individuals, which would probably be much less pronounced if norms were learned through mass media.

Personal norm interviews

I lived in Boca Manu for approximately three months (September and November 2012, January 2014), Atalaya for two months (December 2012 and February 2014) and Tayakome for 13 months (January–December 2013, March 2014). Over several rounds of semi-structured interviews, I recorded interviewees' life histories and recollections of personal inter-ethnic interaction experience. For Matsigenka, domains of such inter-ethnic experience included education, working as wage laborers and commerce, all with Mestizos. For Mestizos, domains included indigenous family members (e.g. adopted children), hiring Matsigenka wage laborers, and living (previously) in a majority-indigenous community. I then designed a set of vignette questions (Table 1) for the purpose of learning about specific norms in nine contexts of social coordination (commerce, wage labor, education, spousal relations, parent-offspring relations, inheritance, fairness, healthcare and religion) and administered these questions privately to 74 (94%) residents of Tayakome (including the Mestizo health technician), 45 (~56%) residents of

Boca Manu (including four Matsigenka), and 42 (~65%) residents of Atalaya (including two Matsigenka), all of whom had been previously interviewed regarding life history and inter-ethnic interaction experience. I refer to this round of interviews as Personal Norm interviews, and people's responses during this interview are referred to as their personally held, or 'ego', norms. No interviewee self-identified as bi-cultural, i.e. belonging to both Matsigenka and Mestizo ethnic groups (see also Supplementary Appendix A.3.3). Here and in subsequent rounds of interviews, interviewees were selected out of convenience: I interviewed whoever was available and willing during the days I was present in the communities.

Guesses about ingroup and outgroup norms

I wrote, on index cards, the Personal Norm responses to each of the 14 vignette questions provided by a sample of 25 interviewees whose responses were representative of the Matsigenka of Tayakome and 24 interviewees whose responses were representative of the Mestizos of Boca Manu and Atalaya, one card for each interviewee. Figure S3 illustrates the representativeness of the cards for the respective communities.

I then re-interviewed 53 residents of Tayakome (all Matsigenka), 26 residents of Boca Manu (including two Matsigenka) and 24 residents of Atalaya (including two Matsigenka), all of whom had participated in Personal Norm Interviews approximately five months prior (Tayakome), 16 months prior (Boca Manu) or one week prior (Atalaya). Owing to people's work schedules and temporary absences from the communities, I was able to re-interview only a subset of all participants who had previously completed Personal Norm Interviews. I briefly reminded interviewees about the previous Personal Norm Interviews in which I had asked them the 14 vignette questions. I then repeated each question one by one. After each, I asked the interviewee to guess how the majority of people in their own community had answered each question (in-group guess), and how the majority of people in the other ethnically distinct community had answered each question (out-group guess). The out-group for both Mestizo communities of Boca Manu and Atalaya was the Matsigenka community of Tayakome. The out-group for Tayakome residents was a generic Mestizo from either Boca Manu or Atalaya. For the four Matsigenka interviewees who resided in Boca Manu and Atalaya, the in-group was Tayakome and the out-group was the Mestizo community in which they lived. Thus, in-group and out-group designations used here reflect the emphasis of this study on self-identified ethnicity and do not necessarily reflect feelings of community-belonging on the part of interviewees.

To motivate serious guesses, after an interviewee had made both an in-group and an out-group guess for a given question, I presented her with the two stacks of index cards upon which Personal Norm responses representative of the Matsigenka and Mestizo communities had been written, and explained how the cards had been generated. The cards were shuffled and presented face-down, and the interviewee was asked to select one card from the Matsigenka stack, and one from the Mestizo stack. After each card was chosen, I compared the answer written on the card for the appropriate question with the interviewee's in-group guess (or out-group guess, as appropriate) for that question. I verbally narrated this comparison and, if the guess corresponded to the answer on the card, I congratulated the interviewee on winning 0.5 Peruvian Nuevos Soles (~US\$0.15) for that question. If the guess did not correspond to the answer on the card, I explained that she did not win money for that question. Further description of data collection methodology, as well as translations of vignette questions, are provided in Supplementary Appendix A.2. General characteristics of the participants are provided in [Table 2](#).

Statistical analysis

I fit a series of IRT models (Bafumi *et al.* 2005; Jackman 2001; Schacht and Grote 2015; Bunce and McElreath 2017; van der Linden 2016), in a Bayesian framework (McElreath 2016), to interviewees' Personal Norm (ego) responses, in-group guesses and out-group guesses using the software R (R

Table 2. Characteristics of the participants in this study. Columns 3 and 4 contain numbers of participants in Personal Norm interviews and Guess (both in-group and out-group) interviews, respectively. For the first four categories, proportions of interviewees per interview type (Personal Norm or Guess) are given in parentheses. For the last two categories, proportions of Matsigenka or Mestizo interviewees (respectively) per interview type are given in parentheses. Note that each individual can have multiple types of experience, so proportions in these last two categories do not sum to 1. Definitions of characteristics, as well as additional details, are provided in Supplementary Appendix A.3.3

Category	Characteristic	Personal Norm interview	Guess interview
Ethnicity	Matsigenka	79 (0.49)	57 (0.55)
	Mestizo	82 (0.51)	46 (0.45)
Residence	Tayakome	74 (0.46)	53 (0.52)
	Boca Manu	45 (0.28)	26 (0.25)
	Atalaya	42 (0.26)	24 (0.23)
Sex	Female	81 (0.5)	55 (0.53)
	Male	80 (0.5)	48 (0.47)
Age	Adolescent	9 (0.06)	5 (0.05)
	Adult	119 (0.74)	76 (0.74)
	Elder	33 (0.2)	22 (0.21)
Experience of Matsigenka	Education	17 (0.22)	10 (0.18)
	Labor	37 (0.47)	26 (0.46)
	Commerce	65 (0.82)	47 (0.82)
Experience of Mestizos	Community	31 (0.39)	19 (0.41)
	Employer	56 (0.68)	34 (0.74)
	Family	36 (0.44)	21 (0.46)

Core Team 2017) and RStan (Stan Development Team 2018). IRT models are a standard extension of logistic regression, using covariances to construct a representation of individuals' responses to multiple questions simultaneously (i.e. as positions on a latent axis or axes), as well as characteristics of particular questions, such as their usefulness for discriminating among (i.e. separating) respondents on the latent axis. Responses to the 14 vignette questions for each of the targets (ego, in-group and out-group) co-varied in a single dimension, represented by a latent axis for each target. Models estimated individual-level variance in interviewees' positions on the three latent target axes (random intercepts), covariance in interviewees' positions across target axes, covariance in question positions and discriminations within and across target axes, as well as the effects of binary individual-level predictors for inter-ethnic experience in the contexts of education, wage labor worker, wage labor employer, commerce, family and community (see Supplementary Appendix A.3.3). I draw statistical inference from distributions of posterior predictions for the probability of positive responses to the vignette questions (see Table 1) for each target. To represent the inaccuracy of guesses, I calculate Kullback-Leibler (K-L) divergences (Kullback and Leibler 1951) between probabilities of ego responses and in-group and out-group guesses for average (randomly chosen) Matsigenka and Mestizo individuals with different types of inter-ethnic experience (Figure 1). K-L divergence is a standard measure of the additional uncertainty generated when using one probability distribution (e.g. probabilities of a positive and negative guess) to approximate another probability distribution (e.g. probabilities of a positive and negative ego response), and is calculated in units of information entropy (McElreath 2016). Note that this measure of guess inaccuracy applies only in the aggregate, and is not a measure of the inaccuracy of guesses made by individual participants. For instance, the out-group guesses of individual Matsigenka participants are used together to calculate the probability that a randomly

chosen Matsigenka would guess that a randomly chosen Mestizo would give the positive response to a given question. The inaccuracy of Matsigenka guesses, in the aggregate, is calculated by comparing this probability with the actual probability that a randomly chosen Mestizo participant would give the positive response. Because each participant provided only one guess per condition (in-group or out-group) per question, it is not possible to calculate such probabilities, and thus inaccuracies, at the individual level. For all analyses, Mestizo residents of Boca Manu and Atalaya are grouped together in the category Mestizos, as the distributions of responses in these two communities are similar (Figure S3). Further details of analysis, including IRT model definitions and priors, K–L divergence calculations and links to data and analysis scripts are provided in Supplementary Appendix A.3.

Research ethics

I obtained informed consent from all study participants under University of California, Davis IRB 226284-2, and I presented and discussed results during assemblies in each study community prior to publication. Permission to conduct research inside Manu National Park was provided by the Peruvian Servicio Nacional de Areas Naturales Protegidas (SERNANP), with permit numbers 23-2012-SERNANP-PNM-JEF and 23-2013-SERNANP-PNM-JEF.

Results

General response characteristics

Figure 2a and the first column of Figure 3 show that Matsigenka and Mestizo participants tended to answer the 14 vignette questions in different ways. For all questions, a larger proportion of Matsigenka than Mestizos gave the response that was arbitrarily coded as positive. This suggests that Matsigenka and Mestizo participants tend to differ in the norms that they personally hold. For example, question 9 dealt with a norm for how to fairly divide an inheritance consisting of two pots among two daughters. One daughter already has her own two pots, while the other has none. Some 68% of Mestizos responded that each daughter should receive one pot, with a typical justification being ‘so that they don’t fight’. In contrast, 75% of Matsigenka responded that both pots should go to the daughter who has none, with a typical justification being that ‘the other one already has pots’. Supplementary Appendix A.2 provides ethnographic descriptions of the norms that I attempted to illustrate with each question, as well as typical participants’ justifications for their responses. Figures 2b and c and S9 show that Matsigenka and Mestizo participants tended to guess more accurately about norms personally held by their co-ethnics than about norms held by members of the respective out-group.

There was little evidence of strong pluralistic ignorance among participants for the norms of interest. Inaccuracies of in-group guesses were generally low (see Figure S9), which increases confidence in the appropriateness of the measure of cross-cultural confidence developed here. The most inaccurate in-group guesses are associated with Mestizos on question 5. A randomly chosen Mestizo participant has a 0.37 probability of expressing a personal norm for the corporal punishment of under-performing students, but only a 0.04 probability of guessing that this norm is held by a randomly chosen co-ethnic (compare question 5 on the Mestizo axes in Figure 2a and b). A potential cause of this discrepancy is discussed in Supplementary Appendix B.1.6.

Cross-cultural competence

In general, Matsigenka tend to make less accurate out-group guesses and more accurate in-group guesses than Mestizos (compare columns 2 and 3 of Figure 3, and see also Supplementary Figures S2, S9, S10 and S13). Thus, by the above definition of cross-cultural competence, it is not possible to make a general claim that one ethnic group is more cross-culturally competent than the other. Figure S9 shows that these results are driven by particularly inaccurate Matsigenka out-group guesses

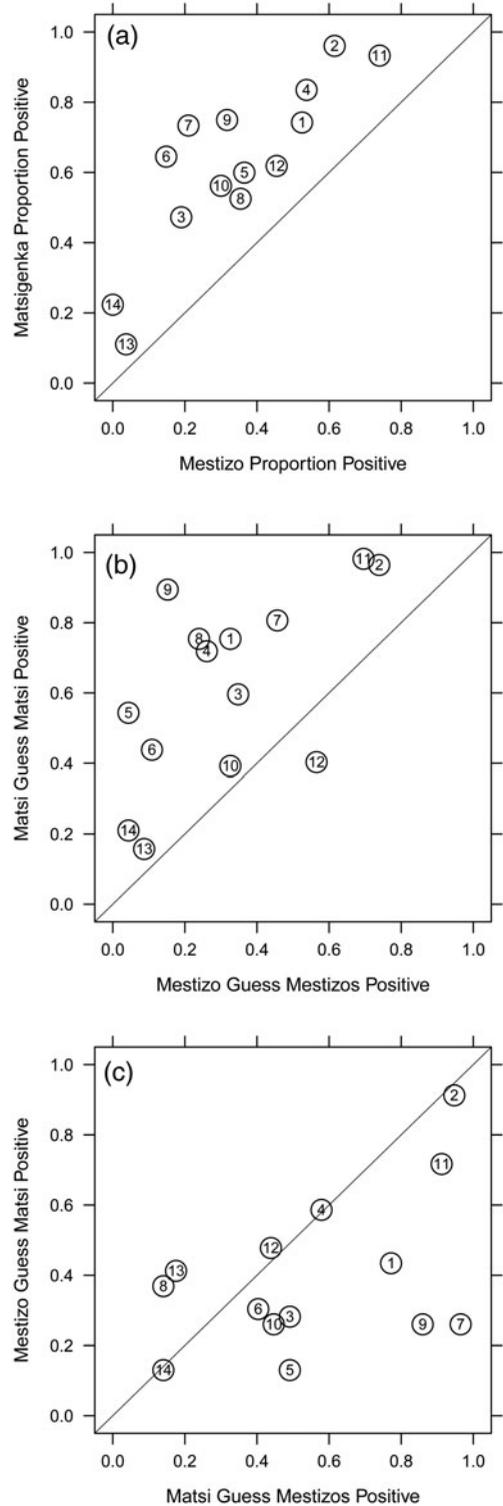


Figure 2. Raw proportions of personally held norms, and in-group and out-group guesses. Proportions of interviewees giving the positive response to the 14 vignette questions in Table 1 are plotted. The diagonal is the line of equal proportions between Matsigenka and Mestizos. The vertical (or horizontal) distance from a point to the diagonal is the difference in proportion between ethnic groups. (a) Personal (ego) Norms for Matsigenka ($n=79$) and Mestizos ($n=82$). Note that, for all questions, a larger proportion of Matsigenka than Mestizos gave positive responses, i.e. all points fall above the diagonal. (b) In-group guesses for Matsigenka ($n=57$) and Mestizos ($n=46$). Proportions of interviewees who guessed that most members of their in-group gave the positive response to a given question are plotted. Note that if in-group guesses were perfectly accurate in the aggregate for this sample (see Methods: Statistical Analysis), plots (a) and (b) would be identical. (c) Out-group guesses for Matsigenka ($n=57$) and Mestizos ($n=46$). Proportions of interviewees who guessed that most members of the out-group gave the positive response to a given question are plotted. Note that if out-group guesses were perfectly accurate in the aggregate for this sample, plots (a) and (c) would be identical.

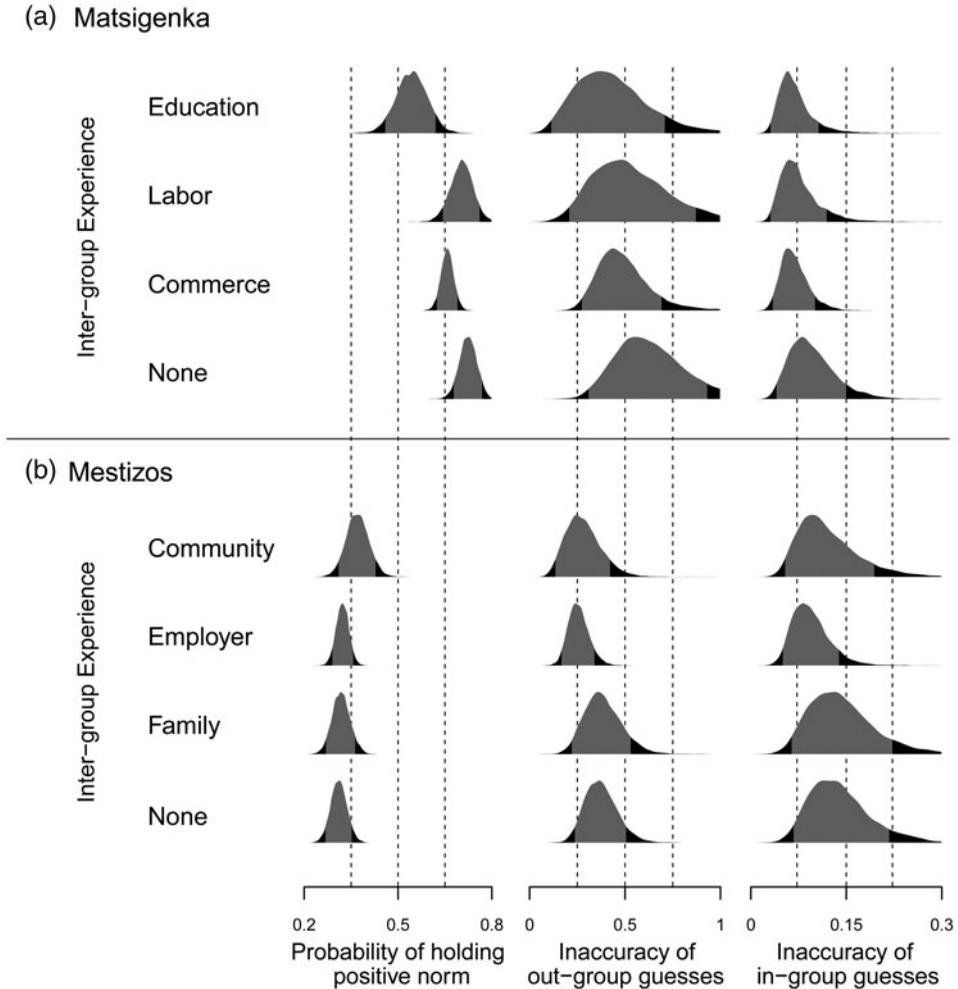
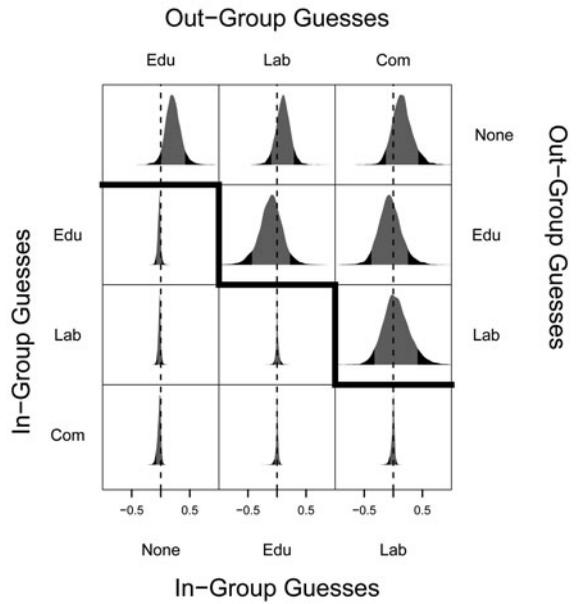


Figure 3. Personally held norms and inaccuracy of in-group and out-group guesses. The four rows of (a) refer to counterfactual (McElreath 2016) (i.e. model estimates of hypothetical) Matsigenka who have interaction experience with Mestizos in only one of the respective domains of education, wage labor or commerce, or none of the three previous domains. Analogously, the four rows of (b) refer to counterfactual Mestizos who have experience in only one of the respective domains of living in an indigenous community, employing indigenous Matsigenka or living in a household with indigenous people, or none of the three previous domains (Supplementary Appendix A.3.3). Left column: posterior distributions (i.e. model estimates with associated uncertainties) of mean probabilities of a positive personally held norm response across all 14 vignette questions (Table 1). Center column: posterior distributions of mean inaccuracy of out-group guesses (calculated as in Figure 1b). Right column: posterior distributions of mean inaccuracy of in-group guesses. Posterior distributions are derived from IRT models (A, m11; and B, m19 in Tables S1 and S2). The 90% highest posterior density intervals (HPDI) are shown in grey.

in the domain of healthcare, and particularly inaccurate Mestizo in-group guesses in the domain of education. This finding is discussed in more detail in Supplementary Appendix B.1.6, and its implications for Fiske's (1993) theory of stereotyping and group-level power differences are explored in Supplementary Appendix B.1.7.

For Matsigenka, Figures 3a and 4a show that education experience with Mestizos, in the absence of and relative to other types of inter-ethnic experience, tends to be associated with: (a) holding cultural norms more similar to those of an average Mestizo; (b) lower inaccuracy when guessing about the norms of Mestizos (particularly compared to no inter-ethnic experience); and (c) comparable

(a) Matsigenka Inaccuracy Contrasts



(b) Mestizo Inaccuracy Contrasts

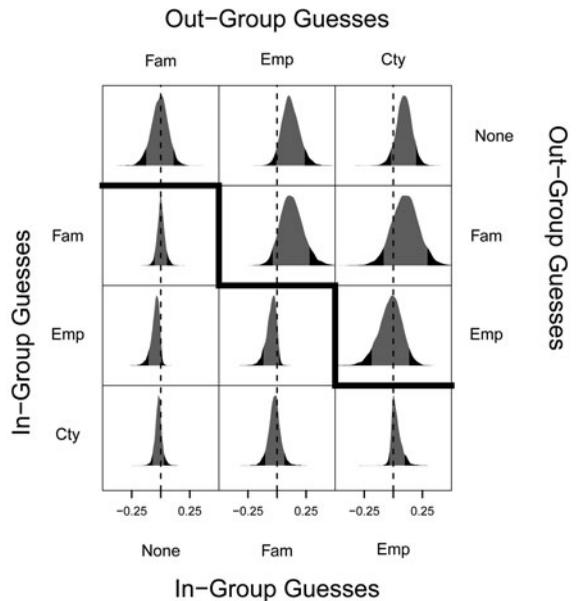


Figure 4. Contrasts (differences) of mean guess inaccuracy. (a) Above diagonal: each cell contains the contrast (row minus column) of the posterior distributions for the mean inaccuracy of out-group guesses by counterfactual Matsigenka with each experience type in Figure 3a. Distributions to the right of 0 indicate that the row experience type tended to make more inaccurate guesses than the column experience type. Distributions to the left of 0 indicate the opposite. Distributions around 0 indicate no detectable differences in guess inaccuracy between experience types. (a) Below diagonal: analogous contrasts for Matsigenka mean in-group guess inaccuracies. (b) Analogous contrasts for Mestizo mean out-group (above diagonal) and in-group (below diagonal) guess inaccuracies. The 90% HPDI are shown in grey.

inaccuracy when guessing about the norms of co-ethnics (see also Figures S11, S12, S14 and S15). Thus, for Matsigenka, education experience tends to be associated with higher levels of cross-cultural competence. Figure S14 shows that this is due to relatively more accurate guesses about Mestizo norms in the domains of education, healthcare and fairness.

For Mestizos, Figures 3b and 4b show that the experience of living in an indigenous community, in the absence of and relative to other types of inter-ethnic experience, is associated with holding norms more similar to those of an average Matsigenka. This experience, as well as that of employing

Matsigenka wage laborers, tends to be associated with: (a) lower inaccuracy when guessing about the norms of Matsigenka, compared with no inter-ethnic experience or indigenous family experience; and (b) comparable inaccuracy when guessing about the norms of co-ethnics (see also Figures S11, S12, S16–S19). Thus, for Mestizos, community experience and employer experience, although each associated with holding different norms, both tend to be associated with higher levels of cross-cultural competence. Figures S16 and S18 show that this is due to relatively more accurate guesses about Matsigenka and Mestizo norms in the domains of education, healthcare, fairness and labor. Additional aspects of these results, including comparisons of variance in responses and implications of ethnic differences in power, are presented and discussed in Supplementary Appendix B.1.

Ethnographic interpretation

Ethnographic evidence suggests that Matsigenka students acquire certain Mestizo-typical norms while attending Mestizo-run boarding schools, partly as a consequence of their low bargaining power in student–teacher coordination occurring exclusively with Mestizos (Bunce and McElreath 2017). Cross-cultural competence probably results from learning that such norms are common among Mestizos, yet not forgetting that alternative norms are common among their fellow Matsigenka. An analogous process is plausible for Mestizos who live temporarily as minorities in indigenous communities (see Supplementary Appendix B.1.8). In contrast, Mestizos who employ Matsigenka wage laborers (e.g. in agriculture, logging, and tourism) usually also employ at least as many Mestizos for the same jobs. The frequent shortage of labor in this region increases laborers’ bargaining power relative to employers (Bunce and McElreath 2017). Thus, cross-cultural competence of employers (e.g. in domains of labor, fairness and healthcare) facilitates good relations with a wider range of potential laborers, yet there is little incentive for employers to personally adopt Matsigenka-typical norms, as interactions in this domain with their fellow Mestizos are at least as important. Such accommodation of perceived Matsigenka-typical norms is illustrated in the words of a Mestizo who routinely contracted both Matsigenka and Mestizo field hands: ‘[Matsigenka] work well, but I let them work in their own way, because their world is different. A type of person like us [Mestizos] already knows how this kind of work is. [We] work until late, [and are] more demanding. But a Machi [*recte* Matsigenka], when you bring him [to the agricultural field], you let him work in his own way. If he wants to leave, then we leave. If he wants to go for a little while because he is tired, I let him ... If I say something to them, like demanding that they do something, they get angry and they leave you, just like that’ (Bunce and McElreath 2017).

Discussion

As shown, cross-cultural competence may develop in individuals who retain personal norms typical of their co-ethnics, such that knowledge of out-group norms is added in a supplementary capacity to the norms that they personally hold (e.g. Mestizo employers of Matsigenka). For convenience, I refer to this as the ‘supplement’ path to cross-cultural competence. Alternatively, cross-cultural competence may be a side effect of the process of adopting out-group norms, such that these new norms replace in-group-typical norms as those that individuals personally hold (e.g. Matsigenka educated among Mestizos). I refer to this as the ‘replacement’ path. The ethnographic evidence above suggests that the path taken may be a function of the frequency of intra- and inter-ethnic coordination interactions and the balance of bargaining power during such interactions. Other factors may also contribute. For instance, the desire both to maintain an ethnic identity closely linked to a suite of cultural norms, while also engaging with members of an ethnically distinct group, may facilitate the supplement path to cross-cultural competence (e.g. integration of immigrants: Berry 1997). In contrast, if ethnic groups exhibit salient differences in subjectively perceived success or prestige, cultural norms of the more prestigious group may be personally adopted by members of the other, regardless of the frequency of direct inter-group interaction (success-biased inter-ethnic social learning; Bunce and McElreath 2017), facilitating the replacement path.

The two paths to cross-cultural competence suggested here parallel two paths to bilingualism proposed by Lambert (1981): additive bilingualism occurs when two languages learned by an individual have comparable social value and respect. The second language is learned in order to supplement, rather than replace, the first. In contrast, subtractive bilingualism results from social pressure on individuals to reject their native language in favor of a more prestigious second language. Subtractive bilingualism constitutes a transition state from a low- to a high-status language, and, as such, would be expected to result in the eventual loss of language diversity in a population (Kandler 2009).

Multiethnic societies are often characterized by a high prevalence or prominence of cross-culturally competent individuals (Wise and Velayutham 2014). However, the long-term sustainability of extant cultural diversity in such societies seems doubtful if one ethnic group becomes cross-culturally competent as a consequence of adopting personally held out-group norms. Similar to subtractive bilingualism, this replacement path to cross-cultural competence may contribute to the loss of cultural diversity, as it can facilitate the invasion of a group by out-group-typical norms (see Supplementary Appendix B.2). Inversely, the scope for sustainability may be wider if the supplement path is followed, such that cross-cultural competence is achieved while retaining personally held in-group norms.

Supplementary Appendix B.2 outlines theoretical support for this latter prediction. The argument depends on cross-culturally competent individuals receiving a benefit to inter-ethnic coordination interactions that outweighs the benefit to such interactions received by non-cross-culturally competent individuals. Under such conditions, the supplement path to cross-cultural competence could facilitate stable states of a population where cultural norms typical of each group are present. Whether these conditions are sufficient, and relevant in the real world, awaits further theoretical and empirical investigation. However, if shown to be widely applicable across populations, this finding suggests that immigration-induced inter-ethnic engagement following the supplement path to cross-cultural competence may, in theory, result in neither the inevitable loss nor dilution of either host-nation or immigrant cultural norms within their respective communities. Consequently, the two paths to cross-cultural competence suggested here have potentially important implications for our understanding of cultural dynamics in humans, and perhaps other species that use horizontal social learning to acquire group-specific coordination behavior (e.g. *Cebus*: Perry *et al.* 2003).

It is important to emphasize the tentative nature of the above proposals regarding paths for the individual-level development of cross-cultural competence, and the population-level implications of these paths for the long-term sustainability or loss of cultural norms. A rigorous empirical study of individual development or cultural dynamics requires a longitudinal research design, preferably replicated in multiple societies. The primary contribution of the present cross-sectional study is methodological: I present a simple field data collection technique that can be used to construct a quantifiable proxy of two forms of cross-cultural competence, and a statistical method to compare people's interaction experiences on the basis of this measure. These tools facilitate future longitudinal cross-cultural work.

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Conflicts of interest. J.A.B. declares no conflict of interest.

Ethical standards. J.A.B. asserts that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

Research transparency and reproducibility. Data and code in R and Stan to reproduce the analysis in the main text and the Supplementary Materials are available on Github at <https://github.com/jabunce/bunce-2018-cross-cultural-competence>.

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APPENDICES

Field evidence for two paths to cross-cultural competence: implications for cultural dynamics

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Appendix A. Supplementary Methods

Appendix B. Supplementary Discussion

Appendix C. Supplementary Figures and Tables

Supplementary References

Appendix A. Supplementary Methods

Appendix A.1. Procedure for in-group and out-group guess interviews

I repeated the following procedure for each of the 14 questions: I read one question. The interviewee made in-group and out-group guesses for that question. The interviewee selected one card at random from the in-group stack and one card from the out-group stack. I compared the interviewee's in-group guess to the Personal Norm response for that question written on the selected in-group card, and the same for the out-group guess relative to the response on the out-group card. I informed the interviewee whether she had won money for her in-group and out-group guesses. I then read the next question and repeated the procedure. Interviewee winnings were tallied at the end of the 14 questions and dispensed in cash. This methodology bears some similarities to that employed by Gurven et al. (2008), Ross et al. (2007), and Medin et al. (2007). Responses recorded during this round of interviews are referred to as in-group and out-group guesses, and are distinguished from the personally-held (ego) norms recorded during the Personal Norm interview, above.

Further description of data collection methodology, as well as translations of vignette questions are provided in Section [Appendix A.2](#).

Appendix A.2. Vignette question development

In Tayakome and Atalaya (Figure S1), I lived with a host family, routinely participating in household and community activities and sharing meals. In Boca Manu, I lived in a rented room, ate at local restaurants, and participated in activities such as boat building and wood extraction at the invitation of residents. In all three communities I conducted several rounds of individual semi-structured and structured interviews with adult residents. All interviews were conducted by me in the interviewee's preferred language (Matsigenka or Spanish) while out of earshot of other community members. I conducted at least one interview with all but two residents of Tayakome, and with approximately two thirds of the residents of Boca Manu and Atalaya. Included in this study are interviews with members of two of the three Matsigenka families living in Boca Manu, two Matsigenka residents of Atalaya, as well as one Mestizo technician working in the health post in Tayakome. The first rounds of interviews entailed soliciting a life-history narrative. From these interviews, I identified education, labor, commerce, domestic relations,

and community relations as domains of common Matsigenka-Mestizo inter-ethnic interaction. In follow-up interviews I recorded each individual's recollection of personal intra- and inter-ethnic experience in these domains. Based on my own experience living in these communities, I then designed a set of vignette questions (Bernard, 2006), fourteen of which are presented below. From the perspective of this study, none of the vignette questions has a correct or incorrect answer, so no value is assigned to affirmative versus negative responses to any question. In cases of individuals who are bi-culturally competent, I assume that these vignette questions measure an individual's favored norms. Thus, during some inter-ethnic interactions, such an individual may actually coordinate using non-favored norms which do not coincide with her answers to the vignette questions (e.g., Mestizos hiring Matsigenka wage laborers).

Table 1 presents the fourteen vignette questions employed in this study, across eight social coordination contexts. I developed questions in Spanish with the help of an English-Spanish bilingual Peruvian collaborator. I translated the questions into Matsigenka, and then had them back-translated from Matsigenka to Spanish with the help of a Matsigenka-Spanish bilingual Matsigenka collaborator in Tayakome (translations below). Due to organizational difficulties during the Personal Norm Interview, questions were presented in the same order to interviewees from Tayakome and Boca Manu, but the order of questions 13 and 14 changed for interviewees in Atalaya. Questions were presented in the same order to all interviewees in all communities during the in-group and out-group guess interview.

The number of questions per social context is not balanced, i.e., there are two questions for some contexts, while other contexts have only one question. Only a subset of the questions asked during Personal Norm Interviews was also asked during the guess interviews. The particular questions chosen for the guess interviews represent a balance between covering all social coordination contexts of interest and choosing questions that had (according to my impressions) been easiest for participants to understand and would likely pose fewer problems of interpretation in the context of the novel guessing interview. Only questions that were asked in both Personal Norm Interviews and Guess Interviews are presented and analyzed here.

During the Personal Norm Interviews, interviewees responded affirmatively or negatively (or, for some questions, selected one of the answer options) after I initially presented each vignette question. For a subset of interviewees, I then asked them why they responded the way they did. Upon

hearing my request for an explanation, occasionally they then changed their answer from negative to affirmative, or vice versa. If the interviewee did not wish to explain why they changed their initial answer, I did not include their response to that particular question in the present analysis. I exclude these responses in case my request to explain their initial answer led them to believe that I was not in agreement with their answer, which they then changed in order to answer in the way they believed I wanted them to. This occurred despite assurances that their answers were confidential and that I believed there were no right or wrong answers to the vignette questions. These cases of response changes may be due to the fact that interviewees were unaccustomed to answering such unusual questions in this unfamiliar format. On other occasions, some interviewees explained that their response (affirmative or negative) to a vignette question was contingent on additional information that I had not provided in the vignette itself. For example, for Question 1 (below), an informant responded that it is okay for a wife to go hunting sometimes while her husband stays home, but it is not okay if she does it often. Such responses resulted from interviewees thinking more deeply about a vignette than I had when I designed it. I excluded these contingent responses from the present analysis, because I had not provided the requested details (e.g., frequency of the behavior in question) to the rest of the interviewees. For all those interviewees who answered the question without requesting additional details, I assume that they interpreted the question in a similar way (e.g., the wife always goes hunting, not just sometimes). As a result of these two classes of interviewer-interviewee misunderstanding, I excluded a total 155 out of 2310 Personal Norm responses (6.7%). To check the effect of excluding these data, I included people's initial responses, and included contingent responses after providing the additional requested information such that these interviewees interpreted the questions in the way I assumed all other interviewees had. Including or excluding these data has no qualitative effect on the conclusions. For analysis of the in-group and out-group guess questions, only one interviewee's guesses for one question were excluded, as this individual guessed that the majority of people in both the in-group and the out-group had rejected the binary answer choice offered to them for this question and had instead given an alternative answer.

Abbreviations of the vignette questions, corresponding to the figures, are in bold after the question numbers, below. The social context of each question (education, wage labor, commerce, spousal relations, parent-offspring relations, inheritance, fairness, healthcare, and religion) is included in paren-

theses. The response coded as positive (1) on the ego axis (see [Appendix A.3.2](#), below) is indicated below the Matsigenka translation. Questions that were coded differently for the in-group and out-group axes are indicated. My rationale for designing each vignette, my expectations for Personal Norm responses, and examples of people's actual responses are provided below.

Question 1, reverse gender (Spousal Relations)

There is a married couple with no children. The woman hunts and fishes (Mestizo: has a job and makes more money). The man stays home and cooks, weaves (Mestizo: cleans), and washes clothes. Is this okay or not okay?

Hay una pareja sin hijos. La mujer trabaja y gana plata. El hombre se queda en la casa, cocina, limpia, y lava ropa. ¿Está bien?

Ainho ogari tsinane, mameri otomi, mameri oshintu. Iroro ogotake omatsigatake ochacopi cameti. Onti kovinsari. Iroro oati onkogira ivatsa inkenishkue. Yogari ojina ainho iripitake ivanko, yonkotia sekatsi, intiri ijamatia, ikiviasarati igamisate. Cameti o tera cameti?

A response of “Okay” was coded as positive. This question is coded in the same way for the in-group and out-group latent axes. Differences between questions asked of Matsigenka and Mestizo interviewees reflect the different tasks stereotypical of each gender in the two ethnic groups. This illustrates a norm for flexibility in gendered labor roles.

This question was inspired by my observation of the salient division of labor by sex in many domains of Matsigenka life in Tayakome, e.g., men hunt, build houses, and clear swidden fields, while women cook, weave, and sweep the home area. However, I also observed many activities in which men and women often participate together, e.g., fishing, making roof thatching, planting and weeding fields. Occasionally I observed some men helping with “women’s work”, e.g., peeling manioc, and some women doing “men’s work”, e.g., going into the forest alone in search of meat. Though people would laugh about such behavior being unusual, there seemed to be little negative stigma associated with it. In Boca Manu and Atalaya, I observed more overlap in men’s and women’s labor. For instance, both made wooden boats, tended stores, served food, drove boats, and worked in banana fields. However, despite this overlap, my impression was that there was considerably more

machismo in the Mestizo towns, i.e., more value was placed on men and the labor that they performed. Among the Matsigenka, my impression was that, despite a stricter division of labor, the activities performed by each sex were valued to a similar degree. I did not have a strong a priori hypothesis about how Matsigenka and Mestizos would answer this question.

A large majority (74%) of Matsigenka answered “Okay”, while only about half (53%) of Mestizos did (Figure 2A). Most Matsigenka thought this question was highly unusual, and an example of a typical initial response is, “Women don’t go to the forest . . . A woman stays in the house and cooks manioc”, which reflects the behavior actually performed by most Matsigenka women. However, when I asked if it would be okay if a woman wanted to engage in male activities, an example of a typical response is, “[Women performing those activities] is okay sometimes [i.e., in some cases]. If she has no sons and no daughters, it’s okay if she goes to hunt. [The man says to her] go hunt spider monkey. I’ll cook manioc, I’ll wash your clothes.” An example of a typical Mestizo response is, “[Reversal of gender roles] is okay because work must be shared. Just because they’re men doesn’t mean that they aren’t going to wash, or if they’re women they won’t do other things. Rather, the work must be shared.” However, an example of another common Mestizo response is, “In my way of thinking, the one who should work is the man. He should support the house, and the woman should take care of the house. Or also the woman could help him with work, but both together should share responsibilities. [In the question, the portrayed activities by gender] should be reversed.”

Question 2, daughter babysits (Parent-Offspring Relations)

After school, a ten-year-old daughter cannot go to friend’s house to play because she has to care for her two-year-old brother until their parents come home at night. Is this okay?

Después de salir de la escuela en la tarde, una hija de diez años no puede ir a jugar con sus amigas porque tiene que volver a la casa y cuidar a su hermano menor de dos años hasta que lleguen sus papás en la noche. ¿Está bien?

Oga oshintō oshiriagakota diez años. Hatanai chavini, okonteiganae escuela. Hanki agavea omagempitira. Ogari oatae ovankokue ogierira iariri itiomiani ishiriagakota dos años, iripigaira iriegi tsitenigeti. Cameti o tera

cameti?

A response of “Okay” was coded as positive. This question is coded in the same way for the in-group and out-group latent axes. This illustrates a norm that older children share responsibility for care of their siblings.

This question was inspired by my observation that Matsigenka children, especially girls, are given considerable responsibility for tending to their younger siblings. Girls as young as six or seven are already adept at carrying and entertaining infants. I did not observe Mestizo children being given so much responsibility. I hypothesized that Matsigenka interviewees would answer “Okay” and Mestizos would not.

Nearly all (96%) Matsigenka answered “Okay”, and a slight majority (62%) of Mestizos did as well (Figure 2A). Most Matsigenka responded with a decisive “Okay”, as if the answer was obvious. In contrast, an example of a common Mestizo response is, “You know that all children have the right to a little bit of freedom to have fun. It’s a child and children tend to play a lot. And it’s too much responsibility for a girl of that age to take care of a child.”

Question 3, not wear dead hat (Inheritance)

A man always wears his favorite hat. After he dies, his son takes the hat and wears it. When he wears it he remembers his father. Is this okay?

Un hombre siempre lleva un gorro favorito. Se muere. El hijo coge el gorro y se lo pone. Cuando se lo pone, piensa en su papá. ¿Está bien?

Yogari sidadi kantani yamea igorate. Imbogini ikamake. Itomi yagakero igorate irashi iriri ikamake. Itomi kantani igoraterora, kantani ikenkirira iriri. Cameti o tera cameti?

A response of “Not okay” was coded as positive. This question is coded in the same way for the in-group and out-group latent axes. This illustrates a norm for the transfer of goods with sentimental value from the deceased to the living.

This question was inspired by my observation, during a Matsigenka funeral, that nearly all of the (few) possessions of the deceased that had been used (e.g., clothes, pots, sleeping mat, arrows) are either destroyed or buried

with the person. Results of my conversations with people coincide with the interpretation of Shepard (2002), that spirits of the deceased return to look for their possessions and companionship, causing sickness in the living. I did not observe such concern about the belongings or dangerous spirits of the deceased while attending a Christian Mestizo wake, though I was not as close to this family and so I did not learn what happened to the belongings of the deceased. I hypothesized that Matsigenka would answer "Not okay" and Mestizos would answer "Okay".

About half (47%) of Matsigenka answered "Not okay", while a large majority (81%) of Mestizos answered "Okay" (Figure 2A). An example of a typical Matsigenka explanation is, "The old man dies, he takes his hat with him, and wears it. The son says, 'That hat, I'll leave it alone. It's yours, a Viracocha [Mestizo] gave it to you. Now I'll leave it alone there. I won't take it.' [The dead father] takes it with him . . . [If you take your dead father's hat] you will remember your father and you will get sick." An example of a typical Mestizo response is, "Some who want to be close to their most beloved [deceased] person take it [i.e., the hat] . . . But to be in that moment with all those memories also brings other bad things, heart problems, anxiety, to be thinking that your mother is watching you, or is here. It brings with it many consequences. But I would do it [i.e., take the hat]. In my opinion, I would do it."

Question 4, wife drinks alone (Spousal Relations)

A woman wants to drink alcohol, but her husband doesn't want to drink. So the wife goes to drink without her husband. Is this okay?

Una mujer quiere tomar, pero su esposo no quiere tomar. Así que ella va sola a tomar. ¿Está bien?

Oga tsinane okogake ovikempara owidoki. Yogari ojina tenka inkogira irovikemprara owidoki. Paniro oatake ovikempara ijina owidoki aiñoni. Cameti o tera cameti?

A response of "Okay" was coded as positive. This question is coded in the same way for the in-group and out-group latent axes. This illustrates a norm for the proper behavior of married women with respect to alcohol.

This question was inspired by my observation that there is, in general, no

stigma against Matsigenka women drinking and getting drunk with fermented manioc beer in Tayakome. This is the only readily available alcohol in the community. It is made in great quantities, and, as interpreted by Shepard (2002) and confirmed by my own observations, is vital to Matsigenka social life, identity, and emotional equilibrium. In my experience, it is not very common for a Matsigenka woman to go to a drinking party without her husband, but it does indeed occur, and seems to lack any negative stigma. In contrast, rarely have I observed Mestizo women drink beer (by far the most common type of alcohol in these Mestizo communities), with or without their husbands, and I have never seen them drunk. In contrast, for most Mestizo men (excepting some evangelical Christians), drinking serves an important social function to establish and maintain friendships, and several Mestizo men in the communities are drunk quite often, in my experience. My impression is that there is a belief among Mestizos that drinking is a male activity and is not appropriate behavior for a woman. I hypothesized that Matsigenka would respond “Okay”, and Mestizos would respond “Not okay”.

The vast majority (84%) of Matsigenka responded “Okay”, while a slight majority (54%) of Mestizos responded “Okay” (Figure 2A). An example of a typical Matsigenka response is, “My wife wants to go drink manioc beer, I say, ‘Go, drink manioc beer. I don’t want to go. Bring some manioc beer back for me, I’ll drink it here.’ That is good.” An example of a common Mestizo response is, “[A wife drinking along] is bad. How am I going to go have fun knowing that my husband doesn’t have time to go with me? Then (and this occurs often around here), that brings gossip. We call the husband [who stays at home] a ‘long coat’, and things like that. Also, one must take care of the couple’s image [i.e., reputation] . . . [the wife can drink] maybe with her husband. As a couple there is more protection.”

Question 5, teacher hits (Education)

A teacher hits students when they don’t learn. Is this okay?

Un profesor golpea a sus alumnos cuando no aprenden. ¿Está bien?

Yogotagantasirira ipasatakeri estudiante tera irogoigia sankevantera. Cameti o tera cameti?

A response of “Okay” was coded as positive. This question is coded in

the same way for the in-group and out-group latent axes. This illustrates a norm for the appropriate behavior of teachers with respect to students.

This question is inspired by my observation that, though rare among the Matsigenka families that I lived with, corporal punishment of children was occasionally deemed both acceptable and necessary. This usually entailed spanking or hitting with the stem of a stinging nettle plant (*Urtica* sp.) which causes intense but transient discomfort. Causes included disobedience, or neglect of a younger sibling under the child's care. I never observed or heard about either of the two Matsigenka primary school teachers in Tayakome hitting students, except for one instance of a particularly disobedient older student, who was hit after school in the presence, and with the approval, of the child's parents. I did not observe corporal punishment of children by their parents in the Mestizo towns, though beating of women by their male partners is a serious problem. I did observe corporal punishment of Mestizo primary school children by their teacher. Students formed a line, and the teacher asked each in turn to answer a math problem learned the previous day. Those answering incorrectly received a slap on the palm with a stick. The slaps were not delivered with much force, and I did not observe any of the struck students to be in obvious discomfort afterward. I did not have a strong a priori hypothesis about how Matsigenka and Mestizos would answer this question.

More than half of the Matsigenka (60%) responded "Okay", while less than half of Mestizos (37%) responded "Okay" (Figure 2A). An example of a common Matsigenka response was, "It is okay to hit him [i.e., the student who doesn't learn]. He'll learn faster." An example of a common Mestizo answer was, "It's not okay [to hit students], because one must teach children . . . Some children are best treated with tenderness, but others are best treated strictly. But this doesn't mean hitting them. Rather, constant communication . . . It's best [if the teacher] talks with the parents, saying, 'Your son isn't doing his homework.' Then, between father and son they settle the score in their house because the son didn't do his homework."

Question 6, no questions (Education)

A student pays attention to the teacher and never asks any questions. Is this okay?

Un estudiante siempre escucha y hace caso al profesor. Nunca hace

ninguna pregunta. ¿Está bien?

Yogari estudiante kantani ikemisantake yogatagantasirira. Tenka inkogakote. Cameti o tera cameti?

A response of “Okay” was coded as positive. This question is coded in the same way for the in-group and out-group latent axes. This illustrates a norm for the appropriate behavior of students in the classroom.

This question is inspired by my experience teaching English to Matsigenka and Mestizo primary school students at the request of their teachers. In Tayakome, my wife (a fellow anthropologist conducting research in Tayakome independent of this study) and I taught every weekend for a year in the schoolhouse. In the Mestizo communities I taught kindergarten, primary school, and secondary school students, during one school-day. Matsigenka students listened attentively, copied assiduously from the chalkboard, and performed the tasks given to them. They did not ask questions, and most attempted to avoid answering them. The general form of this behavior persisted over the entire year, despite the fact that I taught them in their language, knew them and their families quite well, and had a much more relaxed and egalitarian relationship with them outside of school. Their behavior during class coincided with my observation of their behavior during the normal school day with their regular Matsigenka teachers, during learning interactions with other adults outside of school (e.g., learning to weave or make arrows), and also appears very similar to student school-room behavior described by Aikman (2003) for Harakmbut children in another indigenous community in this region of Peru. In contrast, teaching Mestizo students (of all ages) was a constant negotiation. Students were not shy about asking questions, nor answering them. I felt I needed to convince them to do assigned tasks, and talk continuously and authoritatively in order to maintain their attention. Students’ behavior appeared similar when I observed them in class with their normal Mestizo teachers. I hypothesized that Matsigenka would respond “Okay”, and Mestizos would respond “Not Okay”.

A majority (65%) of Matsigenka responded “Okay”, while a majority (85%) of Mestizos responded “Not okay” (Figure 2A). An example of a typical Matsigenka response is, “He [i.e., the student] pays attention, writes, and reads the book. That’s good.” Such behavior was sufficient, and questioning on the part of the student was not necessary. However, when I asked if it was okay if a student also asked questions, this interviewee stated, “[If] he asks

questions, that's good [too]." An example of a typical Mestizo response was, "[Not asking questions] is not good. The student must always be a person who is listening, and he must be asking whether he agrees with what is said or not. For this, the child should be prepared. One must awaken the interest of children . . . [If the student doesn't ask questions then] that is being a conformist. Up to a certain point and no more they close off from what they have learned. But the child must [rather] be open to the world."

Question 7, post flu (Healthcare)

If you get a respiratory illness (influenza), do you first go to the health post, first use home remedies, or first go to a shaman or curandero?

¿Si tiene gripe, Ud. va primero a la posta, primero usa remedios caseros, o primero va al curandero?

Agakempi merentsi. Okityo piatake postakue? Okityo povetsike inchashi pankotsikue? Okityo piatake irishipokempira? Okityo piatake iritasonkempira?

A response of "Health post" was coded as positive. All other responses were coded as negative. This question is coded in the same way for the in-group and out-group latent axes. This illustrates a norm for the appropriate treatment of respiratory illnesses.

This question is inspired by my observation that respiratory infections occur frequently among the Matsigenka of Tayakome (especially during the wet season) and are a common reason that people visit the health post in the community. I had less opportunity to observe Mestizos' behavior when ill. My impression is that respiratory infections tend to be both less common and less serious among Mestizos than among Matsigenka. I had no strong a priori hypothesis about how Matsigenka and Mestizos would answer this question.

A majority (73%) of Matsigenka responded "Health post", while a majority (79%) of Mestizos responded "Home remedies" (Figure 2A). An example of a typical Matsigenka response is, "First I go to the post." An example of a typical Mestizo response is, "[When I get a respiratory illness I stay] just in my house. I grab a pill, or a hot tea, or I dress warmly, or [I use] some cream like Vics Vapor-rub. That's it."

Question 8, not post chest (Healthcare)

You have chest pain (Mestizos: You wake up one day with chest pain). Do you first go to the health post, first use home remedies, or first go to a shaman or curandero?

Algún día Ud. se despierte y le duele el pecho. ¿Ud. va primero a la posta, primero usa remedios caseros, o primero va al curandero?

Pikatsinegetira. Okityo piatake postakue? Okityo piatake irishipokempira? Okityo piatake iritasonkempira? Okityo povetsike inchashi pankot-sikue?

A response of “Health post” was coded as negative. All other responses were coded as positive. This question is coded in the same way for the in-group latent axes. However, for the out-group latent axis, this coding was reversed: “Health post” was coded as positive and all other responses were coded as negative. This illustrates a norm for the appropriate treatment of chest pain.

This question is inspired by my observation that chest pain is believed by many Matsigenka of Tayakome to be a classic symptom of attack by a witch (see also Shepard (2002)). According to my conversations with Mestizo technicians in the community health post, heart disease appears to be extremely rare among the Matsigenka. For many Matsigenka, illness resulting from witch attack can be cured (or reversed, inflicted back on the witch) with the help of: 1) medicinal plants; 2) a curer, irishipokempira, who uses steam to remove objects (e.g., spines, string) inserted into the victim’s body by the witch; or 3) another type of curer, iritasokempira, who sucks the object out of the body. In conversations with people undergoing these treatments, my impression is that Western medicine is believed to be ineffective against witchcraft. This is consistent with the disconnect between Western indicators of physical health and Matsigenka impressions of well-being in the face of sorcery, observed by Izquierdo (2005). In the Mestizo communities, chest pain is much more salient as an indicator of a serious heart problem, requiring Western medical attention. I suspect that rates of heart-related medical problems are considerably higher in Mestizo communities, as many interviewees told me of conditions, such as type 2 diabetes, that tend to

covary with heart disease in Western societies. I hypothesized that Matsigenka would give a response other than “Health post”, while Mestizos would respond “Health post”.

Less than half (47%) of Matsigenka and more than half (65%) of Mestizos responded “Health post” (Figure 2A, note inverse coding). An example of a typical Matsigenka response is, “You have chest pain in your heart, you want to go to the health post. [The technician] gives you pills [but] it [i.e, the illness] doesn’t get better. Then you go get herbs. There is heart-pain-herb. You mash it up with a rock: ping ping ping. Then you drink it. In the afternoon you feel a little better . . . [if] you drink it and the illness doesn’t get better, you go to the healer. He blows on you. [He asks,] ‘What hurts you?’ He visits you [and he asks] ‘What is inside you? A palm-wood splinter? A stone?’ . . . He is able to take it out of you, so that you can heal.” An example of a typical Mestizo response is, “If I wake up with a painful heart, it’s because I have thought a lot, and there is something wrong with that organ. Well, I’d have to go to the doctor. Because a shaman would lead me in the wrong direction [i.e., not cure me].”

Question 9, not pot each (Fairness)

An old woman has two new pots and two adult daughters. One daughter has her own two pots, but wants her mothers pots. The other daughter has no pots, and also wants her mothers pots. When the mother dies, who should inherit the pots? (Illustrated with a diagram. Possible responses: one pot to each daughter; both pots to the daughter who has none)

Hay una mujer vieja con dos ollas nuevas. Tiene dos hijas adultas. Una hija tiene sus propias dos ollas, pero quiere las ollas de su mamá. La otra hija no tiene ollas. También quiere las ollas de su mamá. Cuando la mamá se muere, ¿a quién debería heredarle las dos ollas?

Ogari tsinane okamake. Aityo pitieti ojiromanga otierira. Ainho pitieni oshintó antaroni. Paniro oshintó aityo pitieti ojiromangane ashí iroro. Okogake oka otierira jiomanga. Ogari apiteni oshintó, mameri ojiromangane. Ariompa okogake oka otierira jiomanga. Tyani gakerone otierira jiomanga ashí iniro?

A response of “Both pots to the daughter who has none” was coded as

positive. This question is coded in the same way for the in-group and out-group latent axes. This illustrates a norm for fair division according to right versus according to need.

This question was inspired by my life history interviews with Mestizos, in which several people recounted instances of tension between siblings over the division of wealth belonging to a recently-deceased parent. In addition to norms of inheritance, this question is designed to investigate norms of fairness, e.g., division according to entitlement (equal shares to both daughters) or division according to need (both shares to the daughter who has less). My impression was that Mestizos tended to emphasize entitlement, and Matsigenka tended to emphasize need. Thus I hypothesized that Mestizos would give the negative response and Matsigenka would give the positive response. The qualification that the mother's pots are new (i.e., unused) when she dies is to circumvent the Matsigenka-typical norm of destroying or burying the used belongings of the deceased in order to avoid attracting a dangerous dead spirit (see Question 3). I hypothesized that Matsigenka would respond "Both pots to the daughter who has none", while Mestizos would respond "One pot to each daughter."

A large majority (75%) of Matsigenka responded "Both pots to the daughter who has none", while most (68%) Mestizos responded "One pot to each daughter." (Figure 2A). An example of a typical Matsigenka explanation for giving both pots to the daughter who has none is because, "the other one already has pots." An example of a typical Mestizo response is, "I would give one [pot] to each one [i.e., daughter], because the first two pots [of the daughter who already has two] are her own. But I as a mother want to give the inheritance. And as I have two pots, and my other daughter has none, then I should give to each one [i.e., daughter] so that they don't fight. But I can't say to the other daughter [who already has two pots], 'Give her [i.e., your sister] the two pots', because [she] bought [her own two pots] with her own money. So I just give one [to each] in order to avoid [fights]. And with the disadvantage that one [daughter] has three [pots] and the other one."

Question 10, good non-baptized not heaven (Religion)

A good person does not want to be baptized. Where does his or her soul go when they die? Possible responses: up (heaven); down (hell); somewhere else.

Una persona es buena, pero no quiere bautizarse. Cuando se muere, ¿adónde va su alma?

Yogari sidadi inti cameti. Tenka ikogira ibautizatakeri Padre. Imbo ikamake. Tyara iriatae isire? Enokue? Saviakue? Pashini?

A response of “Up” or “Heaven” was coded as negative. All other responses were coded as positive. This question is coded in the same way for the in-group and out-group latent axes. Thus illustrates a norm for the appropriate way to obtain a reward in the afterlife.

For some Matsigenka, there is a distinction between a soul going into the ground (kipatsikue) and going to a place with flames below the world (morekakue)(see also Rosengren (2004)). Both of these places can be indicated by the preposition down (saviakue), but they are not necessarily equivalent in terms of favorable or unfavorable outcomes after death. I realized this after most of the interviews were completed. Therefore, a response of “down” to this question by Matsigenka may be interpreted as “anywhere other than a heaven-like place above the world”.

This question was inspired by my interest in how much importance the Matsigenka place on foreign religious (e.g., Catholic) rituals. A Catholic priest ministers to the Matsigenka communities inside Manu National Park, as well as to the Mestizo town of Boca Manu. He usually visits each community twice per year. I was present for one of his visits to Tayakome, during which he said mass (in Spanish), baptized all available children, and distributed gifts (clothes, soap, candy) to all attendees. I had the impression that many attendees came simply to observe the spectacle of the mass, the baptisms, and the gifts, and did not necessarily share the priest’s interpretation that baptism removes the “original sin” of their children. However, most did seem to desire that their children be baptized. This question was designed to explore such subjective impressions. Evangelical Christian proselytizing is not permitted within Manu National Park by the park administration. However, two such groups are active in Boca Manu, and provide weekly services. I did not observe religious services of any variety in Atalaya, though residents self-identifying as Catholic or Evangelical Christian were present in the town. My impression is that residents generally travel 30min by road to the larger towns of Pilcopata or Salvación if they seek religious services.

I interpret a response of “Up”/“Heaven” as suggesting a belief that individual autonomous actions are more important in determining supernatural

benefits than is formal acceptance by a representative of an organized religious community. I had no strong a priori hypotheses about how Matsigenka and Mestizos would answer this question.

A slight majority (56%) of Matsigenka responded that the person would not go to Heaven, while a large majority (70%) of Mestizos responded that the person would go to Heaven (Figure 2A). An example of a typical Matsigenka explanation of the possible destinations of the soul after death is, “Up is good. It’s like here [i.e., the earth]. You’re an angry person, you die, the fire burns you in morekari, down.” This interviewee stated that the soul of a good non-baptized person goes “down”. When I then asked about the soul of a bad person who is baptized, this interviewee responded that their soul goes “up”. Thus, it appears that, for this interviewee, baptism is more important than behavior in determining the destination of the soul after death. An example of a typical Mestizo response is, “That’s a problem. Where would it [i.e., the soul of a good non-baptized person] go? Hell? I don’t think so. If he is not baptized, he could go to Heaven in the end, because he was not a bad person on earth. So he goes directly to Heaven, even if he was not baptized.” When I asked about the soul of a baptized child who grows up to be a bad person, this interviewee responded, “To Hell. It doesn’t matter if he is baptized or not baptized, because he is very bad.” Thus it appears that, behavior is more important than baptism in determining the destination of the soul after death.

Question 11, postpone work visit (Wage Labor)

A man is hired to prepare an agricultural field. He stops work at noon in order to go visit a friend. He returns the next day to finish the job. Is this okay?

Un hombre está contratado limpiar una chacra. Deja de trabajar a mediodía porque quiere visitar a su amigo. El día siguiente termina de limpiar la chacra. ¿Está bien?

Kamatitya, ipuinatakeri koriki yogari sidadi itsamaitera imagashipogote irashi Viracocha. Katinga poriatricsiri, yoga sidadi yapakuianae itsamaitera, ikogake ikamosote ishaninka. Paita onkuita yagatake itsamaitera, itsongatero imagashipogote irashi Viracocha. Cameti o tera cameti?

A response of “Okay” was coded as positive. This question is coded in the same way for the in-group and out-group latent axes. This illustrates a norm for prioritizing social relations over labor contracts.

This question was inspired by my interviews with Mestizo employers of Matsigenka wage laborers in plantain fields in Atalaya, and my experience working with Matsigenka families in their own manioc fields in Tayakome. Some Mestizo employers complained to me that Matsigenka laborers were not diligent workers (see examples in Bunce and McElreath (2017)). Working alongside Matsigenka and Mestizo wage laborers for a day in both Atalaya and Boca Manu, I did not observe ethnic differences in diligence, though my sample size was small. In Tayakome, social obligations can sometimes take priority over a day of weeding a manioc field, but, in my observation, never to the point of jeopardizing the productivity of a field. I hypothesized that Mestizos would respond “Not okay”, but I did not have a strong a priori hypothesis about how Matsigenka would answer.

A large majority of both Matsigenka (94%) and Mestizos (74%) responded “Okay” (Figure 2A). Most Matsigenka answered this question with a decisive “Okay”, as if the answer was obvious. An example of a typical Mestizo response is, “He can do it [i.e., stop work to visit a friend], because there was no time limit [in the contract] for when he should finish the field.”

Question 12, cheap store (Commerce)

There are two stores. One is cheap with a mean owner. The other is expensive with a nice owner. Where would you buy? (Illustrated with a diagram for Matsigenka.)

Hay dos tiendas. Una tienda es barata pero el dueño es malo. La otra tienda es cara pero el dueño es bueno. ¿Dónde iría Ud. para comprar?

Aityo pitieti otiendate Viracocha. Patiro otiendate tenka opuinasanotempa. Yogari shintarorira inti kisantari. Apiteni otiendate onti puinasanori. Yoga shintarorira tenka irikisante. Tyaka picompratake? Hanta puinasanori irashi cameti shintarorira o apiteni tenka opuinasanotempa irashi kisantari?

A response of “Cheap store with mean owner” was coded as positive for the ego latent axis. However, for both the in-group and out-group latent axes, the response of “Expensive store with nice owner” was coded as positive. This

contraposes a norm of frugality with a norm of courtesy.

This question was inspired by my observation that Mestizos tended to have strong norms of personal respect in the domain of commerce (e.g., courtesy and formality, unless among very close friends), yet also tended to be concerned with frugality and not being cheated. Matsigenka tend to have smaller amounts of money, which they are usually anxious to convert into as much Western merchandise as possible, yet they also tend to avoid displays of anger (see also Shepard (2002)). I had no strong a priori hypotheses about how Matsigenka or Mestizos would answer this question.

A majority (62%) of Matsigenka and less than half (46%) of Mestizos responded “Cheap store with mean owner” (Figure 2A). An example of a typical Matsigenka explanation for buying in the cheap store with a mean owner is, “The merchandise costs little. If he [the owner] gets angry at me, I’ll just buy a little.” An example of a typical Mestizo explanation for buying in the expensive store with the nice owner is, “It doesn’t matter if the product costs a little more. I go to the store that has an owner who is more friendly, more welcoming, more open. That’s where I go. It doesn’t matter if the price costs a little more.”

Question 13, daughter must marry (Parent-Offspring Relations)

Parents want their daughter to marry a certain man that she does not like. She wants to marry someone else. Should she obey her parents and marry him anyway or not? (Matsigenka: she does not obey her parents, and instead marries the man she wants. Is this okay?)

Los papás quieren que su hija se case con un chico. Pero a la hija no le gusta el chico. Ella quiere otro. ¿Debería hacerles caso a sus papás y casarse con ese chico, o no?

Iriegi ikogaigake ojinantempera irishinto antaroni. Ikantakero “Noshinto, gaeri yogari sidadi, inti cameti.” Kantangicha, ishinto tenka okogiri yogari sidadi, okogakeri pashini. Iroventi, iroro, irishinto, tenka okematsataeri iri. Tenka ojinantaigiri yoga sidadi. Agakeri pashini. Cameti o tera cameti?

A response of “She must obey her parents and marry the man she does not like” (Matsigenka: “Not okay”) was coded as positive for the ego and in-group latent axes. However, for the out-group latent axis, the response of “She

must not obey her parents. She should marry who she wants” (Matsigenka: “Okay”) was coded as positive. This illustrates a norm of arranged marriage.

This question was inspired by my conversations with some Mestizo men who were of the opinion (derived from second-hand stories they reported having heard) that Matsigenka fathers “give away” their daughters to non-Matsigenka men. The daughters apparently have no choice in the matter. This was explained to me as an exotic custom of the Matsigenka, meant to contrast with the more conservative norms held by the Mestizos who told me the stories. Such behavior was inconsistent with my observations in Tayakome, where I observed the formation of one young couple. In that case, the decision to be together seemed mutual, as I saw them openly flirting at a community-wide party before they moved in together. Neither set of parents seemed particularly happy about the match, evidenced by a public argument over the marriage between the two mothers during a community meeting. However, no one objected, as the decision was regarded to be that of the two young people. The marriage only lasted a few months before the young man left to work downriver and the young woman returned to her parents’ house. However, during this incident I did not observe any norms that indicated a system of arranged marriage. However, a young married woman in Tayakome recounted to my wife that she was initially resistant to the idea of marrying her current husband. She said that her parents pressured her until eventually she agreed to marry him. Ultimately the choice was hers. I hypothesized that neither Matsigenka nor Mestizos would respond that the daughter should obey her parents and marry a man she does not want.

The vast majority of both Matsigenka (89%) and Mestizos (96%) responded “She must not obey her parents. She should marry who she wants” (Figure 2A). An example of a common Matsigenka explanation for this response, told from a father’s perspective is, “Someone comes and says, ‘I want to marry your daughter’, [but] she doesn’t want him, [she says] ‘I don’t want him’. There is someone else whom she loves . . . She doesn’t want to marry him, [she says] ‘I don’t want him’. She gets mad at him, and she says ‘Go away!’. She wants someone else.” Although this explanation diverges slightly from the original question, it illustrates the autonomy of partner choice generally recognized for Matsigenka women of marriage age. An example of a typical Mestizo response is, “Before it was like that [i.e., arranged marriage]. The dad would say, ‘You know what, daughter? I’ve found your ideal partner. He is for you.’ If the girl is not in love with him, she doesn’t pay attention to him. But the parents insist insist insist. The girl who is not in

love ends up having children, and that's when the fights come, the problem, the resentment against the father. [The daughter says to her father] 'I didn't want to, but you told me to, and now I did it!' So, I don't agree [with arranged marriage]. The person who chooses the partner should be the one who is going to live and share their whole life [with the partner]."

Question 14, laborer is drunk (Wage Labor)

A man is hired to work two days: Monday and Tuesday. Monday night there is a party (Matsigenka: hosted by a Matsigenka). Should he go and get drunk? (Matsigenka: He goes and gets so drunk that he can't work on Tuesday. Is this ok?)

Un hombre está contratado trabajar dos días: lunes y martes. Lunes en la noche hay una fiesta. ¿El hombre debería ir y emborracharse?

Itinkame ipuinakeri koriki yogari sidadi intsamaitera pitieti kuitagita: Lunes ontiri Martes. Lunes tsitenigeti aityo owidoki irashi ishaninka. Iriro iati, para ishinkitaka. Tenka iragavea intsamaitira Martes. Cameti o tera cameti?

A response of "Okay to go and become drunk" was coded as positive. This question is coded in the same way for the in-group and out-group latent axes. This illustrates a norm for the importance given to a labor contract. In my experience, all wage-labor contracts are verbal.

This question is inspired by my observation that there are a few members of both Matsigenka and Mestizo communities (all men, in my experience) who are occasionally so drunk that they neglect previously-made commitments. This behavior is generally frowned upon in both ethnic groups. However, because of the important role of manioc beer parties in Matsigenka society (see Question 4, above), and Matsigenka autonomy over their own production while living in Tayakome (i.e., a lack of work contracts), I hypothesized that Matsigenka might be more accepting of this behavior than Mestizos and would thus be more likely to respond "Okay".

The vast majority of both Matsigenka (78%) and Mestizos (100%) responded "Not okay", though there were a few Matsigenka who believed this behavior to be acceptable (Figure 2A). An example of a typical Matsigenka response is, "He goes [to the party]. He won't get drunk. He'll come back."

An example of a typical Mestizo response is, “He should not go [to the party] because he is contracted to work. Also, he should cultivate the values of responsibility, because if I don’t keep my word with the woman who contracted me, at another time [in the future] she is not going to give me work. Surely I won’t get any [work]. Then she’ll point me out with an accusing finger, ‘That is an irresponsible [person].’ . . . to work one must go sober.”

Appendix A.3. Statistical analysis

Appendix A.3.1. Overview

A series of Item-Response Theory (IRT) models (Bafumi et al., 2005; Fox, 2010; Jackman, 2001; Schacht and Grote, 2015; Bunce and McElreath, 2017; van der Linden, 2016), in a Bayesian framework (McElreath, 2016), was fit to interviewees’ Personal Norm (ego) responses, in-group guesses, and out-group guesses. Responses to the 14 vignette questions for each of these targets (ego, in-group, and out-group) co-varied in a single dimension, represented by a latent axis for each target. Models estimated individual-level variance in interviewees’ positions on the three latent target axes (random intercepts), covariance in interviewees’ positions across target axes, covariance in question positions and discriminations within and across target axes, as well as the effects of binary individual-level predictors for inter-ethnic experience in the contexts of education, wage labor worker, wage labor employer, commerce, family, and community (see Section Appendix A.3.3). Statistical inference is drawn from distributions of posterior predictions for the probability of positive responses to the vignette questions (see Table 1) for each target. Kullback-Leibler divergences (McElreath, 2016; Kullback and Leibler, 1951) are calculated between probabilities of ego responses and in-group and out-group guesses for average Matsigenka and Mestizo individuals with different types of inter-ethnic experience (Figure 1). For all analyses, Mestizo residents of Boca Manu and Atalaya are grouped together in the category Mestizos, as the distributions of responses in these two communities are similar (Figure S3). Further details of analysis, including IRT model definitions and priors are provided below. Data and code in R (R Core Team, 2017) and RStan (Stan Development Team, 2018) to repeat this analysis can be found on Github at <https://github.com/jabunce/bunce-2018-cross-cultural-competence>.

Appendix A.3.2. IRT model structure

The norms measured by the vignette questions may covary, such that knowing how an individual answered one question gives you information about how she answered another question, and, in the ideal case, about how she answered all of the other questions. If true, then people’s responses to the fourteen vignettes can be represented by a smaller number of latent dimensions, and, ideally, by a single latent dimension. I use Item Response Theory (IRT) models (Bafumi et al., 2005; Fox, 2010; Jackman, 2001; Schacht and Grote, 2015; Bunce and McElreath, 2017; van der Linden, 2016) in a Bayesian framework (McElreath, 2016) to show that, for this study, the vignette responses of each interviewee are well represented by a single dimension. This latent dimensional axis constitutes a convenient way to compare individuals on the basis of all fourteen measured norms simultaneously. It does not necessarily represent a unitary, overarching belief held by actual people (e.g., a meta-norm). For instance, it may be that the fourteen measured norms are functionally independent but happen to covary within this sample of people. Questions are coded such that a response corresponding to the positive pole of the latent axis is represented as 1, and a response corresponding to the negative pole is represented as 0. Such coding is arbitrary and can be reversed without changing interpretation of the model. From the perspective of this investigation, the vignette questions have no correct or incorrect answers, and thus responses coded as “positive” imply no judgment about the “correctness” of such a response. Although the latent axes of IRT models are often given interpretations (e.g., (Jackman, 2001; Schacht and Grote, 2015; Bunce and McElreath, 2017)) the conclusions below do not depend on interpretation of such constructed axes. The location on the latent axis of individual j is represented by the parameter α_j . I model α_j as a linear function of a random (i.e., individual-specific) intercept b_j , for each individual j , and various hypothesized predictors, including inter-ethnic commerce, wage labor, education, family, employer, and community experience:

$$\alpha_j = b_j + mCOM \cdot COM_j + \dots, \quad \text{for } j \text{ in } 1, \dots, J \quad (\text{A.1})$$

where J is the number of interviewees. An example fixed effect predictor, $mCOM \cdot COM_j$, is the product of the coefficient for inter-ethnic commerce experience and the binary commerce experience indicator for individual j .

To construct an IRT model, the linear model α_j is embedded within a logistic function. This allows us to simultaneously evaluate properties of each

individual and each vignette question with respect to the latent dimension. The probability that the response y of a particular interviewee j to a particular vignette question k is the positive response (column four of Table 1), $\Pr(y_{jk} = 1)$, is given by a logistic function (inverse logit) ranging between zero and one:

$$\Pr(y_{jk} = 1) = \text{logit}^{-1}[\gamma_k(\alpha_j - \beta_k)] \quad (\text{A.2})$$

The domain (x axis) of this logistic function is the latent dimension. The slope at the function’s inflection point, γ_k , is the degree to which a positive (1) versus negative (0) response to question k discriminates among individuals’ positions on the latent axis. The location of the inflection point on the latent axis, β_k , is how close a person must be to the positive pole of the latent dimension in order for the model to predict that she give the positive response to question k . See Bunce and McElreath (2017) and Bafumi et al. (2005) for further explanation and illustrations.

In the present analysis, I fit an IRT model to personally-held (ego) norms, in-group guesses, and out-group guesses simultaneously. I had an a priori hypothesis that peoples’ answers with respect to each of these targets (ego, in-group, and out-group, respectively) would covary, either positively or negatively. For instance, an individual’s personal norms may coincide with the norms she believes are held by the majority of her co-ethnics, and diverge from the norms she believes are held by most members of the out-group. Thus, the model constructs a separate axis for ego responses, in-group guesses, and out-guesses, and I estimate the covariance among people’s positions on these three latent axes (α_{jt} for person j on target axis t). I also allow covariance between individual question locations and discriminations on each axis (β_{kt} and γ_{kt} for question k on target axis t), as well as among the axes. Note that the three latent axes, because they are constructed separately by the IRT model, do not represent identical covariance structures among the questions (though, in these models, they are fairly similar). Thus, the positive pole of the ego axis does not correspond exactly with the positive poles of the in-group and out-group axes, as the coding of some questions changes on each axis in order to better fit the data, and the contributions of each question to the construction of the three axes (γ_k) are estimated separately for each axis t (though they are allowed to covary).

I incorporate ethnicity into the model by estimating the mean location of Matsigenka individuals separately from the mean location of Mestizo in-

dividuals on each axis, as well as ethnicity-specific covariances across axes. This has the same effect as including a main effect predictor for ethnicity in the linear model for α . I also allow the effects of inter-ethnic experience predictors (e.g., inter-ethnic commerce or education experience) for each axis to vary by ethnicity. This has the same effect as including an interaction of the predictors for ethnicity and inter-ethnic experience in the linear model for α . Thus, an IRT model incorporating ethnicity and inter-ethnic commerce experience is:

$$y_{jkt} \sim \text{Binomial}(1, p_{jkt}) \quad (\text{A.3})$$

$$p_{jkt} = \text{logit}^{-1}[\gamma_{kt}(\alpha_{jt} - \beta_{kt})] \quad (\text{A.4})$$

$$\alpha_{jt} = b_{jt} + mCOM_{t, \text{ETH}[j]} \cdot COM_j + \dots \quad (\text{A.5})$$

$$\begin{bmatrix} b_{t=\text{ego}} \\ b_{t=\text{in}} \\ b_{t=\text{out}} \end{bmatrix}_j \sim \text{MVNormal} \left(\begin{bmatrix} \mu_{b_{t=\text{ego}}} \\ \mu_{b_{t=\text{in}}} \\ \mu_{b_{t=\text{out}}} \end{bmatrix}_{\text{ETH}[j]}, \mathbf{S}_{\text{ETH}[j]} \right) \quad (\text{A.6})$$

$$\mathbf{S}_{\text{ETH}[j]} = \begin{bmatrix} \sigma_{b_{t=e}} & 0 & 0 \\ 0 & \sigma_{b_{t=i}} & 0 \\ 0 & 0 & \sigma_{b_{t=o}} \end{bmatrix}_{\text{ETH}[j]} \quad \mathbf{R}_{\text{ETH}[j]} = \begin{bmatrix} \sigma_{b_{t=e}} & 0 & 0 \\ 0 & \sigma_{b_{t=i}} & 0 \\ 0 & 0 & \sigma_{b_{t=o}} \end{bmatrix}_{\text{ETH}[j]} \quad (\text{A.7})$$

$$\begin{bmatrix} \beta_{t=\text{ego}} \\ \beta_{t=\text{in}} \\ \beta_{t=\text{out}} \\ \gamma_{t=\text{ego}} \\ \gamma_{t=\text{in}} \\ \gamma_{t=\text{out}} \end{bmatrix}_k \sim \text{MVNormal} \left(\begin{bmatrix} \mu_{\beta_{t=\text{ego}}} \\ \mu_{\beta_{t=\text{in}}} \\ \mu_{\beta_{t=\text{out}}} \\ \mu_{\gamma_{t=\text{ego}}} \\ \mu_{\gamma_{t=\text{in}}} \\ \mu_{\gamma_{t=\text{out}}} \end{bmatrix}, \mathbf{T} \right) \quad (\text{A.8})$$

$$\mathbf{T} = \begin{bmatrix} \sigma_{\beta_{t=e}} & 0 & 0 & 0 & 0 & 0 \\ 0 & \sigma_{\beta_{t=i}} & 0 & 0 & 0 & 0 \\ 0 & 0 & \sigma_{\beta_{t=o}} & 0 & 0 & 0 \\ 0 & 0 & 0 & \sigma_{\gamma_{t=e}} & 0 & 0 \\ 0 & 0 & 0 & 0 & \sigma_{\gamma_{t=i}} & 0 \\ 0 & 0 & 0 & 0 & 0 & \sigma_{\gamma_{t=o}} \end{bmatrix} \mathbf{U}$$

$$\begin{bmatrix} \sigma_{\beta_{t=e}} & 0 & 0 & 0 & 0 & 0 \\ 0 & \sigma_{\beta_{t=i}} & 0 & 0 & 0 & 0 \\ 0 & 0 & \sigma_{\beta_{t=o}} & 0 & 0 & 0 \\ 0 & 0 & 0 & \sigma_{\gamma_{t=e}} & 0 & 0 \\ 0 & 0 & 0 & 0 & \sigma_{\gamma_{t=i}} & 0 \\ 0 & 0 & 0 & 0 & 0 & \sigma_{\gamma_{t=o}} \end{bmatrix} \quad (\text{A.9})$$

$$(mCOM_{t=e}, mCOM_{t=i}, mCOM_{t=o})_{\text{ETH=Mat}} \sim \text{Normal}(0, 1) \quad (\text{A.10})$$

$$(mCOM_{t=e}, mCOM_{t=i}, mCOM_{t=o})_{\text{ETH=Mes}} \sim \text{Normal}(0, 1)$$

$$(\mu_{b_{t=e}}, \mu_{b_{t=i}}, \mu_{b_{t=o}})_{\text{ETH=Mat}} \sim \text{Normal}(0, 1) \quad (\text{A.11})$$

$$(\mu_{b_{t=e}}, \mu_{b_{t=i}}, \mu_{b_{t=o}})_{\text{ETH=Mes}} \sim \text{Normal}(0, 1)$$

$$(\sigma_{b_{t=e}}, \sigma_{b_{t=i}}, \sigma_{b_{t=o}})_{\text{ETH=Mat}} \sim \text{Exponential}(2) \quad (\text{A.12})$$

$$(\sigma_{b_{t=e}}, \sigma_{b_{t=i}}, \sigma_{b_{t=o}})_{\text{ETH=Mes}} \sim \text{Exponential}(2)$$

$$(\mathbf{R}_{\text{ETH=Mat}}, \mathbf{R}_{\text{ETH=Mes}}) \sim \text{LKJcorr}(4) \quad (\text{A.13})$$

$$(\mu_{\beta_{t=e}}, \mu_{\beta_{t=i}}, \mu_{\beta_{t=o}}) \sim \text{Normal}(0, 1) \quad (\text{A.14})$$

$$(\mu_{\gamma_{t=e}}, \mu_{\gamma_{t=i}}, \mu_{\gamma_{t=o}}) \sim \text{HalfNormal}(0, 1) \quad (\text{A.15})$$

$$(\sigma_{\beta_{t=e}}, \sigma_{\beta_{t=i}}, \sigma_{\beta_{t=o}}, \sigma_{\gamma_{t=e}}, \sigma_{\gamma_{t=i}}, \sigma_{\gamma_{t=o}}) \sim \text{Exponential}(2) \quad (\text{A.16})$$

$$\mathbf{U} \sim \text{LKJcorr}(40) \quad (\text{A.17})$$

for j in $1, \dots, J$ individuals, k in $1, \dots, K$ questions, and t in (ego, in-group, out-group) target axes. This notation roughly follows that of McElreath (2016, pg 393) for varying-slopes models. See Bafumi et al. (2005) for notational changes if not all interviewees answered all questions. The subscript $\text{ETH}[j]$ is an indicator for the ethnicity (Matsigenka or Mestizo) of individual j . Thus, $mCOM_{t,\text{ETH}[j]}$ is the predictor for inter-ethnic commerce experience on target axis t for the ethnic group to which individual j belongs. It is multiplied by a binary indicator of individual j 's commerce experience (0 or 1).

Informative $\text{Normal}(0, 1)$ priors for mean intercepts (μ_b 's), mean question locations (μ_β 's), and predictor coefficients (e.g., $mCOM$'s), together

with exponential hyperpriors on standard deviations to control ceiling and floor effects common in such logistic models (McElreath, 2016, pg 363-364), effectively identify the model by constraining the position and scale of the α_j 's and β_k 's to fall within a reasonable distance (e.g., usually within two standard deviations) on either side of zero, resolving additive and multiplicative aliasing (Bafumi et al., 2005). Any choice of position and scale in IRT models is arbitrary and results in equivalent inference. Reflection (or rotational) invariance (Jackman, 2001; Bafumi et al., 2005) is not a concern as mean discriminations of all questions are positive (justifying positive priors on the μ_γ 's), effectively polarizing the latent axis. \mathbf{R} and \mathbf{U} are correlation matrices, and are given conservative regularizing priors biasing against extreme correlations (McElreath, 2016, pg 394). These priors can be overcome by relatively strong signal in the data.

After fitting the model, the variance-covariance matrix \mathbf{S} contains estimates of residual covariance among individual-specific (i.e., random) intercepts for individuals' locations (b_{jt}) across target axes, after accounting for the variance in location among individuals on each target axis explained by their inter-ethnic experience. For instance, how an individual answered the vignette questions (ego responses) may covary with how she guessed members of the out-group answered the questions (out-group guesses), even after accounting for the fact that certain types of inter-ethnic experience may affect both her own answers and her guesses about out-group individuals' answers. If true, estimates of the ego - out-group covariance contained in \mathbf{S} will be non-zero.

To check the robustness of results to the effects of different predictors, I fit a series of 20 models varying in the fixed effect predictors included in the linear function for α_{jt} (Tables S1 and S2). Parameter estimation for each model was accomplished with RStan 2.17.3 Stan Development Team (2018), running four Hamiltonian Monte Carlo chains in parallel until convergence was suggested by a high effective number of samples (> 500) and \hat{R} estimates of 1.00 (McElreath, 2016, pg 257). This entailed 3000 samples per chain, half of which were warm-up. In practice, a non-centered parameterization of the above model with Cholesky factorization of the correlation matrices \mathbf{R} and \mathbf{U} was fit in RStan (Stan Development Team, 2017, pg 151). I compared model fit with WAIC (McElreath, 2016, pg 191). Data and statistical analysis scripts in R (R Core Team, 2017) implementing RStan are available from Github at <https://github.com/jabunce/bunce-2018-cross-cultural-competence>.

Appendix A.3.3. Model predictors

Combinations of the following individual-level predictors are incorporated into linear models for individuals' locations on the latent axes (α_{jt}) in the IRT models.

Ethnicity

Interviewees were coded as Matsigenka if they self-identified as Matsigenka. Two siblings had a Matsigenka mother and a Mestizo father. Both of them had lived for several years in Matsigenka communities in Manu, self-identified as only Matsigenka upon questioning, and were coded as such. All non-Matsigenka in this study were classified as Mestizos. Within the study communities, the ethnic boundary between these two groups is stark, and I know of only three cases of marriage between Matsigenka and non-Matsigenka in the three study communities in the last three generations. Other interviewees who could plausibly have self-identified as bi-cultural, i.e., Matsigenka residing in Mestizo towns, all, without hesitation, self-identified as only Matsigenka. This coincided with how I observed them to interact with other Matsigenka and Mestizos. Further description of the relationship between Matsigenka and Mestizos in this population is provided in Bunce and McElreath (2017). Although this study does not explore in detail conceptions of ethnic identity, it is important to note that the relationship between ethnic identity and personally-held norms in cross-culturally competent individuals can be complex (Benet-Martínez and Haritatos, 2005; Schwartz et al., 2010). Sample sizes of Matsigenka and Mestizo interviewees are provided in Table 1.

Sex (1=Male)

Sex was coded according to self-identified gender. Sample sizes (# interviewees) for Matsigenka ego (female, male), in-group (female, male), out-group (female, male): (41, 38), (30, 27), (30, 27). Mestizos: (40, 42), (25, 21), (25, 21).

Age Category (Adolescent, Adult, Elder)

Many Matsigenka, especially older adults, do not know their exact age in years. For this reason I use age categories as predictors, estimating ages where necessary. Adolescents were younger than 20, adults were 20 to 50, and elders were older than 50. Note that binary predictors for only two of these categories need be included in the model at the same time. Adolescent

interviewees (ego, in-group, out-group): 9, 5, 5. Adults: 119, 76, 76. Elders: 33, 22, 22.

Education Experience (Edu = 1 : attended school with Mestizos)

All Mestizos attended primary and/or secondary school with other Mestizos, so all were coded as 1. Several Matsigenka interviewees grew up outside of Tayakome and went to either a boarding- or non-boarding primary school with Mestizos. These individuals were coded as 1. Most Matsigenka in Tayakome attended primary school in Tayakome, with Matsigenka teachers and all Matsigenka students. If this was an interviewee's only education experience, she or he was coded as 0. There is no secondary school in Tayakome. A few Matsigenka from Tayakome attended boarding secondary schools with Mestizos outside of Tayakome for at least four of the requisite five years, and some had additional educational training after high school (e.g., for tour-guide certification). These boarding school attendees were coded as 1. Two Matsigenka interviewees attended a boarding secondary school for a few months before either being expelled or leaving because they did not like it. These interviewees were coded as 0. The average amount of inter-ethnic education experience among Matsigenka scored as 1 was approximately 6.5 years. Matsigenka interviewees coded as 1 (ego, in-group, out-group): 17, 10, 10.

Wage Labor Worker Experience (Lab = 1 : wage labor experience with Mestizos)

All Mestizos were coded as having wage labor experience with other Mestizos. The vast majority of these interviewees, both men and women, had, at some point in their lives, worked for someone else to earn money, helped their spouse or relative earn money, and/or hired people to work for them. In contrast to the wage labor experience of most Matsigenka, many Mestizos are currently self-employed (e.g., banana farmers, small restaurant owners, boat builders) and do not have a "boss". Matsigenka were coded as 1, i.e., having wage labor experience with Mestizos, if they spent an approximate total of at least 1 month living with and working under Mestizos in their lifetime. This experience occurred in Mestizo towns, Mestizo-run tourist lodges or work camps (e.g., for logging or oil companies), or Mestizo-staffed park guard posts. Several Matsigenka interviewees attended boarding secondary school in Mestizo towns for several years and were hired as wage laborers on most weekends. These individuals were also scored as 1. The average amount

of wage labor experience among Matsigenka scored as 1 was approximately 3.5 years. Matsigenka interviewees coded as 1 (ego, in-group, out-group): 37, 26, 26.

Commerce Experience (Com = 1 : commerce experience with Mestizos)
All Mestizos were coded as 1, i.e., having commerce experience with other Mestizos, as all had purchased items in stores. Matsigenka were coded as 1 if they had ever directly bought or sold/traded items to Mestizos. Most Matsigenka had bought from Mestizo stores at least a few times in their life, although quantification based on memory was difficult. Matsigenka interviewees coded as 1 (ego, in-group, out-group): 65, 47, 47.

Family Experience (Fam = 1 : indigenous family experience)
All Matsigenka were coded as 1, i.e., having family experience with other Matsigenka. Mestizos were coded as 1 if, at some point in their lives, they had indigenous spouses or romantic partners, lived in the same household with indigenous people, and/or cared for indigenous children in the absence of the children's parents. Of the 36 Mestizos (43%) who had such experience, 26 (72%) had such experience with Matsigenka, as opposed to members of Yine or Harakmbut indigenous groups. 20 Mestizos with indigenous family experience (56%) raised Matsigenka children in their home for several months to years, with the consent of the children's parents. Sending children (ahijados or "entenados") to live with wealthier foster parents (sometimes official godparents, padrinos, but often not) is a custom in both the highlands and the lowlands of Peru. In the Manu region, the fostering is exclusively one-directional, with Matsigenka sending children to live with Mestizos, rather than vice-versa. Mestizo interviewees coded as 1 (ego, in-group, out-group): 36, 21, 21.

Wage Labor Employer Experience (Emp = 1 : experience employing Matsigenka)
Only one Matsigenka was coded as 1, as all other Matsigenka interviewees had never officially hired another Matsigenka as a wage laborer. 56 Mestizos (67%) were coded as 1 because they had, at some point, paid money to a Matsigenka in return for labor. Most of this labor was short-term, on the order of one, or a few, days (e.g., harvesting a plantain field). However, 15 (27%) of the Mestizos scored as 1 employed Matsigenka for at least several months at a time (e.g., as crew for tour boats during tourist seasons). Mes-

tizo interviewees coded as 1 (ego, in-group, out-group): 56, 34, 34.

Community Experience (Cty = 1 : lived in an indigenous community)

All Matsigenka were coded as 1, i.e., having lived in a majority-indigenous community at some point in their life. Matsigenka who were currently living in Boca Manu and Atalaya had previously spent years living in indigenous communities. Mestizos were coded as 1 if they had spent longer than one month living in one of the indigenous communities (Native Communities) in the region of Manu. These include some communities where the majority ethnic group is Yine or Harakmbut, rather Matsigenka, and also some Matsigenka communities outside of Manu National Park. The reason for including experience of Mestizos living in indigenous communities other than Matsigenka communities is my impression (as yet un-tested) that many Yine and Harakmbut have norms in many domains that are more similar to the norms of Matsigenka than to those of Mestizos. 31 Mestizos were coded as 1 (37%). Of these, 23 (74%) lived for at least one year in an indigenous community, and 12 (39%) had experience living in a majority-Matsigenka indigenous community. Mestizo interviewees coded as 1 (ego, in-group, out-group): 31, 19, 19.

Predictors for education, wage laborer, and commerce experience are meaningful only for Matsigenka interviewees (as such experiences are invariant among Mestizos), and are thus included in IRT models separate from those with predictors for family, employer, and community experience, which are meaningful only for Mestizo interviewees. This modeling strategy permits counterfactual contrasts of Matsigenka interviewees with education, wage labor, and commerce against Mestizos in general, and Mestizos with family, employment, and community experience against Matsigenka in general.

Appendix A.3.4. Model comparison and inference

Models with different combinations of predictors were compared using the Widely Applicable Information Criterion (WAIC) (McElreath, 2016, pg 191). Inference was based on the posterior distributions of predictions from models representing the hypotheses of interest, even if these were not the best fitting models (Tables S1 and S2).

Because the IRT models used in this analysis construct three separate latent axes (for ego responses, in-group guesses, and out-group guesses), interviewees' positions on these latent axes cannot be directly compared (contrast

with Bunce and McElreath (2017)). Instead, I translate posterior predictions of the models onto the probability scale (p_{jkt} in Eqs A.3 and A.4). This results in a posterior distribution of predictions for the probability that individual j gives the positive response for question k when the target of the question is t (i.e., ego, in-group, or out-group). Taking the average for an individual of a given ethnicity (i.e., ignoring estimated individual-level random effects) yields the distributions in Figure S8. For an average individual with given ethnicity and inter-ethnic experience, and a given target, I compute the mean probability across questions for each sample set of posterior predictions. This results in a posterior distribution of the mean probability that an average individual for a given target gives the positive response to an average (i.e., randomly-chosen) vignette question (e.g., column 1 of Fig 3).

Each posterior sample for a given individual, question, and target (p_{jkt}) is a probability distribution (i.e., the probability of giving the positive response and the probability of giving the non-positive response, $1 - p_{jkt}$). To compare probability distributions, I use a measure of divergence. For comparing distributions for which one distribution represents an individual’s guess about another distribution (e.g., a Matsigenka out-group guess about the average Mestizo ego response), I calculate Kullback-Leibler (K-L) divergence (Kullback and Leibler, 1951; McElreath, 2016), where the ego response is the K-L “target” (p) and the guess is the K-L “approximation” (q):

$$D_{KL}(p||q) = p_1 \ln \left(\frac{p_1}{q_1} \right) + p_0 \ln \left(\frac{p_0}{q_0} \right) \quad (\text{A.18})$$

where p_1 and $p_0 = 1 - p_1$ are the probabilities of positive and non-positive ego responses (respectively), and q_1 and $q_0 = 1 - q_1$ are the probabilities of positive and non-positive guesses (respectively). Notation roughly follows McElreath (2016, pg 179). K-L divergence is calculated for each pair of samples from the two posterior distributions to be compared, resulting in a posterior distribution of K-L divergence for each comparison of interest, e.g., guesses about the out-group responses versus ego responses of the out-group (see columns 4-7 of Figure S9 and Figures S14, S16, and S18). Such distributions represent the inaccuracy of guesses by average counter-factual individuals with given ethnicity and inter-ethnic experience (in units of the natural log of probability). Because K-L divergence does not permit examination of the direction of guess inaccuracy (e.g., over-estimation versus under-estimation of actual out-group mean ego responses), I also calculate simple contrasts of

posterior probabilities of guesses and ego responses (e.g., Figures S15, S17, and S19). Taking the mean K-L divergence across each sample set of questions yields the mean inaccuracy of guesses for an average individual, for an average (i.e., randomly-chosen) vignette question (e.g., columns 2 and 3 of Fig 3). To compare these inaccuracies of guesses, averaged across questions, by average individuals with differing counter-factual inter-ethnic experience, I calculate contrasts of their respective distributions of K-L divergence (e.g., Fig 4, and rows 2 and 3 of Figure S13).

For comparing probability distributions for which one distribution does not represent an individual’s guess about another distribution (e.g., a Matsigenka ego response and an Mestizo ego response), I calculate Jeffreys divergence (Kullback and Leibler, 1951; Jeffreys, 1948), which is a symmetric version of K-L divergence between two distributions p and q : $D_J(p; q) = D_{KL}(p||q) + D_{KL}(q||p)$ (Crooks, 2008) (see columns 1-3 of Figure S9). Taking the mean Jeffreys divergence across questions yields the divergence in the probabilities that the individuals represented by the two distributions gave the same response to an average (randomly-chosen) vignette question (e.g., Figure S11, and row 1 of Figure S13). Because Jeffreys divergence does not permit examination of the direction of the difference between distributions (i.e., which of the two probabilities of a positive response is greater), I also calculate simple contrasts of the posterior probabilities for each question (e.g., Figure S10), as well as for the mean probabilities across questions (e.g., Figure S12).

Inference about cross-cultural competence is drawn from comparisons of the inaccuracies (i.e., divergences among posterior probability distributions) of in-group and out-group guesses made by counter-factual respondents differing in ethnicity and inter-ethnic experience (Figure 1).

Appendix B. Supplementary Discussion

Appendix B.1. Additional Results and Discussion

Appendix B.1.1. Ethnicity differences in personal norms

Figure 2A shows that, for all fourteen vignette questions, a larger proportion of Matsigenka than Mestizos gave positive Personal Norm (ego) responses. These raw proportions suggest an overall ethnic difference in the distributions of the norms applied by the interviewees to answer the questions, and they demonstrate the utility of the interview instrument to distinguish between these two ethnic groups. This is further supported by the results of

the IRT models (Figures 3 and S2), which show a notable difference in the probability that Matsigenka and Mestizos give the positive ego response for an average (i.e., randomly chosen) vignette question.

Figure 2B and C show that Matsigenka and Mestizos guessed differently about how their respective co-ethnics (in-group) answered most questions, and about how their respective out-groups answered most questions (i.e., points generally fall far from the diagonal of equal proportions). This is supported by the results of the IRT models, shown in Figure S8. The fact that both Matsigenka and Mestizos guessed that in-group and out-group responses would differ for some questions (Figure S10) supports the conclusion that interviewees understood the guessing task in the interviews.

Posterior estimates of the discrimination parameters (γ_k) for most vignette questions on all target axes are reliably greater than zero (Figures S4-S7). This indicates that most questions can reasonably discriminate among individuals along a single latent axis for each target (Jackman, 2001).

Appendix B.1.2. Model comparison

Coefficient estimates for all models, including models m4, m11, and m19 used for inference above and in the main text, are provided in Tables S1 and S2. Exploratory models including sex and categorical age predictors achieved <1% of model weight, and the coefficients of each of these predictors could not be distinguished from zero (m12 and m20 in Tables S1 and S2). Furthermore, coefficient estimates for the inter-ethnic experience predictors were not distinguishable from those of the models used for inference, above. This gives me confidence that inclusion of sex and age in the models has little effect on the results.

Appendix B.1.3. Covariance of personal norms and out-group guesses

Matsigenka interviewees tended to guess that both the in-group and the out-group answered the vignette questions the way that the interviewees themselves answered them. This is seen in the positive covariance between Matsigenka individual locations on the latent ego axis and on the latent in-group and out-group axes (Figures S20-S22). Because there is considerable variance in Matsigenka ego locations, this covariance leads to considerable variance in location on the in-group and out-group axes. In contrast, Mestizos exhibited much less covariance in individual locations among the latent target axes, and much less variance on each target axis. These results suggest that there is much variance in the norms held by Matsigenka. However,

regardless of which norms she holds, each individual Matsigenka tends to believe that Mestizos hold norms like hers (with the notable exception of norms for healthcare: Figure S10). In contrast, it appears that Mestizos exhibit considerably less variation in how they perceive the norms of both Matsigenka and their fellow Mestizos, suggesting a shared stereotype of both Matsigenka and Mestizo norms. Interestingly, these seemingly different strategies for guessing about the norms of the in-group and out-group result in more inaccurate out-group guesses and less inaccurate in-group guesses for Matsigenka relative to Mestizos (Figure S2).

Appendix B.1.4. Cross-cultural competence and familiar out-group members

It could be the case that Matsigenka and Mestizos derive their perceptions of out-group norms from the norms of particularly familiar out-group individuals. Figure S23 shows that the Matsigenka individuals most familiar to Mestizos in this population have norms that are considerably different from the norms of the average Matsigenka. In contrast, the norms of the Mestizo individuals most familiar to Matsigenka have norms that are more similar to the norms of the average Mestizo. Thus, if individuals were basing out-group guesses on the norms of particularly familiar out-group members, we would expect Matsigenka out-group perceptions to be more accurate than those of Mestizos. The fact that this appears not to be the case (Figure S2) suggests either that such a strategy is not used, or that it is used to a lesser extent by Matsigenka than by Mestizos.

Appendix B.1.5. Domain-specificity of cross-cultural competence

The measure of overall cross-cultural competence developed here is driven by more accurate out-group guesses in a subset of norm domains plausibly linked to particular types of inter-ethnic interaction, e.g., education norms for Matsigenka education experience (Figure S14), labor norms for Mestizo employer experience (Figure S16). This suggests that knowledge of out-group norms is being put to use, and may thus covary with other characteristics often viewed as components of cross-cultural competence, such as motivation and skill (Spitzberg and Changnon, 2009).

Appendix B.1.6. Errors in Matsigenka and Mestizo guesses

As noted in the main text, and as can be seen in Figures 2, S8, and S9, in general, Matsigenka tended to guess that Mestizos answered question 7 (What do you do first when you have a respiratory illness?) by saying

that they would go to the health post (i.e., the response arbitrarily coded as positive). In fact, 96% of Matsigenka participants made this guess. Such a guess was highly inaccurate, as nearly 80% of Mestizos actually responded that they would first use home remedies for such an illness. However, in light of my experience living in these communities, the inaccuracy of Matsigenka out-group guesses for this question seems predictable in hindsight. Matsigenka generally perceive respiratory illnesses (merentsi) as originating among Mestizos, and subsequently being carried into Tayakome by Matsigenka returning from travel outside the community among Mestizos. I know of no Matsigenka-specific remedy for merentsi, although tobacco snuff is sometimes used as a prophylactic. The Mestizo-run health post in Tayakome dispenses medicine, usually in the form of pills and injections, to community members suffering from merentsi. Therefore, from a Matsigenka perspective, merentsi is an illness of Mestizo origin for which Mestizos have medicine that Matsigenka can obtain only at a Mestizo-run health post. With this in mind, it seems logical that Matsigenka would expect Mestizos who have merentsi to seek treatment at a health post. However, as shown, most Mestizos in fact rely heavily on home remedies for minor respiratory illnesses. Several Mestizo interviewees pointed out to me that medicine obtained from the health post is generally ineffective against respiratory illnesses, and that the best course of action is to rest, use a home remedy such as hot tea, and let the illness run its course. In my experience, Matsigenka visitors to Mestizo towns generally have few opportunities to observe Mestizos with respiratory illnesses (as such Mestizos are generally home resting), and therefore they may have little exposure to the types of treatments that Mestizos rely on in this context.

It is also apparent in Figures 2, S8, and S9, that the vast majority (96%) of Mestizos guessed that their co-ethnics answered question 5 (Is it okay for a teacher to hit a student who doesn't learn?) by saying that hitting a student is unacceptable. While such a guess is strictly accurate at the individual level, in that more than half of Mestizos gave this response, in the aggregate it is statistically inaccurate, because a substantial minority (37%) of Mestizos responded that teachers should hit students in order to motivate them to study harder. In my experience, most Mestizos are familiar with current Peruvian law that prohibits corporal punishment of students by teachers. However, many adults recalled how they themselves were subjected to painful treatment by their own primary and secondary school teachers when they lapsed in their schoolwork. A common saying among Mestizo interviewees is

that, in previous generations, “La letra entra con sangre” (The letter enters with blood), meaning that knowledge must be beaten into students. Several interviewees reminisced that the threat of such punishment motivated them to study harder when they were young, and that current students are much lazier because these punishments are no longer allowable. It seems plausible that Mestizos who hold such beliefs are unlikely to express them publicly, as these beliefs conflict with current law. This may lead to underestimation of the number of other members of their community who actually think like they do. Similarly, the norm for the corporal punishment of students is not acted upon by those Mestizos who personally hold it because it is against the law.

Appendix B.1.7. Power differences and cross-cultural competence

Fiske (1993) proposed a theory in which members of a less powerful subgroup form more accurate impressions of individuals in a powerful subgroup, while powerful individuals form potentially less-accurate stereotypical impressions of less-powerful individuals. The reasoning is that it behooves the powerless to pay close attention to powerful individuals, whose behavior can have a large impact on their lives. In contrast, powerful individuals need pay less attention to the powerless, whose behavior has little impact on their lives. In the present ethnographic context, despite large differences in the material wealth of manufactured items, there is little evidence that most Matsigenka feel themselves to be inferior to, or less powerful than, Mestizos in most important domains of life (Bunce and McElreath, 2017). Thus, there is no a priori expectation that the out-group guesses of an average Matsigenka would be more accurate than those of an average Mestizo, and indeed, such a prediction is not supported by these data (Figure S2). However, note that this methodology is amenable to testing Fiske’s theory in ethnographic contexts where power differences between groups are salient.

Appendix B.1.8. Mestizo inter-ethnic experience and cross-cultural competence

Figure 3B shows that, for Mestizos, indigenous family experience is associated with lower cross-cultural competence than is experience employing Matsigenka wage laborers or experience living in an indigenous community. This may seem surprising, given that family members engage in important coordination interactions in many domains on a daily basis. Thus, one might expect members of a functioning multi-ethnic family to be highly

cross-culturally competent. However, note that, for the majority of Mestizos who had family experience with Matsigenka, this experience consisted of raising Matsigenka foster-children (see Section [Appendix A.3.3](#)), usually in the context of these children attending primary and secondary schools in Mestizo towns. In my observation, many of these Mestizo adults felt it to be their duty to instill morals and values in the children under their charge. These morals and values usually took the form of idealized Mestizo-typical norms (e.g., Mestizo interpretations of cleanliness, obedience, responsibility, respect for elders, diligence in schoolwork, etc.). Thus, because of the power differential between Mestizo foster-parents and Matsigenka children, Mestizos with inter-ethnic family experience had no need to learn Matsigenka-typical norms. They were, for the most part, engaged in imposing Mestizo-typical norms on the Matsigenka children with whom they interacted.

Figure 3B also suggests that, compared to indigenous family experience and no inter-ethnic experience, the experience of living in an indigenous community is associated with Mestizos who hold more Matsigenka-typical norms and who are more cross-culturally competent. I have not had the opportunity to observe Mestizos living as minorities in indigenous communities outside of Manu National Park. Mestizos (other than the health post technician) are not permitted to live in Tayakome or other Matsigenka communities inside the park. Thus, any explanation for why this type of experience is more strongly associated with Matsigenka-typical norms than is the experience of hiring Matsigenka wage laborers, should be regarded as tentative. I hypothesize that Mestizo residents in indigenous communities necessarily engage in coordination interactions in many domains (e.g., commerce, employment, community obligations) primarily with the majority indigenous residents, who likely hold norms different from those of most Mestizos. As minorities, Mestizo residents likely have lower bargaining power in such interactions, and consequently adopt and internalize norms typical of the indigenous residents, analogous to Matsigenka boarding-school students adopting norms typical of their Mestizo teachers and care-takers. Alternatively, it is also likely that only Mestizos who hold norms most similar to those of indigenous people are willing to settle and live in indigenous communities. Either mechanism, or both, could be responsible for the results found in this study.

Appendix B.2. Hypotheses for cultural dynamics

Appendix B.2.1. Prediction 1: Loss of cultural norm diversity

The prediction is made in the main text that the long-term sustainability of ethnically-structured cultural norm diversity in a society is unlikely if members of one ethnic group become cross-culturally competent as a consequence of adopting personally-held out-group norms. In such a situation, cross-cultural competence itself will eventually disappear. This prediction is inspired by the model of language shift in Kandler (2009). To think through this argument, I sketch a hypothetical model.

Assume a population in which there are two varieties of coordination norm, designated norm 1 and norm 2, and each individual personally holds only one of the two norms. During coordination interactions, both individuals receive a payoff $\beta > 0$ if they both employ the same norm, and both receive a payoff of 0 if they each employ different norms. Assume interaction partners are drawn at random from within the entire population. There are three states that people may occupy: 1) individuals in state P_1 personally hold norm 1 and always employ norm 1 when they attempt coordination interactions with all other individuals; 2) individuals in state P_2 personally hold norm 2 and always employ norm 2 when they attempt coordination interactions with all other individuals; and 3) individuals in state C (cross-cultural competence) personally hold either norm 1 or norm 2, but all are capable of employing either norm 1 or norm 2 in any attempted coordination interaction. The norm that a C individual personally holds is the norm that she employs when interacting with another C individual. When she interacts with a P_1 or P_2 individual, she always employs norm 1 or norm 2, respectively.

To begin, assume an initial population comprising P_1 and P_2 individuals. At each time step t , allow P_1 individuals to enter state C with probability $r_{P_1 \rightarrow C} > 0$, but only on the condition that they adopt norm 2 as their personally-held norm. Under the above conditions, C individuals receive higher coordination payoffs, on average across all interactions, than either P_1 or P_2 because they can successfully coordinate with everyone in the population. All other state transition probabilities, $r_{P_1 \rightarrow P_2}$, $r_{P_2 \rightarrow P_1}$, $r_{P_2 \rightarrow C}$, $r_{C \rightarrow P_1}$, $r_{C \rightarrow P_2}$, are initially assigned values of zero. Under these conditions, all P_1 individuals will transition to C , and the population will evolve to comprise only P_2 and C individuals, all of whom personally hold norm 2. Norm diversity has not been lost, in the sense that all C individuals still retain knowledge of,

and the ability to coordinate using, norm 1. However, because all C individuals employ norm 2, i.e., the norm that they personally hold, when interacting with other C individuals, norm 1 will, in practice, cease to be employed in the population. Thus, because any C individual who forgets norm 1 suffers no decrease in average payoff (in the context of this hypothetical model), any non-zero probability of such forgetting on the part of C individuals, i.e., $r_{C \rightarrow P_2} > 0$, will lead to the loss of both cross-cultural competence and norm diversity, as the entire population transitions to state P_2 .

Such dynamics would appear to parallel the language dynamics investigated formally by Kandler and colleagues (Kandler, 2009; Kandler et al., 2010), in which the only equilibria are those in which one language, and all bilingual speakers, go to extinction. Kandler’s models show that requiring language adoption to proceed through a transition state of bilingualism can slow, and even reverse, the direction of this dynamic compared to models where individuals switch directly from being speakers of only one language to being speakers of only a different language. However, in the absence of external intervention in these models, bilingualism can never result in a mixed equilibrium where both languages are simultaneously present in the population.

Appendix B.2.2. Prediction 2: Sustainability of cultural norm diversity

A second prediction is made in the main text that the sustainability of norm diversity in a population is more likely if cross-cultural competence is acquired while retaining in-group norms. Using the above example, this corresponds to a situation in which P_1 individuals are allowed to enter state C , but only on the condition that they retain norm 1 as their personally-held norm. C individuals coordinate with P_2 individuals using norm 2, which is not C ’s preferred (personally-held) norm. In the terminology of Carvalho (2017), P_2 and C are misaligned (coordination is possible only if members of one group employ norms that they do not prefer), but they are not incompatible (such that coordination would be impossible, e.g., between P_1 and P_2). Carvalho (2017) showed formally that coordination between P_2 and C using norm 2 can evolve, provided that the payoffs of coordination to C individuals are substantially greater than the payoffs to C individuals of miscoordinating while attempting to employ norm 1. If this condition holds (along with the others above), then C individuals initially receive greater average coordination payoffs than either P_1 or P_2 for the same reason as in the previous model. Allowing $r_{P_1 \rightarrow C} > 0$, while holding all other transition probabilities

at zero, will result in all P_1 individuals transitioning to the cross-cultural competence state C .

In contrast to the previous scenario, now all C individuals employ norm 1 (their personally-held norm) when interacting with other C individuals. Both norm 1 and norm 2 are actively employed in the population, and, as in the previous model, cultural norm diversity has not decreased. However, if there is some subjective cost $\delta > 0$ to coordinating using one's non-preferred norm, then, once P_1 individuals disappear (or become sufficiently rare), P_2 individuals receive a higher average payoff than C individuals. This is because P_2 individuals coordinate with everyone in the population using their preferred norm 2. In contrast C individuals coordinate with other C individuals using their preferred norm 1, but their coordination payoffs are reduced by an amount δ whenever they coordinate with P_2 individuals, as, in such cases, they always employ their non-preferred norm, norm 2. Thus, a mutant C who adopted norm 2 as her personally-held norm and forgot norm 1 (effectively transitioning to state P_2), would increase her average coordination payoff. If we then give C individuals the option of transitioning to P_2 , we would find that $r_{C \rightarrow P_2} > 0$, leading to the loss of both cross-cultural competence and norm diversity, as the entire population transitions to state P_2 . This equilibrium is identical to that reached in the previous model.

However, what if there are inter-ethnic differences in bargaining power during coordination interactions? Bunce and McElreath (2018) showed that such power differences can be operationalized as inter-ethnic differences in coordination payoffs. The individual receiving the highest payoff in a coordination interaction has the least bargaining power. In the above example, define $\beta > 0$ as the coordination payoff received by each of two individuals with equal bargaining power who both hold the same preferred norm. Let P_2 individuals receive a lower benefit, $\beta - \theta$ (where $\theta > 0$), from coordination interactions with C individuals, meaning that P_2 individuals have greater bargaining power. Define the benefit to individual i received during a coordination interaction with individual j as $b_{i \leftarrow j}$. Under the above conditions: $b_{C \leftarrow C} = b_{P_2 \leftarrow P_2} = \beta$; $b_{C \leftarrow P_2} = \beta - \delta$; $b_{P_2 \leftarrow C} = \beta - \theta$. If the decrease in the inter-ethnic coordination payoff suffered by P_2 individuals, θ , is at least as large as the cost, δ , suffered by C individuals as a result of having to coordinate with P_2 individuals using C 's non-preferred norm 2, then it is plausible to imagine conditions in which $r_{C \rightarrow P_2} = 0$ and both cross-cultural competence and norm diversity are sustainable at equilibrium. Thus, in order for this path to cross-cultural competence to result in the long-term sustain-

ability of cultural norm diversity in the population, we must add a cost θ to inter-ethnic coordination suffered by only one of the two groups, which outweighs the cost δ to inter-ethnic coordination suffered by cross-culturally competent members of the other group. Equivalently, we could add an additional benefit to inter-ethnic interaction that accrues only to cross-culturally competent individuals suffering the coordination cost δ . If this additional benefit is at least as great as δ , a mixed equilibrium can be stable, resulting in sustainable norm diversity.

The following is one hypothetical illustration of such a situation. Following Bunce and McElreath (2018), imagine minority indigenous Matsigenka and majority Mestizo colonists interacting in the domain of education using either Matsigenka-typical or Mestizo-typical pedagogical norms (e.g., silent observation versus participatory questioning, respectively, on the part of students). Assume both ethnic groups are of equal size and student-teacher pairings are randomized. Possible coordination combinations include: Matsigenka teacher-Matsigenka student, Matsigenka teacher-Mestizo student, Mestizo teacher-Mestizo student, Mestizo teacher-Matsigenka student. Assume all Matsigenka students and teachers are cross-culturally competent, such that they can coordinate using either Matsigenka or Mestizo pedagogical norms, yet all personally hold (prefer) Matsigenka norms. Thus, when a Matsigenka coordinates with a Mestizo, the Matsigenka's coordination payoff is reduced by an amount $\delta > 0$, which represents the subjective cost of having to coordinate using a non-preferred norm. All Mestizo teachers and students prefer, and always coordinate using, Mestizo norms. Following Bunce and McElreath (2018), assume all students receive higher coordination payoffs than all teachers, and all teacher coordination payoffs are equal. As above, the coordination payoff to student i from instruction by teacher j is $b_{i \leftarrow j}$. Assume the following conditions: $b_{Mat \leftarrow Mat} = b_{Mes \leftarrow Mes} = \beta$; $b_{Mat \leftarrow Mes} = \beta - \delta$; $b_{Mes \leftarrow Mat} = \beta - \theta$. Such would be the case if, for instance, Matsigenka students value the knowledge imparted by both Matsigenka and Mestizo teachers equally (e.g., skills to survive in the forest and skills to earn money, respectively), yet Mestizo students only value the knowledge imparted by Mestizo teachers (e.g., if Mestizos rarely venture into the forest), and thus suffer an opportunity cost $\theta > 0$ when they are taught by Matsigenka teachers. If this opportunity cost to Mestizo students, θ , is greater than or equal to δ , the subjective cost suffered by Matsigenka students from having to coordinate with Mestizo teachers using the Mestizo pedagogical norm (these students' non-preferred norm), then cross-cultural competence and

Matsigenka pedagogical norms could be sustainable (in the context of this hypothetical example). The reason is because, given equal numbers of Matsigenka and Mestizos and randomized student-teacher pairings, Matsigenka students would receive higher average payoffs than would Mestizo students across all coordination interactions (intra-ethnic interactions: β ; inter-ethnic interactions: $\beta - \delta > \beta - \theta$). Thus, even if it were possible for Matsigenka students to adopt the Mestizo pedagogical norm as their personal norm and forget the Matsigenka norm, effectively converting themselves into Mestizos, they would not do so, as such a transition would entail a decrease in average coordination payoffs.

This discussion has sketched hypothetical models to argue that the two predictions in the main text are plausible in theory. A formal analysis of more sophisticated models is required to investigate whether these predictions are supported after relaxing some of the more unrealistic constraints imposed above for the sake of simplicity.

Appendix C. Supplementary Figures and Tables

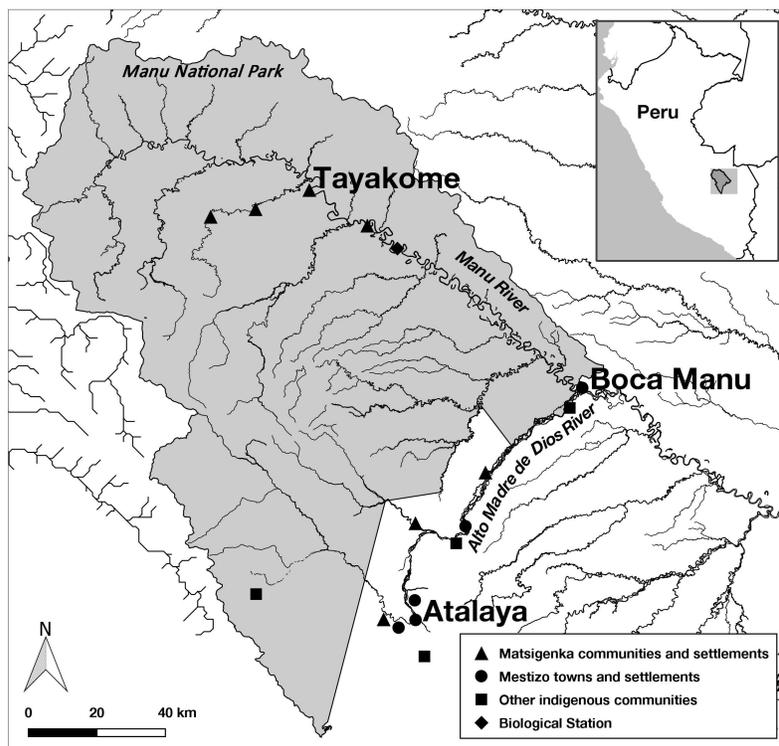


Figure S1: Map of study communities. Map of the Matsigenka study community of Tayakome, and the Mestizo study communities of Boca Manu and Atalaya, as well as the locations of other nearby settlements in and around Manu National Park (in gray), Peru. Assistance with map creation was provided by Ronny Barr.

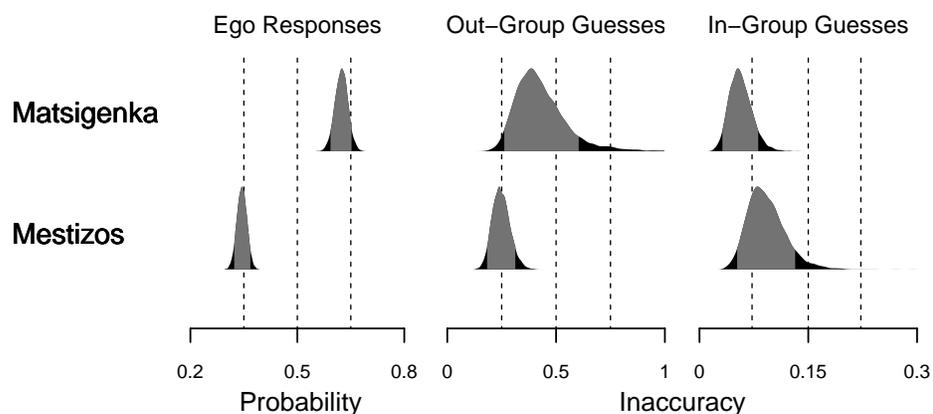


Figure S2: Personally-held norms and inaccuracy of in-group and out-group guesses. Left column: distributions of mean probabilities of a positive Personal Norm (ego) response across all 14 vignette questions, by ethnicity. Center column: distributions of mean (across questions) Kullback-Leibler (K-L) divergence between the probability that an average out-group member gave the positive ego response and the average probability of guessing that an average out-group member gave the positive ego response: $D_{KL}(\text{out-group ego}||\text{guess about out-group})$. This represents the mean inaccuracy of out-group guesses, by ethnicity. Right column: distributions of mean K-L divergence between the probability that an average in-group member gave the positive ego response and the average probability of guessing that an average in-group member gave the positive ego response. This represents the mean inaccuracy of in-group guesses, by ethnicity. Relative cross-cultural competence is defined as lower inaccuracy of out-group guesses and no greater inaccuracy of in-group guesses. Divergence and contrasts of ego responses, out-group inaccuracy, and in-group inaccuracy for Matsigenka and Mestizo inter-ethnic experience types are shown in Figures S12-S15. Distributions of means are derived from posterior predictions of the IRT model m4 shown in Tables S1 and S2. 90% highest posterior density intervals (HPDI) are shown in grey. Vertical lines are drawn for visual guidance. Note that these are posterior distributions of means, not distributions of interviewee responses. There is generally more uncertainty about the counter-factual means in panels A and B of Figure 3 than there is about the overall means shown here (compare variances). Similarly, the mean of the counter-factual mean distributions in panels A and B of Figure 3 need not coincide with the overall mean distribution for a given ethnicity in this figure.

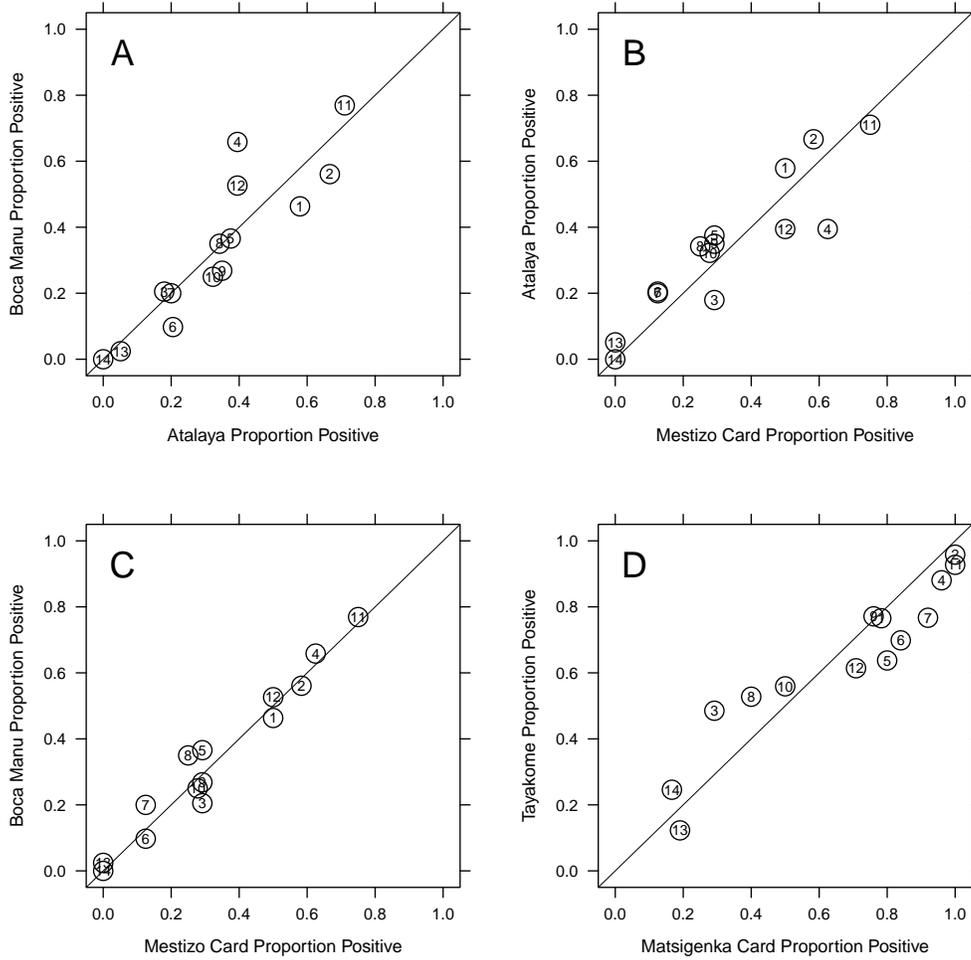


Figure S3: Raw proportions of personally-held norms. Proportions of Boca Manu Mestizos (n=41), Atalaya Mestizos (n=40), Tayakome Matsigenka (n=73), the sample of Mestizo-community respondents represented by cards (n=24), and the sample of Tayakome respondents represented by cards (n=25) giving the positive response to the fourteen vignette questions in Table 1. All proportions are for Personal Norms (ego). The diagonal is the line of equal proportions. The vertical (or horizontal) distance from a point to the diagonal is the difference in proportion between groups represented on the axes. A) Mestizos in Boca Manu and Atalaya. B) Atalaya Mestizos and the sample of Mestizo-community cards C) Boca Manu Mestizos and the sample of Mestizo-community cards. D) Tayakome Matsigenka and the sample of Tayakome cards. Note that, in all figures, proportions are relatively similar, i.e., close to the diagonal (compare to Figure 2).

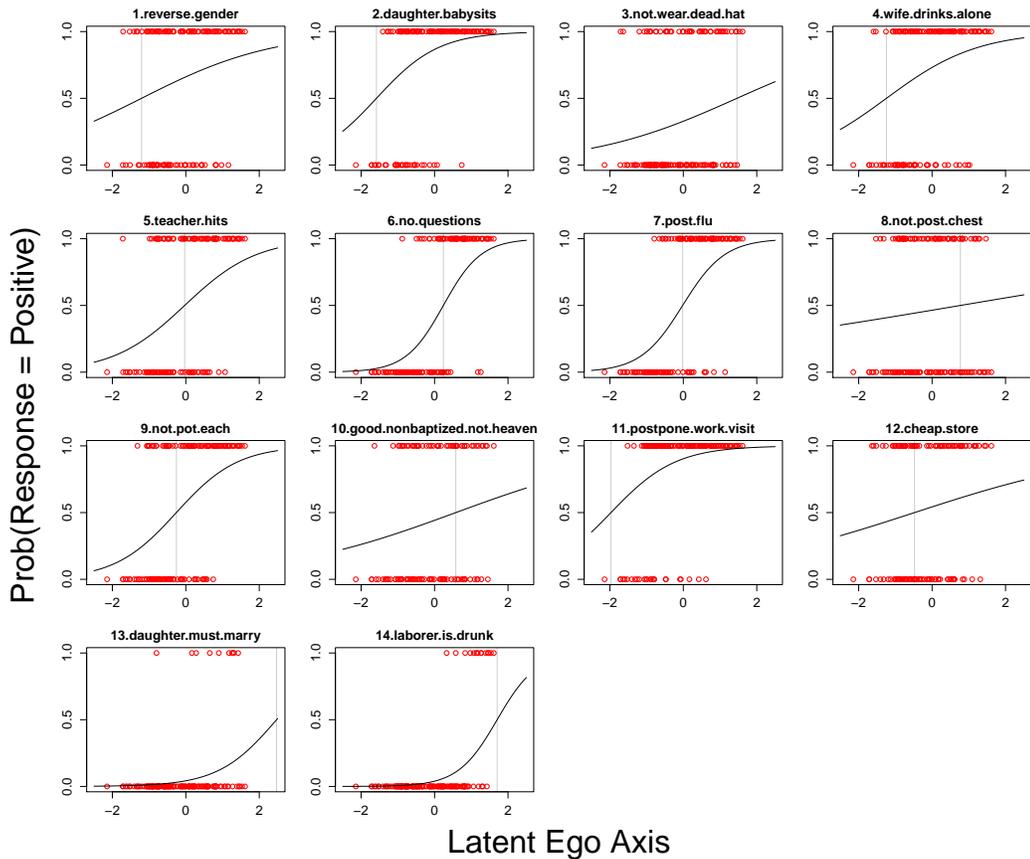


Figure S4: IRT question characteristics for personally-held norms. Logistic functions generated from the mean posterior location (β_k , x-value of vertical grey line) and discrimination (γ_k , slope of the function at intersection with vertical line) of each of the 14 vignette questions on the latent ego axis (target $t = 1$), derived from an IRT model with a random effect for individual and no fixed effect predictors (m1 in Tables S1 and S2 below). Questions with higher absolute value discrimination contribute more to the construction of the latent axis. The discriminations of questions 8 and 12 are only marginally distinguishable from zero (Figure S7). Discriminations that are distinguishable from zero suggest that those questions map well onto a single dimension (Jackman, 2001). The posterior mean location of each individual on the latent axis is plotted in red. A person's y-value of 1 or 0 corresponds with a positive or negative response, respectively, to the given question (defined in Table 1).

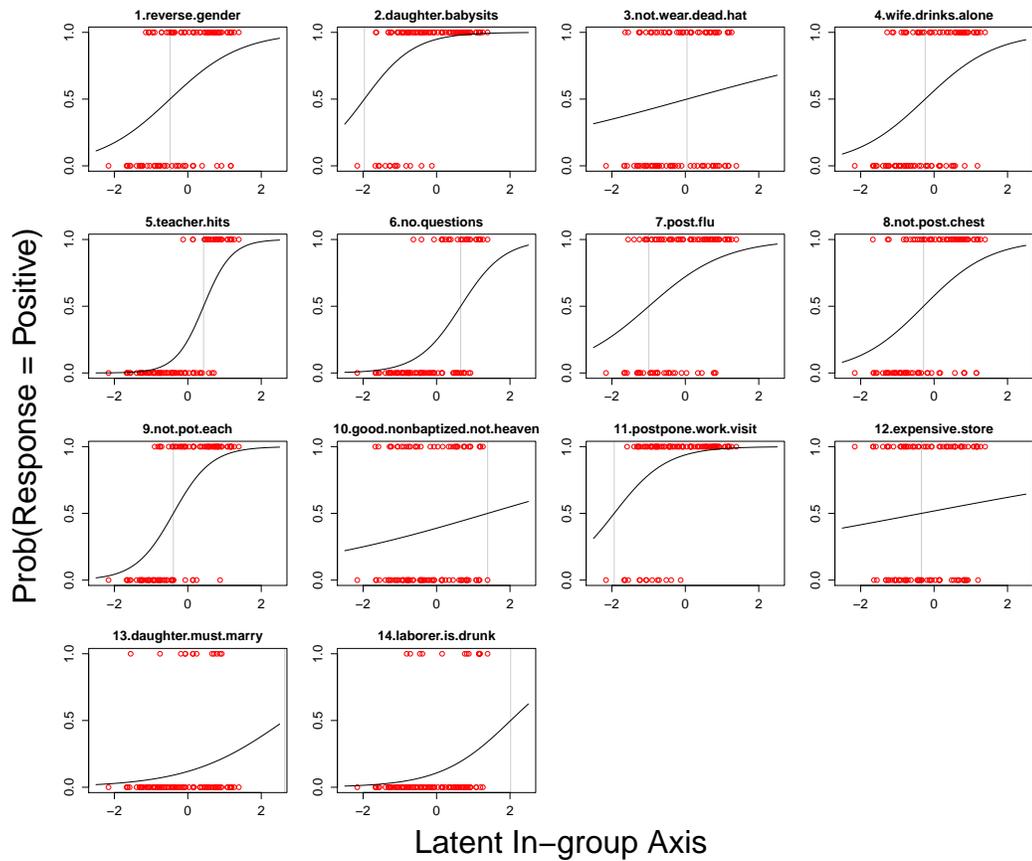


Figure S5: IRT question characteristics for in-group guesses. Analogous to Figure S4 for in-group guesses (target $t = 2$). Note that the coding of question 12 is reversed from that for the latent ego axis. The discriminations (slope at the inflection point) of questions 3 and 12 are only marginally distinguishable from 0 (Figure S7).

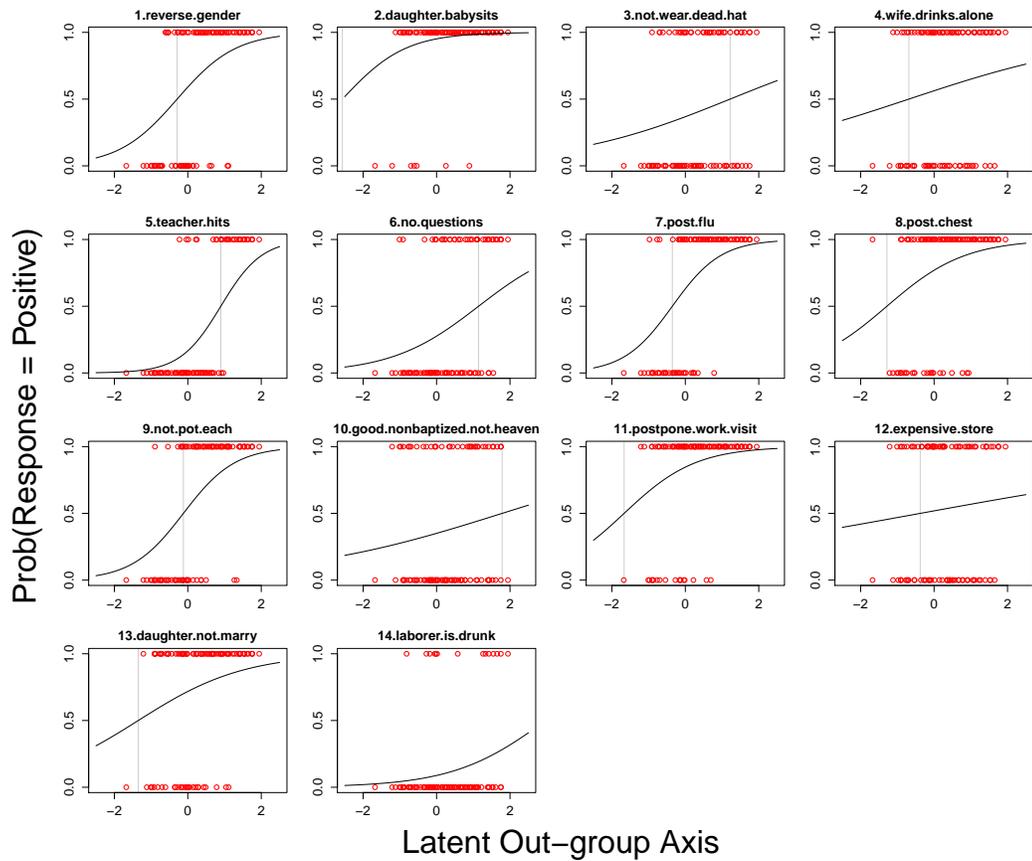


Figure S6: IRT question characteristics for out-group guesses. Analogous to Figure S4 for out-group guesses (target $t = 3$). Note that the coding of questions 8, 12, and 13 is reversed from that for the latent ego axis. The discriminations (slope at the inflection point) of questions 4 and 12 are only marginally distinguishable from 0 (Figure S7).

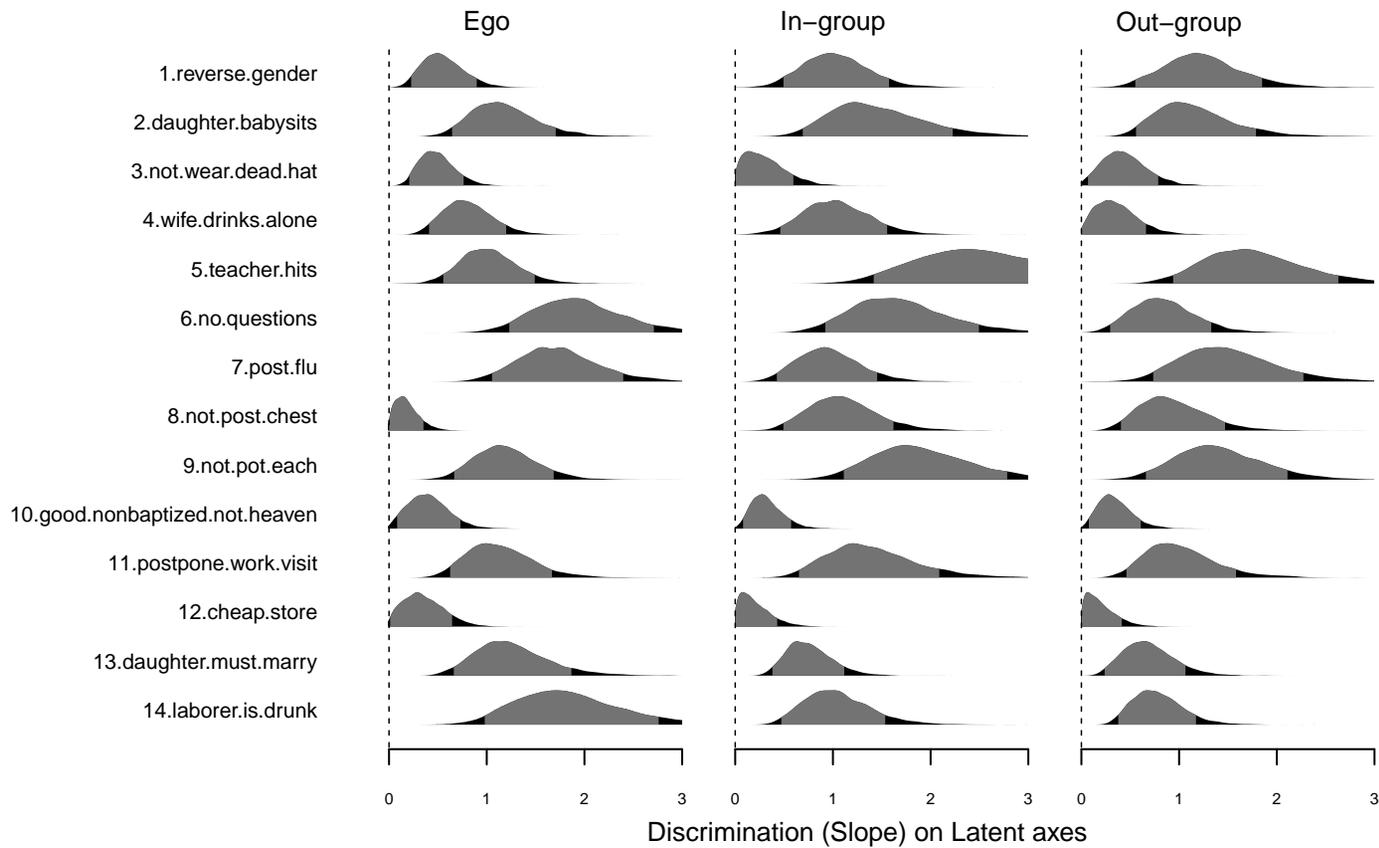


Figure S7: Question discrimination estimates. Posterior probability density estimates for discrimination parameters (γ) for each question k on each latent target axis t (ego, in-group, and out-group) from an IRT model with a random effect for individual and no fixed effect predictors (m1 in Tables S1 and S2 below). 90% highest posterior density intervals (HPDI) are shown in grey. Note that all discrimination estimates are markedly non-zero, with the exception of those for questions 8 and 12 on the ego axis, 3 and 12 on the in-group axis, and 4 and 12 on the out-group axis, which are marginally non-zero. This suggests that most questions contribute substantially to the construction of the latent axes, and supports the decision to limit analysis to a single latent dimension (Jackman, 2001). The coding of question 12 on the in-group axis, and questions 8, 12, and 13 on the out-group axis, are reversed from that for the ego axis.

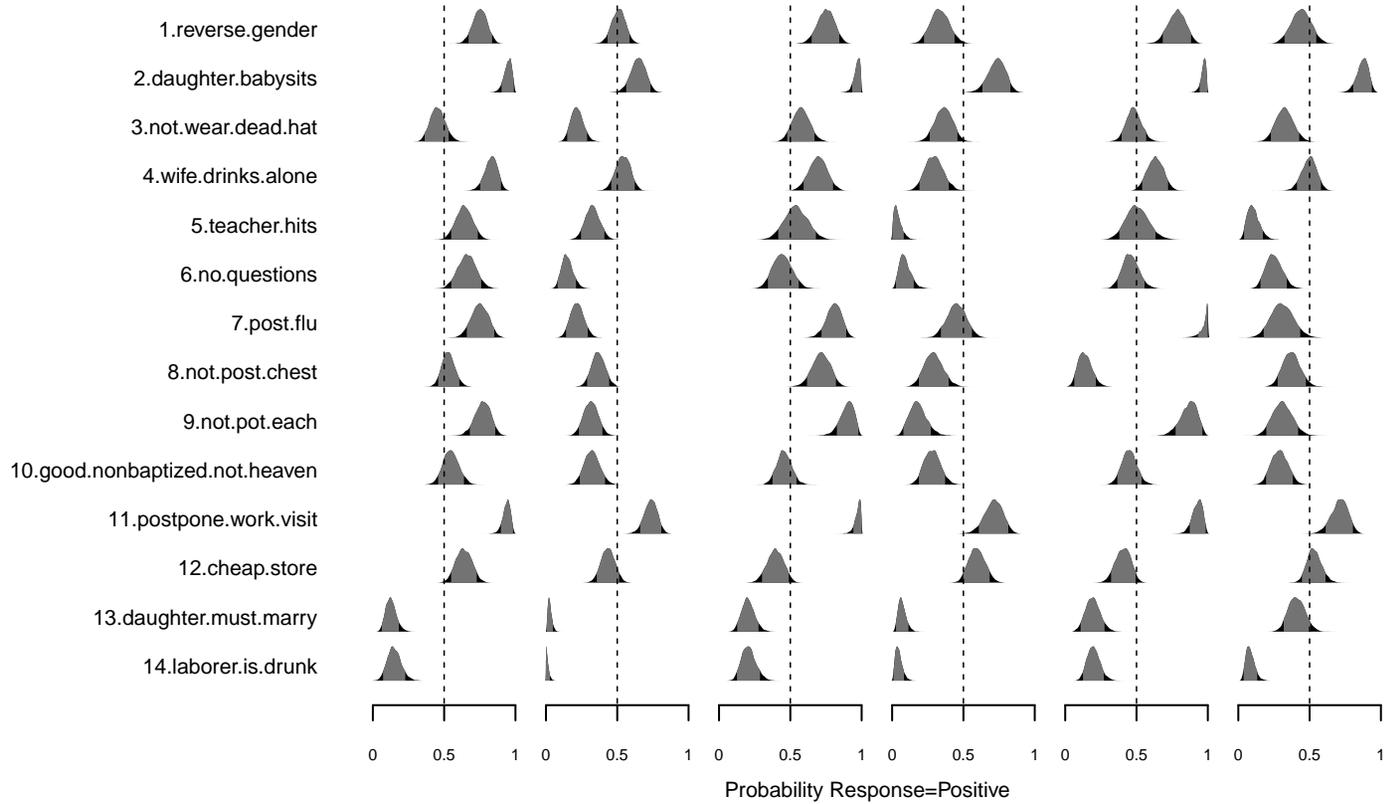


Figure S8: Posterior distributions of response probabilities. Distributions of probabilities of giving the positive response for each of the 14 vignette questions, by ethnicity and target (ego, in-group, and out-group), derived from posterior predictions of the IRT model m4, shown in Tables S1 and S2. 90% highest posterior density intervals (HPDI) are shown in grey. Vertical lines at 0.5 are provided for visual guidance. Coding of questions has been standardized across targets. Note that, on average, for most questions, for all three targets, Matsigenka and Mestizos tended to answer differently.

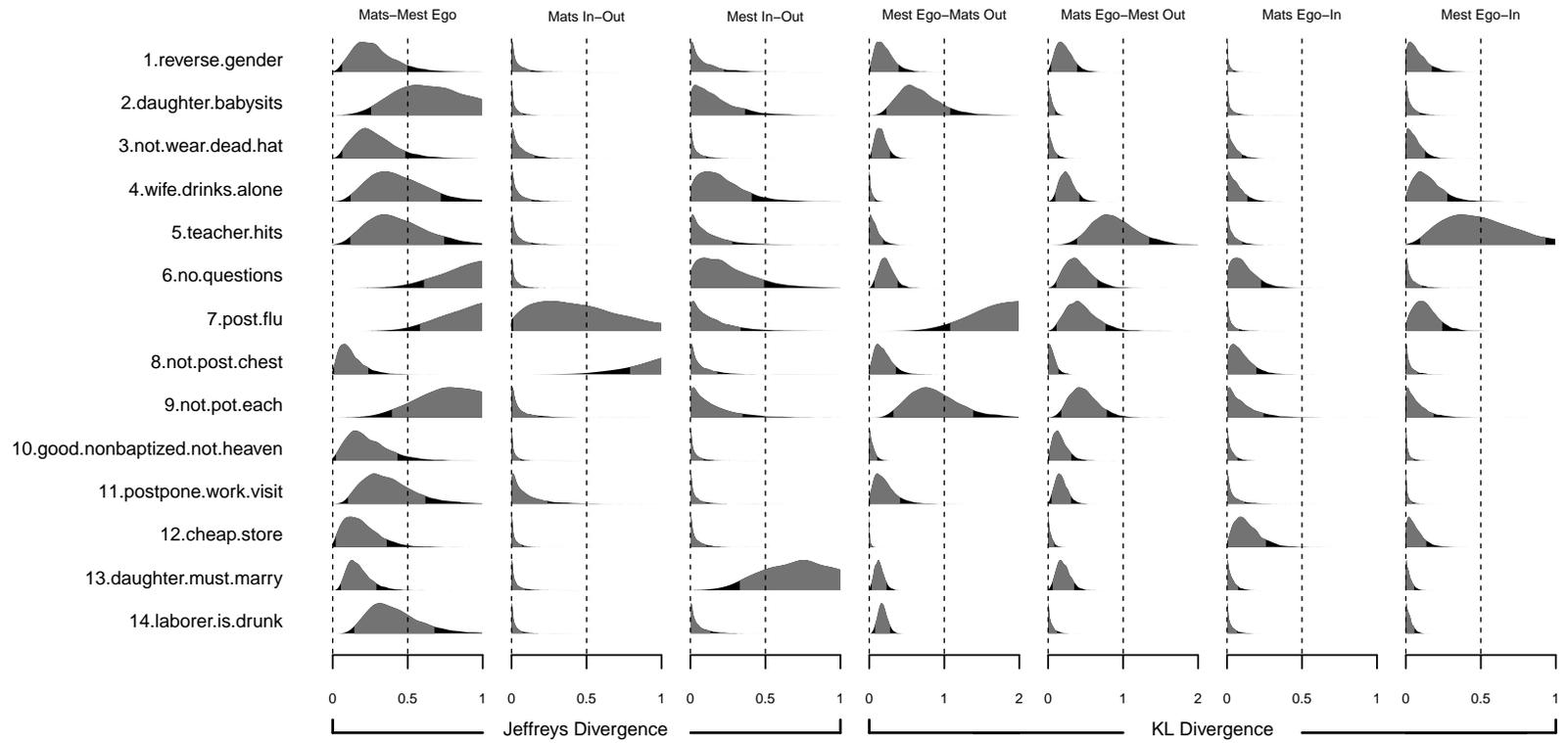


Figure S9: (Caption next page.)

Figure S9: (Previous page) Posterior distributions of response divergences. Distributions of divergences among probability distributions for the responses of average Matsigenka and Mestizos for each of the 14 vignette questions. First column: Jeffreys divergence (Kullback and Leibler, 1951; Jeffreys, 1948) among the probabilities that average Matsigenka and Mestizos gave the positive ego response for each question (Mats Ego and Mest Ego, respectively). This represents how differently Matsigenka and Mestizos tended to answer each question. Second column: Jeffreys divergence between the probability that average Matsigenka guessed that average Matsigenka gave the positive ego response (Mats In) and the probability that average Matsigenka guessed that average Mestizos gave the positive ego response (Mats Out). This represents how differently Matsigenka perceive themselves to be from Mestizos. Third column: Jeffreys divergence between the probability that average Mestizos guessed that average Mestizos gave the positive ego response (Mest In) and the probability that average Mestizos guessed that average Matsigenka gave the positive ego response (Mest Out). This represents how differently Mestizos perceive themselves to be from Matsigenka. Fourth column: Kullback-Leiber (K-L) divergence (Kullback and Leibler, 1951; McElreath, 2016) between the probability that the average Mestizo gave the positive ego response (Mest Ego, the K-L "target") and the probability that the average Matsigenka guessed that the average Mestizo gave the positive ego response (Mats Out, the K-L "approximation"). This represents the inaccuracy of Matsigenka out-group guesses. Fifth column: K-L divergence between Matsigenka ego responses (Mats Ego, K-L target) and Mestizo out-group guesses (Mest Out, K-L approximation). This represents the inaccuracy of Mestizo out-group guesses. Sixth column: K-L divergence between Matsigenka ego responses (Mats Ego, K-L target) and Matsigenka in-group guesses (Mats In, K-L approximation). This represents the inaccuracy of Matsigenka in-group guesses. Seventh column: K-L divergence between Mestizo ego responses (Mest Ego, K-L target) and Mestizo in-group guesses (Mest In, K-L approximation). This represents the inaccuracy of Mestizo in-group guesses. Distributions are derived from posterior predictions of the IRT model m4, shown in Tables S1 and S2. 90% highest posterior density intervals (HPDI) are shown in grey. Vertical lines at 0 are provided for visual guidance. Coding of questions has been standardized across targets. Note that Matsigenka tended to believe that Mestizos answered question 8 very differently from how they believed their co-ethnics answered the question (column 2). For Mestizos, the same is true for question 13 (column 3). This indicates that interviewees understood the nature of the guessing interviews. The inaccuracy of Matsigenka out-group guesses is driven primarily by questions 2, 7, and 9 (column 4), and for Mestizos by questions 5, 6, 7, and 9 (column 5). The inaccuracy of Matsigenka in-group guesses is driven primarily by questions 6, 8, and 12 (column 6), and for Mestizos by questions 4, 5, and 7 (column 7).

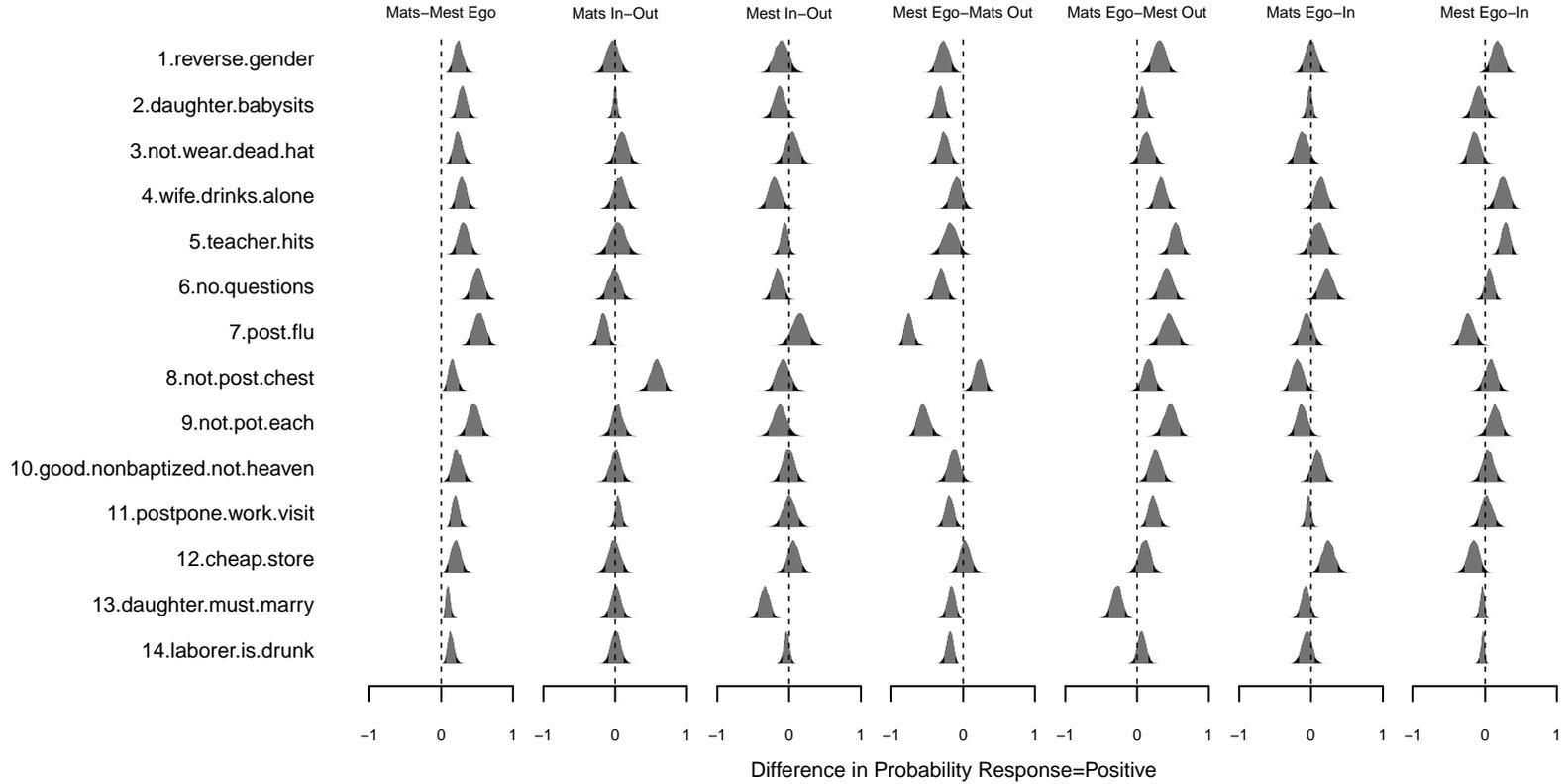


Figure S10: Posterior distributions of response contrasts. Distributions of the contrasts (differences) in probabilities of giving the positive response for each of the 14 vignette questions. Column headings and HPDI match those of Figure S9. Unlike divergences, simple subtraction preserves the direction of the differences between probability distributions. Note that Matsigenka and Mestizos generally believed that the out-group and the in-group answered the vignette questions in similar ways, with the exception of question 8 for Matsigenka (column 2) and question 13 for Mestizos (column 3). This corresponds with the fact that out-group inaccuracies of the two groups broadly mirror each other (columns 4 and 5), except for questions 8 and 13. Thus, the model predicts that Matsigenka and Mestizos tend to make similarly inaccurate guesses about the out-group for most questions, guessing that the out-group and the in-group answered in the same way, when in fact this was generally not the case (column 1).

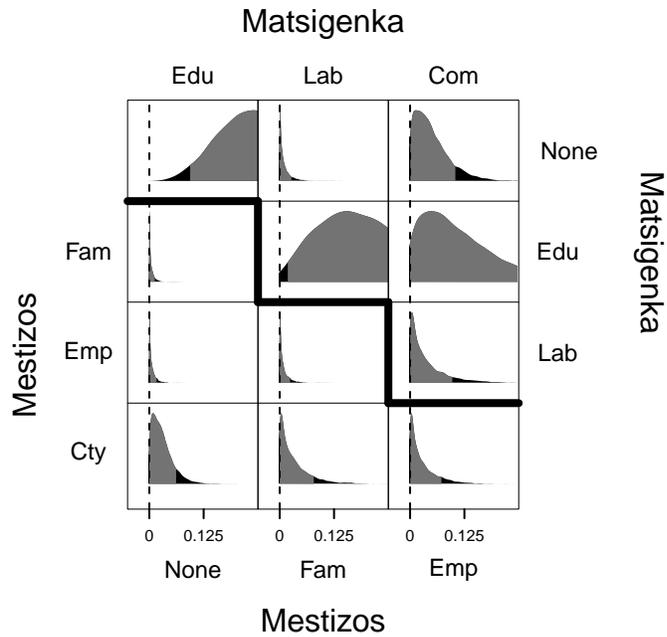


Figure S11: Distributions of divergence for personally-held norms. Distributions of mean (across questions) Jeffreys divergence between the probabilities of giving the positive ego response, for Matsigenka and Mestizos with various types of counter-factual inter-ethnic experience. This corresponds to column 1 of Fig 3. Matsigenka divergences are derived from posterior predictions of response probabilities from the IRT model m11, and Mestizo divergences are derived from model m19 (Tables S1 and S2). 90% highest posterior density intervals (HPDI) are shown in grey. Vertical lines at 0 are provided for visual guidance. Inter-ethnic experience types are: Matsigenka who have experience with Mestizos in the domains of education (Edu), wage labor worker (Lab), commerce (Com), or none of these domains (None); Mestizos who have experience with Matsigenka in the domains of family (Fam), wage labor employer (Emp), community participation (Cty), or none of these domains (see Section Appendix A.3.3). Note that, for Matsigenka with education experience, the average probability of giving a positive response tends to diverge greatly from that of their co-ethnics (upper triangle of matrix). For Mestizos who lived in a Matsigenka community, the average probability of giving the positive response tends to diverge slightly from that of their co-ethnics (lower triangle of matrix).

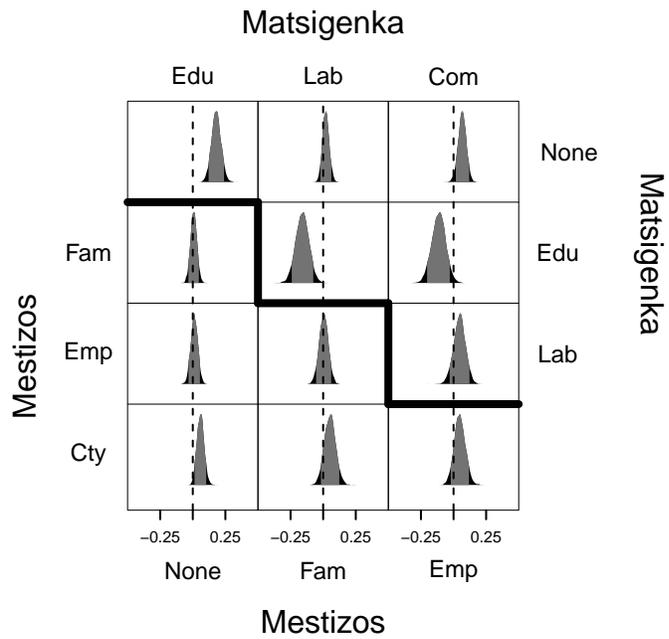


Figure S12: Distributions of contrasts for personally-held norms. Distributions of mean (across questions) contrasts between the probabilities of giving the positive ego response, for Matsigenka and Mestizos with various types of counter-factual inter-ethnic experience. Inter-ethnic experience labels and HPDI match those of Figure S11. All contrasts are computed as row minus column. Unlike divergences, simple subtraction preserves the direction of the differences between probability distributions. Trends match those of Figure S11.

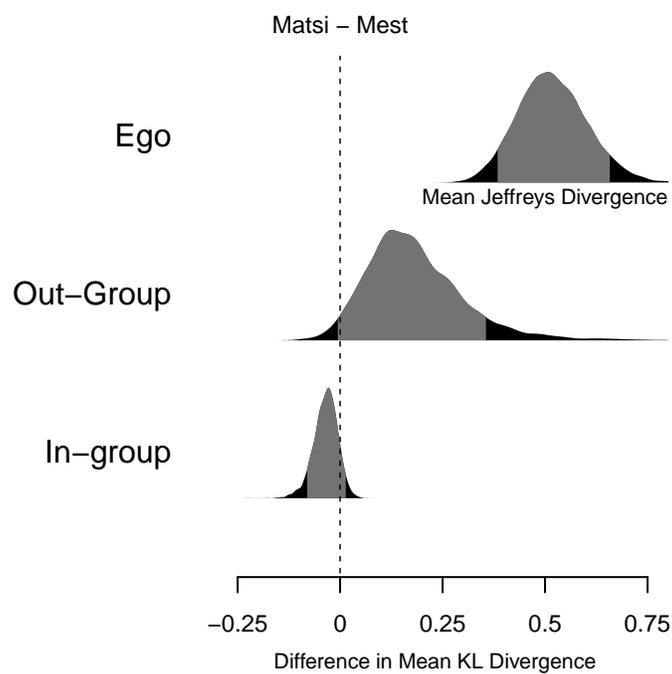


Figure S13: Ethnicity-level distributions of response divergence. Distributions of the mean (across questions) Jeffreys divergence between the probabilities than an average Matsigenka and an average Mestizos gave the positive ego response (top), and contrasts of mean (across questions) inaccuracy of out-group guesses (i.e., K-L divergence between out-group ego response and guess about out-group ego response) and in-group guesses between Matsigenka and Mestizos. Contrasts (middle and bottom) are calculated as mean Matsigenka K-L divergence minus mean Mestizo K-L divergence. This corresponds with columns 2 and 3 of Fig 3. Note that, on average, the probabilities of Matsigenka and Mestizo guesses tend to diverge (top), and Matsigenka tend to have more inaccurate out-group guesses (middle), but less inaccurate in-group guesses (bottom) than Mestizos.

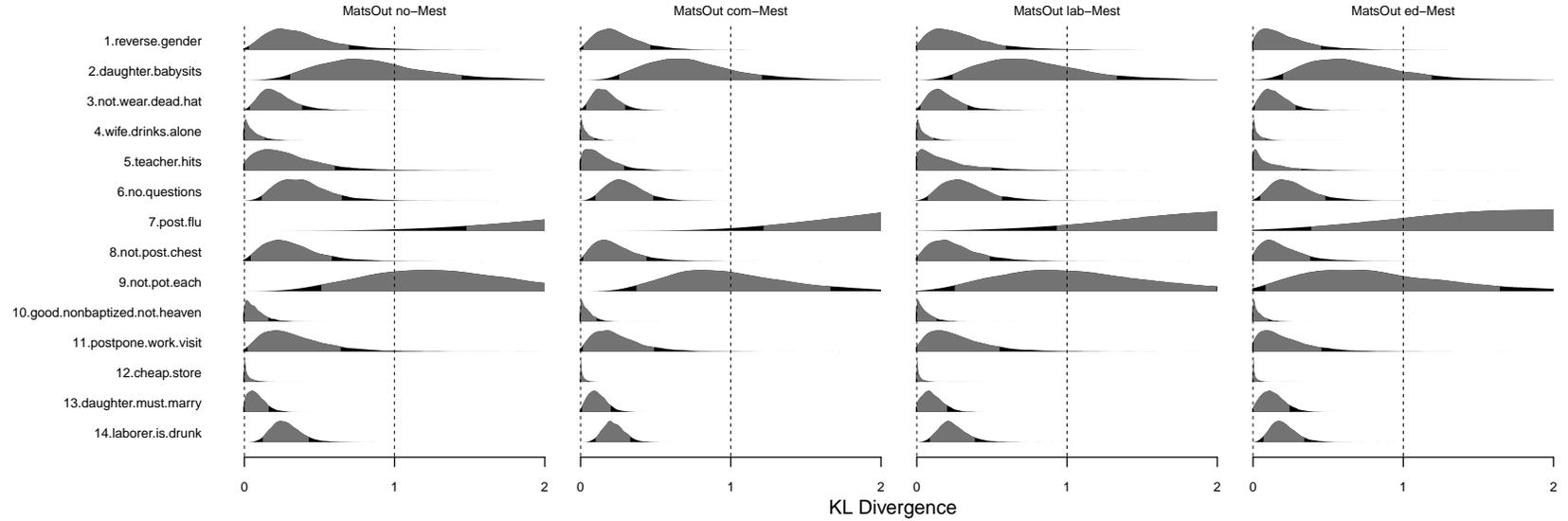


Figure S14: Distributions of Matsigenka out-group guess inaccuracy. Distributions of Kullback-Leibler (K-L) divergence between the probability that an average Mestizo gives the positive ego response (K-L "target") and the probabilities that average Matsigenka with various types of counter-factual inter-ethnic experience guess that an average Mestizo gives the positive ego response (K-L "approximation"). These represent the inaccuracies of Matsigenka out-group guesses for each of the 14 vignette questions. First column: Matsigenka with no inter-ethnic experience. Second column: Matsigenka with commerce experience. Third column: Matsigenka with wage labor worker experience. Fourth column: Matsigenka with education experience (see Section [Appendix A.3.3](#)). K-L divergences are computed using posterior probabilities from the IRT model m11, shown in Table S1. 90% highest posterior density intervals (HPDI) are shown in grey. Vertical lines at 0 and 0.5 are provided for visual guidance. Coding of questions has been standardized across targets. Note that Matsigenka with inter-ethnic education experience (column 4) generally have lower inaccuracy than Matsigenka without inter-ethnic experience (column 1), particularly with regard to out-group guesses for questions 5, 7, and 9 (see Table 1).

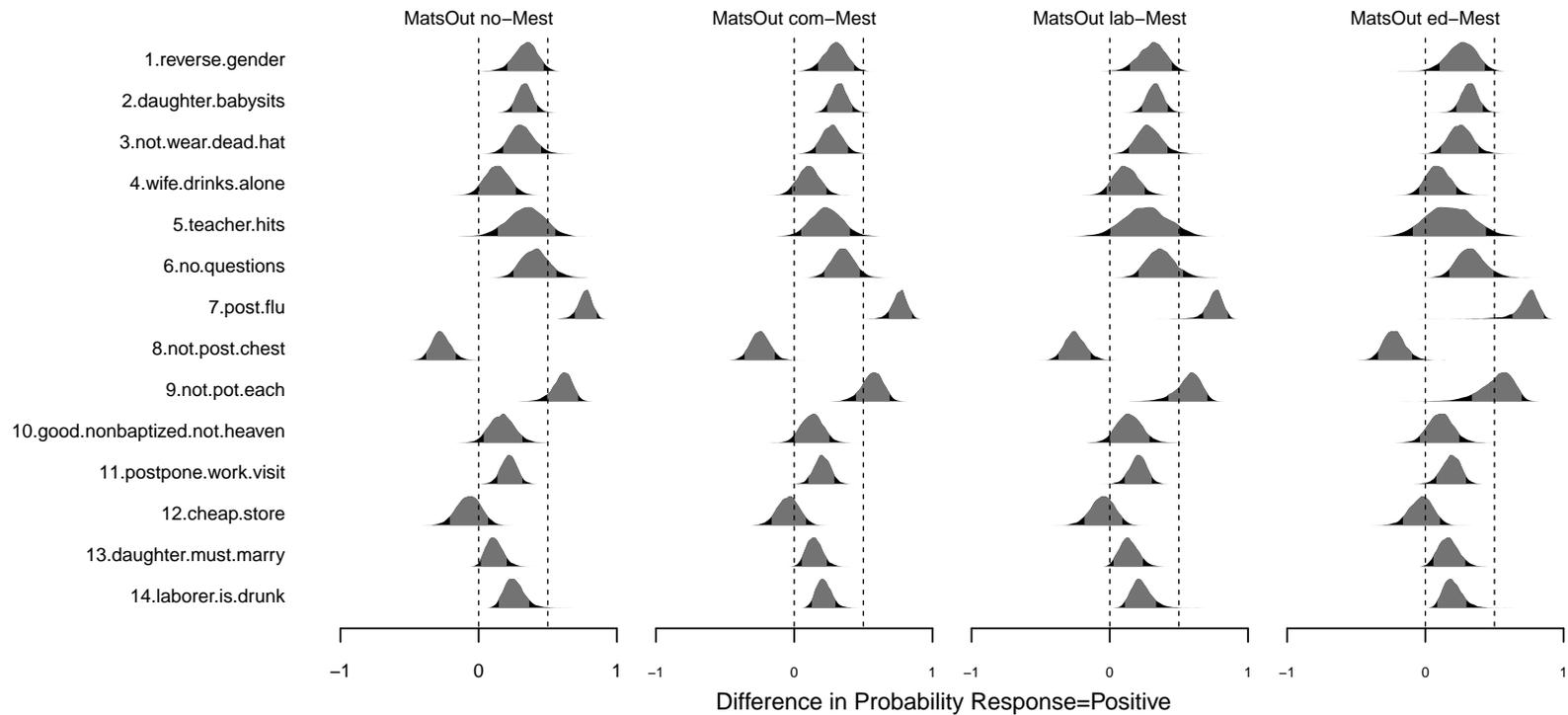


Figure S15: Distributions of Matsigenka out-group guess contrasts. Distributions of the contrasts (differences) in probabilities of giving the positive response for each of the 14 vignette questions. Column headings and HPDI match those of Figure S14. Unlike divergences, simple subtraction preserves the direction of the differences between probability distributions. All contrasts are computed as Matsigenka out-group guess minus Mestizo ego response. Trends match those of Figure S14.

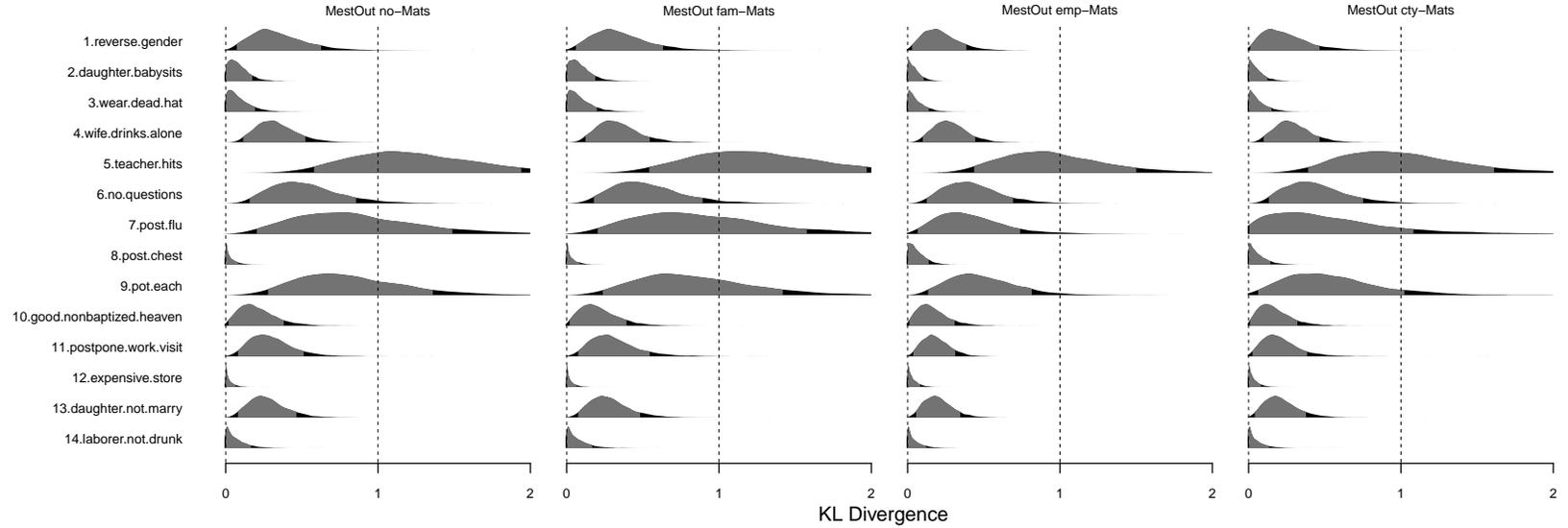


Figure S16: Distributions of Mestizo out-group guess inaccuracy. Distributions of Kullback-Leibler (K-L) divergence between the probability that an average Matsigenka gives the positive ego response (K-L "target") and the probabilities that average Mestizos with various types of counter-factual inter-ethnic experience guess that an average Matsigenka gives the positive ego response (K-L "approximation"). These represent the inaccuracies of Mestizo out-group guesses for each of the 14 vignette questions. First column: Mestizos with no inter-ethnic experience. Second column: Mestizos with indigenous family experience. Third column: Mestizos with wage labor employer experience. Fourth column: Mestizos with indigenous community experience (see Section [Appendix A.3.3](#)). K-L divergences are computed using posterior probabilities from the IRT model m19, shown in Table [S2](#). 90% highest posterior density intervals (HPDI) are shown in grey. Vertical lines at 0 and 0.5 are provided for visual guidance. Coding of questions has been standardized across targets. Note that Mestizos with inter-ethnic employer and community experience (columns 3 and 4) generally have lower inaccuracy than Mestizos with no inter-ethnic experience and family experience (columns 1 and 2), particularly with regard to out-group guesses for questions 5, 7, and 9 (see Table [1](#)).

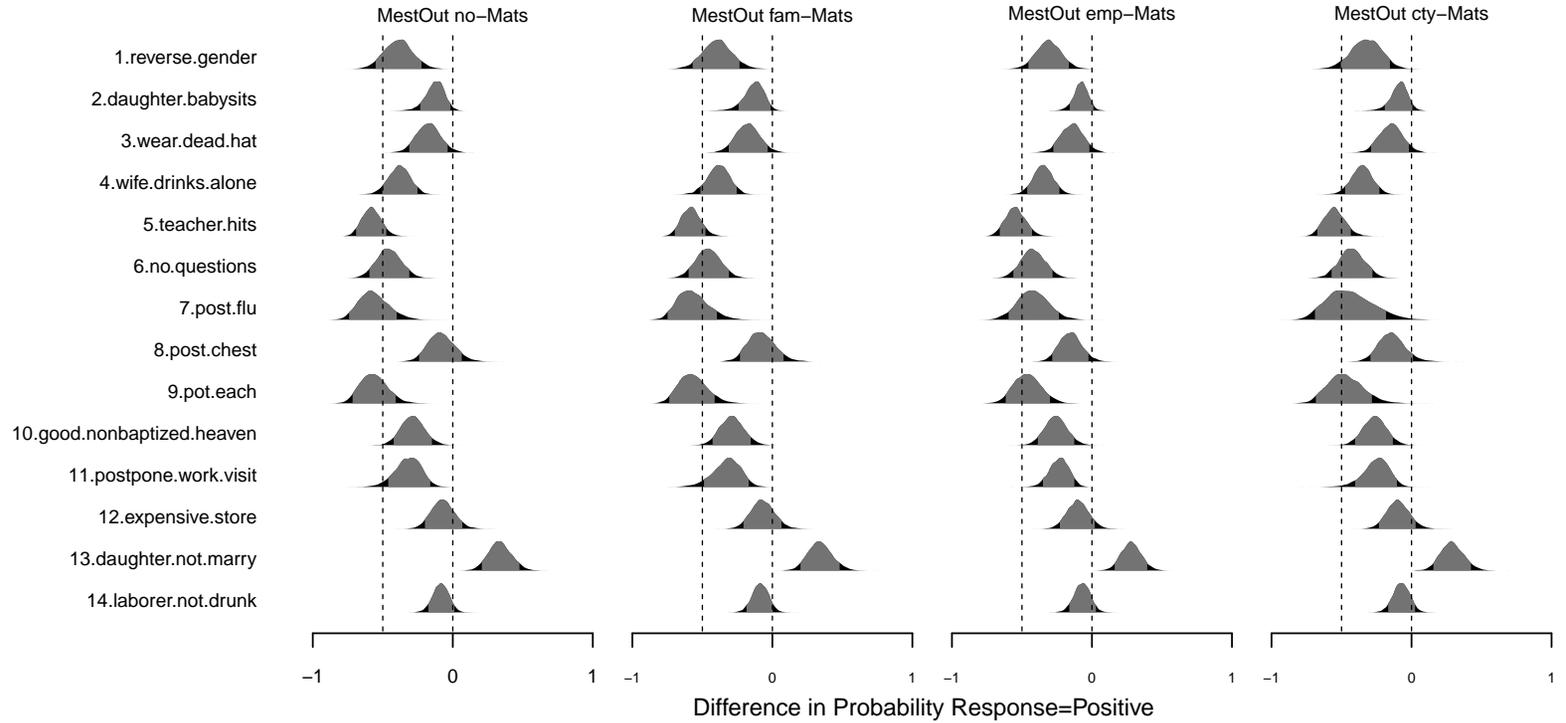


Figure S17: Distributions of Mestizo out-group guess contrasts. Distributions of the contrasts (differences) in probabilities of giving the positive response for each of the 14 vignette questions. Column headings and HPDI match those of Figure S16. Unlike divergences, simple subtraction preserves the direction of the differences between probability distributions. All contrasts are computed as Mestizo out-group guess minus Matsigenka ego response. Trends match those of Figure S16.

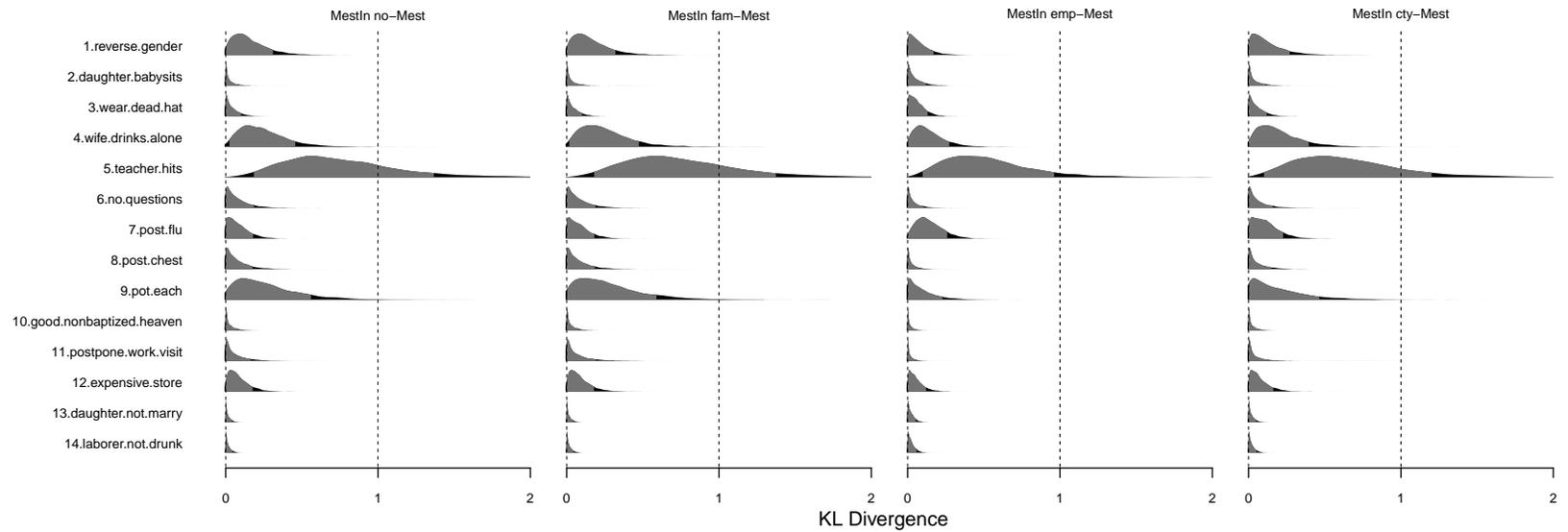


Figure S18: Distributions of Mestizo in-group guess inaccuracy. Distributions of Kullback-Leibler (K-L) divergence between the probability that an average Mestizo gives the positive ego response (K-L "target") and the probabilities that average Mestizos with various types of counter-factual inter-ethnic experience guess that an average Mestizo gives the positive ego response (K-L "approximation"). These represent the inaccuracies of Mestizo in-group guesses for each of the 14 vignette questions. Column headings match those of Figure S16. K-L divergences are computed using posterior probabilities from the IRT model m19, shown in Table S2. 90% highest posterior density intervals (HPDI) are shown in grey. Vertical lines at 0 and 0.5 are provided for visual guidance. Coding of questions has been standardized across targets. Note that Mestizos with inter-ethnic employer experience (column 3) have lower inaccuracy than Mestizos with no inter-ethnic experience and family experience (columns 1 and 2), particularly with regard to in-group guesses for questions 8, 9, and 11 (see Table 1).

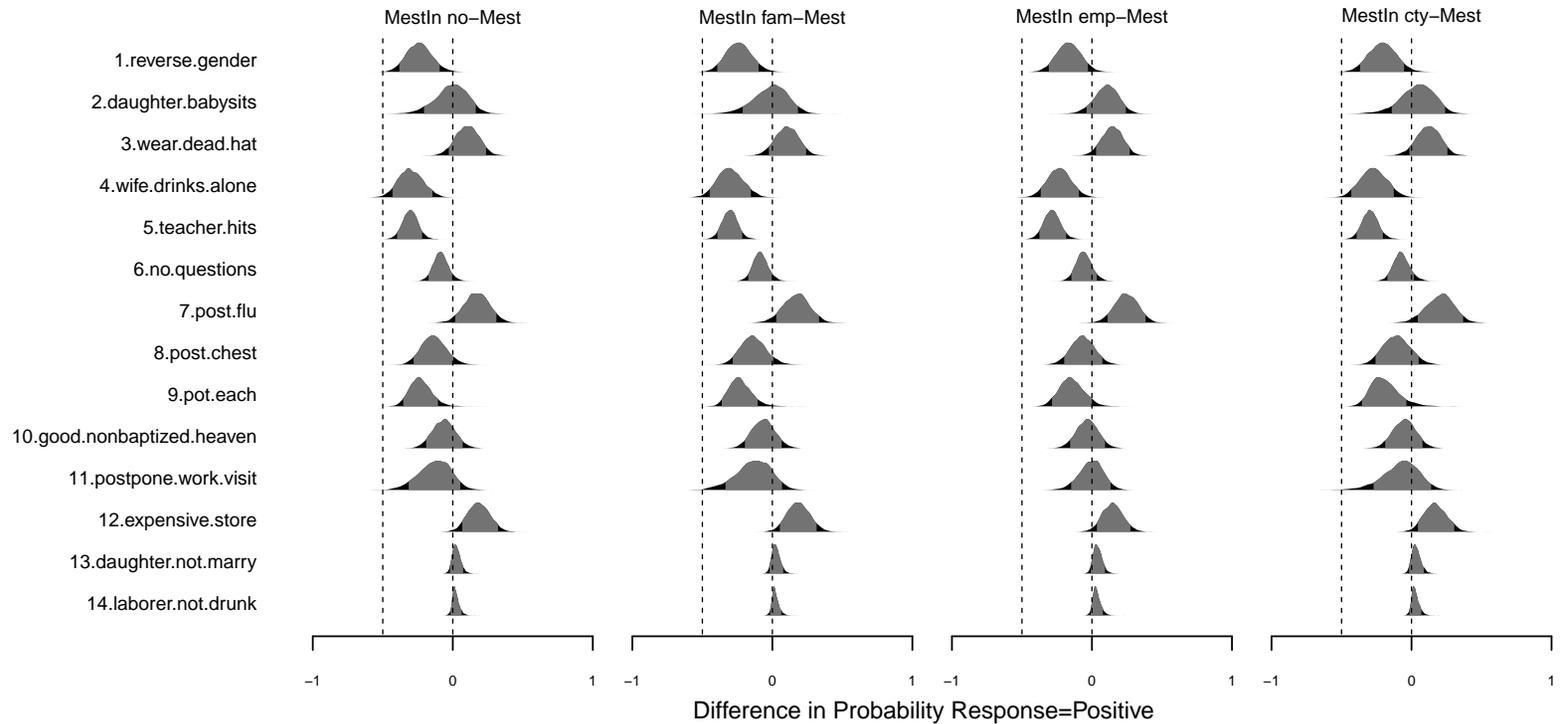


Figure S19: Distributions of Mestizo in-group guess contrasts. Distributions of the contrasts (differences) in probabilities of giving the positive response for each of the 14 vignette questions. Column headings and HPDI match those of Figure S18. Unlike divergences, simple subtraction preserves the direction of the differences between probability distributions. All contrasts are computed as Mestizo in-group guess minus Mestizo ego response. Trends match those of Figure S18.

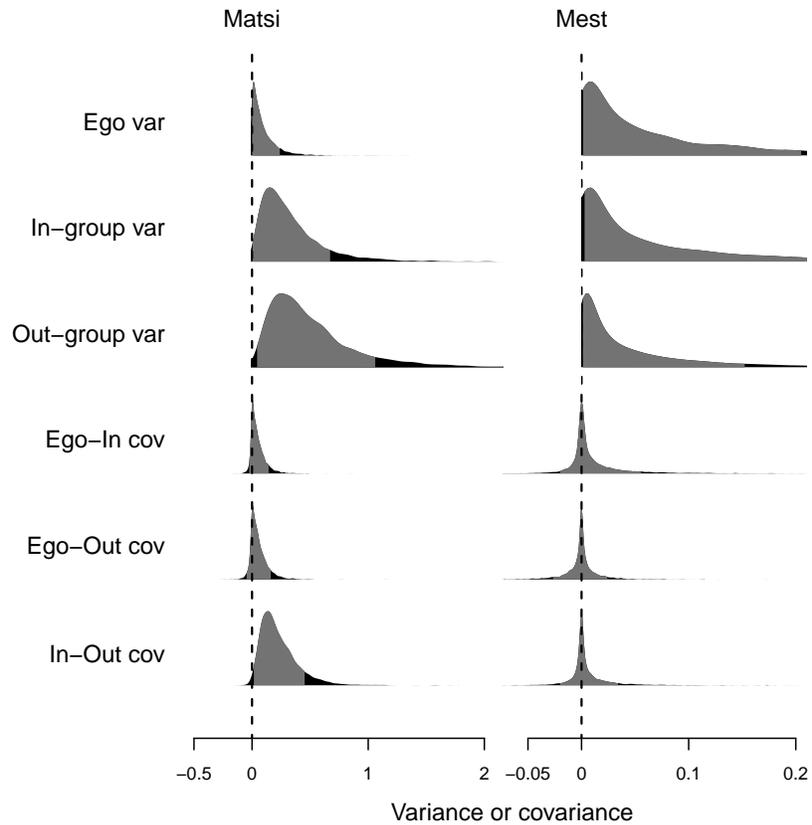


Figure S20: Variance and covariance among personally-held norms and guesses. Residual variance in individual location on the three latent target axes (ego, in-group, and out-group), and covariances in individual locations between target axes, derived from posterior predictions for the \mathbf{S} matrices in Eq A.7. The first column comprises the components of $\mathbf{S}_{Matsigenka}$ from model m11, and second column comprises the components of $\mathbf{S}_{Mestizo}$ from model m19 (Tables S1 and S2). 90% highest posterior density intervals (HPDI) are shown in grey. Vertical lines at 0 are provided for visual guidance. Note that the scale of the axis for Mestizo variance and covariance is an order of magnitude smaller than that for Matsigenka.

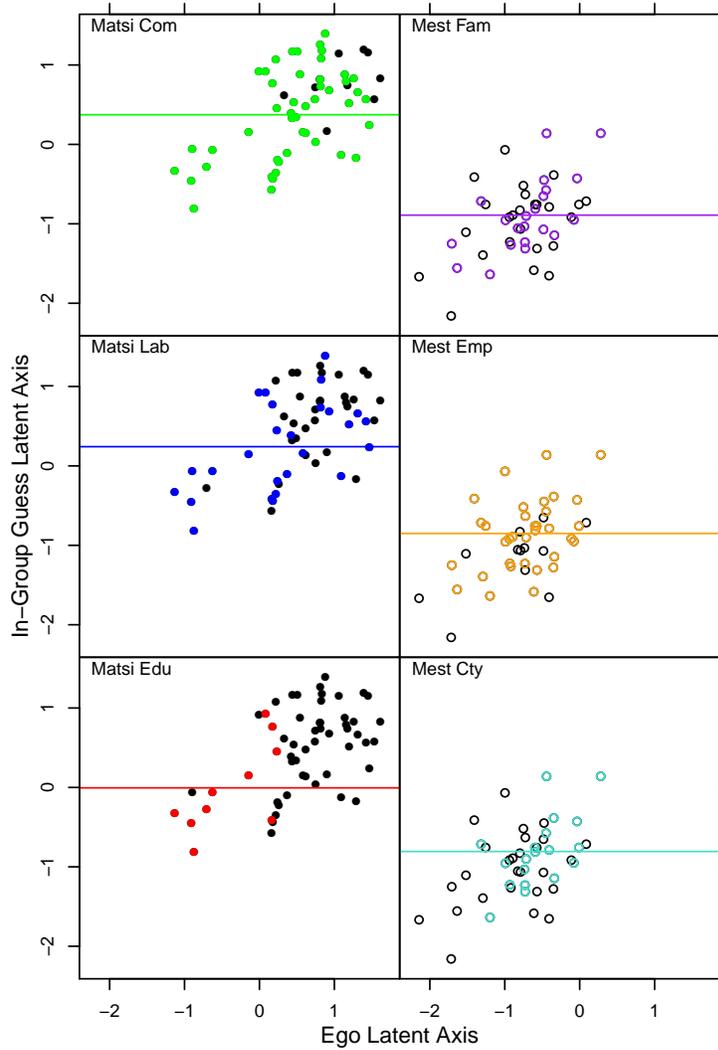


Figure S21: Individual locations on ego and in-group latent axes. Individual locations on the latent in-group axis (y) against individual locations on the latent ego axis (x) for Matsigenka (first column) and Mestizos (second column) by different types of inter-ethnic experience (labels follow Figure S11). Points are means for each individual derived from posterior predictions of model m1, with no estimated covariance among individual locations across target axes and no inter-ethnic experience predictors (Tables S1 and S2). Horizontal lines are drawn at the mean location on the in-group axis for individuals with the given inter-ethnic experience type. Note the positive overall covariance, and residual covariance within each experience type for the Matsigenka.

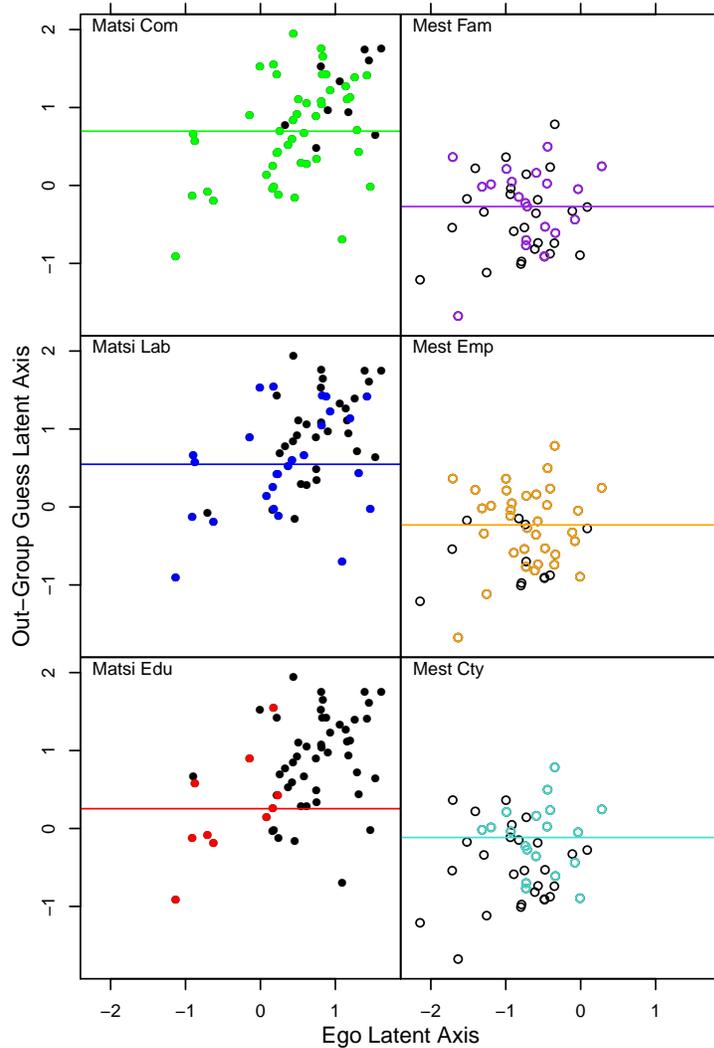


Figure S22: Individual locations on ego and out-group latent axes. Individual locations on the latent out-group axis (y) against individual locations on the latent ego axis (x) for Matsigenka (first column) and Mestizos (second column) by different types of inter-ethnic experience (labels follow Figure S11). Points are means for each individual derived from posterior predictions of model m1, with no estimated covariance among individual locations across target axes and no inter-ethnic experience predictors (Tables S1 and S2). Horizontal lines are drawn at the mean location on the out-group axis for individuals with the given inter-ethnic experience type. Note the positive overall covariance, and residual covariance within each experience type for the Matsigenka.

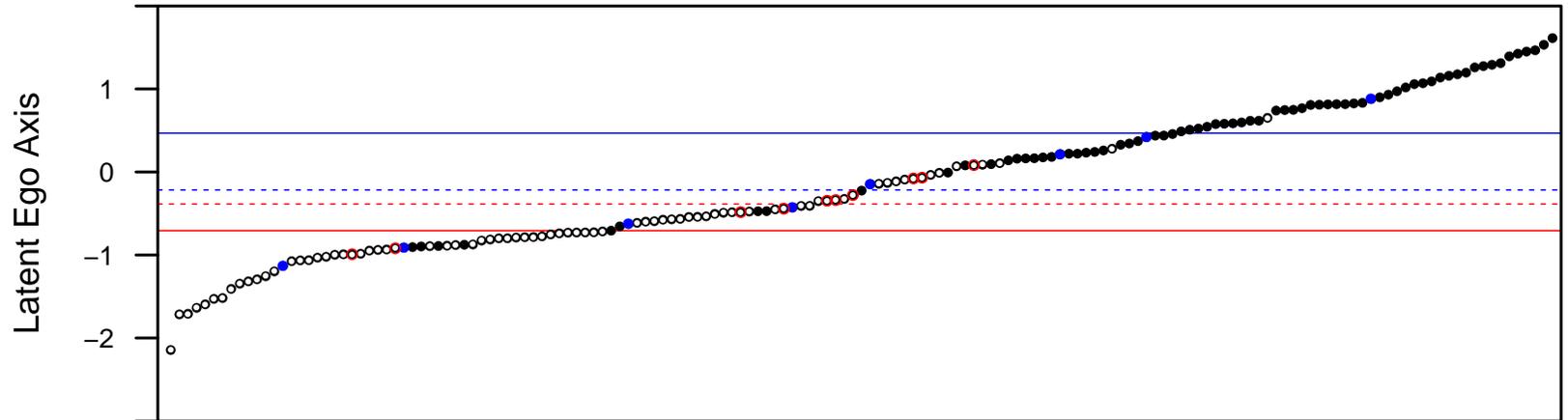


Figure S23: Locations of familiar individuals on ego axis. Individual locations on the latent ego axis for Matsigenka (solid circles) and Mestizos (open circles). Points are means for each individual derived from posterior predictions of model m1, with no estimated covariance among individual locations across target axes and no inter-ethnic experience predictors (Tables S1 and S2). Solid horizontal lines are drawn at the mean locations for Matsigenka (blue) and Mestizos (red). Blue points are Matsigenka individuals most familiar to Mestizos in Boca Manu and Atalaya, derived from my ethnographic observations. The dashed blue line is the mean location of these individuals. Red points are Mestizo individuals most familiar to Matsigenka in Tayakome, derived from my ethnographic observations. The dashed red line is the mean location of these individuals. Note that Matsigenka individuals most familiar to Mestizos are different on average from the average Matsigenka. Mestizo individuals most familiar to Matsigenka are more similar on average to the average Mestizo.

Table S1: (Next page) IRT models for Matsigenka inter-ethnic experience. Posterior mean coefficient estimates for IRT models fit in this analysis (with 90% highest probability density interval in parentheses). Models receiving more than 1% WAIC weight are highlighted in grey. The model used for inference, m11, incorporates all Matsigenka inter-ethnic experience domains of interest, without the exploratory predictors of sex and age. Column headings are predictors and model weight. Adol = Adolescent, Educ = Education experience with Mestizos, Labor = wage labor worker experience with Mestizos, Comm = commerce experience with Mestizos. For m1 and m3, rows are intercepts on the target latent axes (from top to bottom: ego, in-group, and out-group). m1 has a random effect for individual and no covariance estimation. m2 (not shown) is the standard centered parameterization of the model in equations A.3-A.17, and could not be well-estimated. m3 (and all subsequent models) adds covariance among intercepts across targets and among question locations and discriminations within and across targets, and uses the non-centered Cholesky-factored parameterization (along with all subsequent models). Rows of m4 - m12 are, from top to bottom, Matsigenka ego, in-group, out-group, and Mestizo ego, in-group, and out-group estimates.

Table S1: (Caption previous page)

Model	Intercept	Sex	Adol	Elder	Educ	Labor	Comm	WAIC weight	
m1	-0.13 (-0.77, 0.49) -0.17 (-0.84, 0.48) 0.28 (-0.44, 0.98)							1.2e-44	
m3	-0.08 (-1.35, 1.1) -0.08 (-1.35, 1.1) -0.08 (-1.35, 1.1)							1.5e-11	
m4	0.69 (-0.34, 1.81) 0.68 (-0.35, 1.75) 0.7 (-0.41, 1.67) -0.78 (-1.91, 0.26) -0.89 (-1.93, 0.25) -0.57 (-1.59, 0.45)							1.2e-05	
m5	0.69 (-0.42, 1.81) 0.67 (-0.48, 1.82) 0.7 (-0.43, 1.84) -0.52 (-1.87, 0.78) -0.65 (-2, 0.64) -0.42 (-1.67, 0.93)				-1.2 (-1.89, -0.58) -0.63 (-1.14, -0.15) -0.65 (-1.18, -0.09) -0.52 (-1.83, 0.79) -0.65 (-1.9, 0.74) -0.42 (-1.71, 0.87)			0.36	
m6	0.77 (-0.45, 1.9) 0.72 (-0.44, 1.86) 0.75 (-0.5, 1.85) -0.58 (-1.9, 0.71) -0.69 (-2.06, 0.6) -0.44 (-1.79, 0.86)					-0.63 (-1.04, -0.18) -0.49 (-0.91, -0.1) -0.47 (-0.9, -0.05) -0.58 (-1.84, 0.75) -0.66 (-1.99, 0.66) -0.44 (-1.78, 0.9)		3.8e-05	
m7	0.87 (-0.28, 2.04) 0.81 (-0.34, 2.02) 0.83 (-0.3, 2.07) -0.59 (-1.9, 0.75) -0.67 (-1.97, 0.69) -0.46 (-1.75, 0.84)						-0.7 (-1.15, -0.2) -0.48 (-0.97, 0) -0.49 (-1.03, 0.05) -0.59 (-1.95, 0.7) -0.67 (-1.94, 0.67) -0.45 (-1.78, 0.82)	2.9e-05	
m8	0.75 (-0.42, 1.87) 0.74 (-0.37, 2) 0.78 (-0.34, 1.96) -0.45 (-1.93, 0.93) -0.56 (-1.99, 0.84) -0.36 (-1.72, 1.13)				-1.25 (-1.9, -0.57) -0.53 (-1.09, 0.05) -0.55 (-1.17, 0) -0.45 (-1.88, 0.96) -0.56 (-2.03, 0.84) -0.35 (-1.78, 1.01)	-0.24 (-0.55, 0.09) -0.4 (-0.85, 0.04) -0.35 (-0.84, 0.1) -0.44 (-1.82, 0.93) -0.55 (-2.02, 0.86) -0.36 (-1.7, 1.05)		0.052	
m9	0.85 (-0.32, 2.07) 0.83 (-0.34, 2.06) 0.86 (-0.39, 2.05) -0.47 (-1.91, 0.93) -0.56 (-2.02, 0.87) -0.38 (-1.69, 1.17)				-1.18 (-1.79, -0.57) -0.61 (-1.13, -0.07) -0.6 (-1.13, -0.05) -0.46 (-1.86, 0.98) -0.56 (-1.94, 0.88) -0.36 (-1.74, 1.01)		-0.47 (-0.83, -0.07) -0.44 (-0.99, 0.06) -0.45 (-1.06, 0.11) -0.46 (-1.77, 1) -0.55 (-1.99, 0.86) -0.39 (-1.84, 0.99)	0.42	
m10	0.94 (-0.24, 2.14) 0.8 (-0.5, 1.94) 0.87 (-0.33, 2.11) -0.5 (-1.9, 0.93) -0.58 (-1.99, 0.83) -0.39 (-1.76, 1.08)					-0.53 (-0.94, -0.12) -0.45 (-0.91, 0) -0.41 (-0.88, 0.06) -0.52 (-1.94, 0.9) -0.58 (-2.09, 0.72) -0.37 (-1.74, 1.05)	-0.6 (-1.06, -0.08) -0.32 (-0.87, 0.25) -0.36 (-1.02, 0.24) -0.5 (-1.94, 0.83) -0.56 (-1.98, 0.83) -0.38 (-1.79, 0.98)	2.7e-05	
m11	0.92 (-0.27, 2.14) 0.84 (-0.37, 2.1) 0.89 (-0.33, 2.15) -0.4 (-1.98, 0.9) -0.51 (-1.97, 1.01) -0.34 (-1.75, 1.07)				-1.27 (-1.94, -0.62) -0.54 (-1.12, 0.03) -0.56 (-1.15, 0) -0.41 (-1.79, 1.15) -0.49 (-1.96, 1.02) -0.32 (-1.75, 1.14)	-0.16 (-0.48, 0.18) -0.34 (-0.83, 0.16) -0.27 (-0.81, 0.22) -0.41 (-1.91, 1) -0.49 (-1.98, 0.93) -0.33 (-1.77, 1.08)	-0.49 (-0.97, -0.07) -0.33 (-0.91, 0.26) -0.36 (-1.01, 0.32) -0.43 (-1.87, 1.01) -0.48 (-1.97, 0.98) -0.33 (-1.77, 1.13)	0.17	
m12	1.23 (0.04, 2.49) 1.15 (-0.13, 2.39) 1.19 (-0.05, 2.46) -0.6 (-2.15, 0.87) -0.66 (-2.04, 0.87) -0.45 (-1.95, 1)	0.17 (-0.29, 0.62) -0.15 (-0.89, 0.52) 0.09 (-0.62, 0.87) 0.08 (-0.33, 0.49) -0.26 (-0.8, 0.29)	-0.28 (-1.01, 0.4) -0.25 (-1.22, 0.7) -0.4 (-1.42, 0.59) 0.37 (-0.62, 1.38) 0.43 (-0.74, 1.69)	-0.23 (-0.79, 0.33) -0.54 (-1.35, 0.27) -0.6 (-1.41, 0.32) 0.04 (-0.43, 0.52) -0.02 (-0.56, 0.6)	-1.66 (-2.37, -0.94) -0.68 (-1.44, 0.02) -0.67 (-1.44, 0.06) 0.04 (-0.43, 0.52) -0.02 (-0.56, 0.6)	-1.66 (-2.37, -0.94) -0.68 (-1.44, 0.02) -0.67 (-1.44, 0.06) -0.58 (-2.11, 0.84) -0.67 (-2.16, 0.81) -0.45 (-1.86, 1.08)	-0.33 (-0.84, 0.22) -0.38 (-1.1, 0.4) -0.47 (-1.31, 0.29) -0.58 (-2.1, 0.82) -0.67 (-2.2, 0.74) -0.44 (-1.93, 0.99)	-0.69 (-1.25, -0.14) -0.42 (-1.14, 0.35) -0.44 (-1.23, 0.43) -0.6 (-1.99, 0.92) -0.68 (-2.25, 0.71) -0.42 (-1.93, 1.07)	3e-06

Table S2: IRT models for Mestizo inter-ethnic experience. Posterior mean coefficient estimates for IRT models fit in this analysis (with 90% highest probability density interval in parentheses). Models receiving more than 1% WAIC weight are highlighted in grey. The model used for inference, m19, incorporates all Mestizo inter-ethnic experience domains of interest, without the exploratory predictors of sex and age. Column headings are predictors and model weight. Adol = Adolescent, Fam = Family experience with indigenous individuals, Emp = wage labor employer experience with Matsigenka, Cty = experience living in an indigenous community. m1 - m4 are identical to Table S1. Rows of m13 - m20 are, from top to bottom, Matsigenka ego, in-group, out-group, and Mestizo ego, in-group, and out-group estimates.

Model	Intercept	Sex	Adol	Elder	Fam	Emp	Cty	WAIC weight
m1	-0.13 (-0.77, 0.49) -0.17 (-0.84, 0.48) 0.28 (-0.44, 0.98)							1.1e-41
m3	-0.08 (-1.35, 1.1) -0.08 (-1.35, 1.1) -0.08 (-1.35, 1.1)							1.3e-08
m4	0.69 (-0.34, 1.81) 0.68 (-0.35, 1.75) 0.7 (-0.41, 1.67) -0.78 (-1.91, 0.26) -0.89 (-1.93, 0.25) -0.57 (-1.59, 0.45)							0.011
m13	0.52 (-0.89, 1.76) 0.52 (-0.7, 1.89) 0.52 (-0.84, 1.85) -0.77 (-1.88, 0.4) -0.86 (-2.09, 0.3) -0.56 (-1.67, 0.59)				0.51 (-0.8, 1.81) 0.51 (-0.79, 1.85) 0.51 (-0.82, 1.81) 0.17 (-0.09, 0.47) 0.07 (-0.28, 0.4) 0.11 (-0.17, 0.39)			0.0018
m14	0.82 (-0.2, 1.94) 0.89 (-0.19, 1.98) 0.88 (-0.16, 1.98) -0.92 (-2.02, 0.17) -1.15 (-2.29, -0.03) -0.83 (-1.88, 0.22)					-0.71 (-1.77, 0.31) -0.18 (-1.18, 0.79) -0.41 (-1.43, 0.66) 0.14 (-0.14, 0.44) 0.41 (0.03, 0.78) 0.38 (0.07, 0.74)		0.036
m15	0.54 (-0.85, 1.8) 0.53 (-0.72, 1.94) 0.52 (-0.78, 1.83) -0.83 (-1.95, 0.37) -0.89 (-2.05, 0.31) -0.59 (-1.72, 0.53)						0.51 (-0.88, 1.79) 0.51 (-0.77, 1.88) 0.52 (-0.82, 1.8) 0.42 (0.08, 0.73) 0.25 (-0.08, 0.61) 0.34 (0.01, 0.67)	0.64
m16	0.61 (-0.68, 2) 0.64 (-0.65, 1.94) 0.65 (-0.63, 2.01) -0.92 (-2.05, 0.28) -1.12 (-2.35, 0.04) -0.79 (-1.95, 0.37)				0.59 (-0.69, 1.9) 0.63 (-0.6, 2.06) 0.62 (-0.7, 1.94) 0.21 (-0.09, 0.53) 0.06 (-0.32, 0.39) 0.11 (-0.21, 0.4)	-0.73 (-1.91, 0.38) -0.17 (-1.27, 0.79) -0.42 (-1.49, 0.73) 0.18 (-0.15, 0.54) 0.46 (0.03, 0.89) 0.44 (0.07, 0.84)		0.013
m18	0.45 (-0.87, 1.92) 0.44 (-0.97, 1.86) 0.43 (-0.95, 1.83) -0.84 (-2.02, 0.38) -0.91 (-2.17, 0.27) -0.57 (-1.73, 0.66)				0.43 (-1, 1.78) 0.45 (-0.88, 1.97) 0.45 (-1.06, 1.71) 0.04 (-0.3, 0.35) -0.05 (-0.43, 0.42) -0.06 (-0.43, 0.28)		0.42 (-0.98, 1.87) 0.43 (-0.97, 1.82) 0.45 (-1.06, 1.82) 0.46 (0.08, 0.86) 0.3 (-0.13, 0.72) 0.43 (0.02, 0.87)	0.017
m17	0.57 (-0.74, 1.86) 0.62 (-0.6, 2.06) 0.63 (-0.75, 1.9) -0.93 (-2.12, 0.25) -1.15 (-2.41, 0.02) -0.79 (-1.95, 0.3)					-0.74 (-1.91, 0.35) -0.15 (-1.18, 0.9) -0.42 (-1.54, 0.72) 0.08 (-0.24, 0.43) 0.42 (-0.03, 0.88) 0.37 (-0.03, 0.75)	0.6 (-0.72, 1.92) 0.64 (-0.67, 2.01) 0.65 (-0.63, 2.03) 0.44 (0.11, 0.8) 0.18 (-0.2, 0.57) 0.28 (-0.06, 0.64)	0.26
m19	0.49 (-0.93, 1.86) 0.52 (-0.97, 1.91) 0.54 (-0.87, 1.99) -0.96 (-2.22, 0.19) -1.15 (-2.43, 0.06) -0.78 (-1.97, 0.4)				0.48 (-0.94, 1.93) 0.52 (-0.92, 1.97) 0.52 (-0.98, 1.88) 0.06 (-0.27, 0.42) -0.01 (-0.43, 0.44) -0.03 (-0.43, 0.37)	-0.75 (-1.94, 0.45) -0.17 (-1.29, 0.96) -0.43 (-1.57, 0.81) 0.09 (-0.27, 0.48) 0.47 (-0.04, 0.97) 0.42 (-0.03, 0.86)	0.49 (-0.95, 1.85) 0.53 (-0.84, 1.94) 0.53 (-0.95, 1.9) 0.47 (0.07, 0.87) 0.21 (-0.25, 0.68) 0.35 (-0.12, 0.76)	0.025
m20	0.72 (-0.77, 2.12) 0.72 (-0.7, 2.17) 0.75 (-0.61, 2.2) -1.27 (-2.56, -0.09) -1.42 (-2.7, -0.15) -0.92 (-2.12, 0.27)	-0.32 (-0.88, 0.28) -0.44 (-1.01, 0.16) -0.35 (-1.01, 0.35) 0.1 (-0.35, 0.57) -0.17 (-0.73, 0.37) -0.23 (-0.73, 0.26)	0.05 (-0.84, 0.95) -0.13 (-1.08, 0.85) -0.38 (-1.34, 0.75) 0.53 (-0.61, 1.57) 0.46 (-0.73, 1.72) -0.37 (-1.54, 0.79)	0.03 (-0.69, 0.87) -0.44 (-1.2, 0.36) -0.54 (-1.42, 0.41) -0.14 (-0.71, 0.38) -0.17 (-0.81, 0.43) -0.16 (-0.74, 0.38)	0.72 (-0.78, 2.04) 0.74 (-0.75, 2.07) 0.73 (-0.64, 2.26) 0.04 (-0.42, 0.56) -0.09 (-0.67, 0.49) -0.03 (-0.58, 0.44)	-0.72 (-2.11, 0.66) -0.22 (-1.47, 1.04) -0.49 (-1.78, 0.92) 0.08 (-0.44, 0.59) 0.43 (-0.19, 1.06) 0.42 (-0.15, 0.95)	0.71 (-0.71, 2.08) 0.74 (-0.69, 2.13) 0.73 (-0.68, 2.17) 0.69 (0.14, 1.18) 0.39 (-0.26, 1.04) 0.54 (-0.08, 1.16)	2.9e-06

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