Cultural Consonance and Body Morphology: Estimates With Longitudinal Data From an Amazonian Society

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ABSTRACT Researchers have hypothesized that the degree to which an individual's actual behavior approximates the culturally valued lifestyle encoded in the dominant cultural model has consequences for physical and mental health. We contribute to this line of research by analyzing data from a longitudinal study composed of five annual surveys (2002–2006 inclusive) from 791 adults in one society of foragers–farmers in the Bolivian Amazon, the Tsimane'. We estimate the association between a standard measure of individual achievement of the cultural model, cultural consonance, and three indicators of body morphology. Drawing on research suggesting that in societies in the early stages of economic development an increase in socioeconomic status is associated with an increase in mean body mass, we expect to find a positive association between cultural consonance and three anthropometric measures. We found the expected positive association between cultural consonance and anthropometric measures—especially for men—only when using ordinary least square (OLS) regression models, but not when using fixed-effects regression models. The real magnitude of the association was low. The comparison of estimates from OLS and fixed-effect regression models suggests that previous findings on the effects of cultural consonance on body morphology using cross-sectional data should be read with caution because the association might be largely explained by fixed characteristics of individuals not accounted in OLS models. Am J Phys Anthropol 000:000–000, 2010.

Since the 1960s, a large and growing body of research has suggested that cultural context matters in understanding the physical and mental health consequences of exposure to social stressors (Cassel et al., 1960; Henry and Cassel, 1969). One of the most intensively studied social stressors is culture change associated with migration (Janes, 1990) or with integration to the global market economy (Chin-Hong and McGarvey, 1996; Steele et al., 1998; McGarvey, 1999; Dressler and Bindon, 2000; McDade et al., 2000; McDade, 2001, 2002; Sapolsky, 2004). Researchers have found associations between stress generated by culture change and several mental and physical health outcomes, including blood pressure, depressive symptoms (Bindon et al., 1997; McGarvey, 1999; Diener et al., 2003), immune function (McDade, 2002), and nutritional status and body composition (Dressler et al., 2004, 2008b; Bindon, 2007).

Dressler's concept of cultural consonance formalizes the intuition that adequate measurement of social stressors must take into account the culturally defined meaning of potentially stressful experiences. Dressler et al. define cultural consonance in lifestyle as the degree to which individuals in their own beliefs and behaviors approximate the culturally valued lifestyle encoded in the dominant cultural model (Dressler and Bindon, 2000; Dressler et al., 2005, 2007). Cultural consonance is operationalized and measured at the individual level and then used as a predictor of physical and mental health outcomes. For example, in research in urban Brazil analyzing the association between cultural consonance in lifestyle and adult body morphology, Dressler et al. (2008) found that higher cultural consonance in lifestyle was associated with lower weight and smaller waist size and body mass index (BMI). The finding is consistent with the observation that in contemporary Western societies there is an inverse association between socioeconomic status and adult body mass (Brown and Konner, 1987; Messer, 1989; Gremillion, 2005). Dressler et al. (2008) interpret their results as evidence that culture literally becomes embodied: body mass and composition may be indicators of an individual's adherence to cultural norms and expectations for how to live.

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Although suggestive, an important limitation of this research—as with most research on culture change, stress, and health—is that it is cross sectional in design. Cross-sectional studies are potentially problematic because a) culture change, by definition, occurs over time and b) cross-sectional estimates of cultural consonance and other measures of stress exposure may be biased by fixed attributes of individuals that might influence both adherence to cultural norms and response to stressors. Failure to control for individual traits that remain stable over time would bias the estimated effects of cultural consonance on health outcomes.

In this article, we contribute to literature on the health consequences of culture change by examining the association between cultural consonance in lifestyle and adult body morphology using 5 years of panel data collected among the Tsimane', a society of foragers–farmers in the Bolivian Amazon in the early stages of articulation with the market economy. Five years of panel data, or repeated measures of the same individual over time, do not allow us to address the first limitation just notice, that is, the diachronic measure of cultural change, because 5 years are a relatively short period of time to measure a process that most likely occurs over generations. However, panel data allow us to overcome the second limitation, that is, the bias generated by individual-fixed attributes. In the balance of the article, we compare estimates from ordinary least squares (OLS) linear regressions, the approach used in previous studies of cultural consonance and health, with estimates from individual fixed-effects multivariate linear regressions, an approach that allows us to remove biases from fixed attributes of the individual. The comparison of both estimates should provide a deeper understanding of the potentially causal association between cultural consonance and body morphology.

MATERIALS AND METHODS

Site

The study was conducted with the Tsimane', a society of foragers–farmers in the Department of Beni, in the Bolivian Amazon. Relatively isolated until the mid-20th century, the Tsimane' started to engage in more frequent and prolonged contact with Westerners after the arrival of Protestant missionaries in the late 1940s and early 1950s (Huanca, 2008). Nowadays, Tsimane' continue to live in small villages of ~20 households closely linked by ties of blood and marriage and follow their traditional forms of social organization (e.g., cross-cousin marriage). Although some Tsimane' continue to be highly autarkic and practice hunting, plant collection, and slash-and-burn agriculture for subsistence (Vadez et al., 2004), exposure to the market economy and Westerners have produced changes in Tsimane' economy, society, and lifestyle. For example, cash cropping and wage labor are becoming increasingly important economic activities for Tsimane' households (Vadez et al., 2008), who use their cash income to obtain consumption goods (Godoy et al., 2007).

Sample

Data for these analyses were collected annually during June–September from 2002 to 2006 (inclusive) among all adults in 13 Tsimane' villages differing in their proximity to San Borja, the only town along the Maniqui river. The sample contains 399 females and 392 males over the age of 18 with complete data for at least 2 survey years. We included only individuals over 18 years of age because body composition is more stable after that age. Pregnant women were excluded from the analysis.

Explanatory variable: Cultural consonance

We have described in detail elsewhere the method used to measure cultural consonance in lifestyle (Reyes-García et al., 2010), so here we provide a shorter description. Following prior applications (Dressler and Bindon, 2000), we measured cultural consonance through a four-step process.

First, we conducted exploratory ethnographic research to get an emic understanding of how the Tsimane' conceive the cultural domain of "lifestyle." Specifically, we used free listing ($n = 35$) to elicit a range of items in the cultural domain of lifestyle or items that Tsimane' associate with a "good life" (Dressler and Bindon, 2000). The most frequently listed items included behaviors associated with the traditional way of life for the Tsimane', such as spending time with close family, having a good agricultural plot, having good food, succeeding in hunting and fishing, enjoying good health, visiting, and being visited. Tsimane' also mentioned some behaviors associated with a more market-oriented way of life, such as acquiring commercial goods (Reyes-García et al., 2010). We used our ethnographic understanding to select a range of material items. The list of material items included items traditionally owned by the Tsimane' (i.e., machetes, cooking pots), items of recent introduction but related to Tsimane' subsistence activities (i.e., shotgun, fishing net), and items related to a nontraditional lifestyle (i.e., radio).

The second step consisted of a confirmatory ethnographic phase to test whether there was sufficient inter-informant agreement (i.e., cultural consensus) to infer that there is a shared Tsimane' cultural model for what is means to have a "good life." We asked informants ($n = 42$) from four villages with different levels of market exposure to rate the lifestyle items identified above on a scale of "not important at all" (coded as 1), "a little" (2), or "very important" (3). To evaluate whether there was a shared cultural model regarding the importance of these 14 items, we used the formal consensus model in the software ANTHROPAC 4.02 (Analytic Technologies, Natick, MA). Results show evidence of sufficient agreement to assume that all informants in the sample were drawing on the same repository of cultural knowledge (Romney et al., 1986). In particular, the first factor explained about 78% of the variance and was more than six times larger than the second. The mean estimate of cultural knowledge was moderately high (0.70 ± 0.17), and there were no negative knowledge scores. We then used the factor loading of each informant on the first factor (the cultural knowledge score) to calculate a weighted average of the ratings for each of the 14 items in our list. This procedure created an estimate of the culturally appropriate responses to our questions about the relative importance of 14 items for living a "good life" among the Tsimane'.

The third step consisted of a survey phase (conducted each year from 2002 to 2006) in which we measured the occurrence of behaviors and the ownership of items in the list derived from step two. For example, we asked respondents "during the last 7 days, have you spent time

with your close family?" or "How many machetes do you own?" We coded survey questions as binary variables, with 1 indicating the presence of a behavior or item and 0 indicating its absence.

Last, our individual-level measure of cultural consonance consisted of the sum of individual responses to each of the items on the list, calculated separately for each year of the panel. Presence/absence responses were weighted by the cultural saliency of each item or behavior, as determined from the culturally appropriate ratings produced by consensus analysis in the confirmatory ethnographic phase. Responses resulted in a quantitative assessment of cultural consonance at the individual level, with higher values indicating higher levels of adherence to local norms and expectations (Dressler et al., 1998; Dressler and Bindon, 2000).

Outcome variables

Each year, we took anthropometric measurements of all adults in the sample. Measures were taken no later than 1 week after completing surveys from which the measure of cultural consonance was derived. Anthropometric measurements were taken according to standard protocols (Lohman et al., 1988). We measured participants in light clothing without shoes or hats. Waist circumference was assessed by placing a tape measure around the abdomen at the level of the iliac crest. We measured body weight to the nearest 0.20 kg using a Tanita Digital standing scale. We recorded stature (standing height) to the nearest millimeter using a portable stadiometer. BMI was calculated as weight in kg/stature in m^2.

Control variables

Control variables included individual- and household-level variables. Individual-level variables included the person's age measured in years, maximum school attainment, stature (except for regressions using BMI as outcome), and number of days the person drank home-fermented beer during the week before the interview (a proxy for individual caloric intake). Control variables at the household level included household income (amount of cash earned by members of the household through sale, barter, or wage labor during the 2 weeks previous to the interview), household wealth (measured by the monetary value of traditional and modern physical assets owned by the household), household size (total number of people living in the household at the time of the interview), and household caloric intake (proxied by kilograms of plantains, the Tsimane' main staple, consumed by the household the week before the interview). Control variables also include a set of dummy variables for community of residency and for year of the survey.

Estimation strategy

Drawing on evidence that mean body size increases with socioeconomic status in many societies in the early stages of economic development (Brown and Konner, 1987; Bindon, 1995; Gremillion, 2005), we expected to find a positive association between adherence to the prevailing cultural model of lifestyle, or cultural consonance, and measures of body size and proportionality. We used the following linear panel approximation to estimate the association between cultural consonance in lifestyle and three anthropometric measures (waist circumference, weight, and BMI):

$$\ln Y_{\mathrm{ihvt}} = \alpha + \gamma \ln \mathrm{CC}_{\mathrm{ihvt}} + \eta C_{\mathrm{hvt}} + \beta V_{\mathrm{t}} + \varepsilon_{\mathrm{hvt}}. \quad (1)$$

In Eq. (1), ln Y stands for the natural logarithm (hereafter log) of one of the three anthropometric measures of person i in household h in village v at time (or year) t. Our explanatory variable is lnCC, or the log of the annual cultural consonance of person i. We transformed outcomes and explanatory variables to logs to ease the interpretation of coefficients; when explanatory and outcome variables are in logarithms, we can read the coefficients as elasticity, or a percent increase. C includes control variables measured at the individual (i.e., age, schooling, and stature) and household level (e.g., consumption of home-brewed beer, household income and wealth, household size, and household staple consumption), which might change across years and affect anthropometric measures and cultural consonance. V includes a full set of 12 dummy variables for villages ($n = 13 - 1 = 12$) to control for attributes of villages that remain fixed during 2002–2006 but that might affect anthropometric measures and cultural consonance. For example, some villages are closer to market towns than others. Proximity to market towns could affect both cultural consonance and the body size and composition of participants (e.g., through access to different foods). We also used a full set of dummy variables for year of data collection.

We ran three separate regressions with each of the anthropometric measures as an outcome variable, but included the same explanatory variables in all three regressions. Because our outcomes are anthropometric measures, we conducted the analysis separately for men and women. To allow comparison with results from previous research, we first estimated the parameters of expression [1] using OLS multivariate linear regression, the estimation strategy previously used in similar research (Dressler et al., 2008). As we have repeated measures for each individual, we used clustering by individual and robust standard errors. In our second estimation strategy, we used individual fixed-effect panel linear regressions. The use of individual fixed-effect panel regression allows us to remove from our estimates the effect of attributes of the person that remained fixed during the study period. For example, some people might have been more concerned about their weight and about conforming to social norms, a fixed-effect regression allows us to remove such fix characteristics. For the statistical analysis, we used Stata for Windows, 9.0 (Stata Corporation, College Station, TX).

RESULTS

Table 1 shows the descriptive statistics for variables included in the analysis. Over the 5 years of research, the average male in the sample had a cultural consonance score of 11.40, slightly higher than the cultural consonance of the average female (mean = 7.67). We found low variation in both samples (SD = 3.55, min = 1.72, max = 22.93 for the sample of men, and SD = 3.25, min = 1.6, max = 19.22 for the sample of women). To examine the consistency of cultural consonance across years, we ran a series of Pearson correlations between the individual measures of cultural consonance for each year. We found a high ($r \geq 0.5$) and statistically signifi-

TABLE 1. Definition and summary statistics of variables measured annually and used in the regressions

Variable	Definition	Men			Women		
		N	Mean	SD	*N*	Mean	SD
I. Explanatory variable (in regressions entered in natural logarithms)							
Cultural consonance	Degree to which individuals in their own beliefs and behaviors approximate shared cultural models	1,208	11.4	3.55	1,244	7.67	3.25
II. Outcome variables (in regressions entered in natural logarithms)							
Waist circumference	Cms around the abdomen at the level of the iliac crest	1,033	83.33	6.78	816	84.32	8.71
Weight	Kilograms	1,035	62.37	7.26	816	53.86	8.04
BMI	Body mass index (kg/m^2)	1,034	23.56	2.27	816	23.59	3.08
III. Control variables							
Individual level							
Age	Age of participant (years)	1,208	36.28	17.40	1,244	35.40	17.61
Schooling	Maximum school grade achieved by participant	1,146	2.58	2.69	1,196	1.29	1.54
Home-fermented beer	Number of days the person drank home-fermented beer during the week before the interview	1,205	0.56	0.79	1,242	0.34	0.65
Household level							
		N		Mean		SD	
Household income	Monetary income from sale, barter, and wage labor, in Bolivianos	1,230		260.71		405.01	
Household wealth	Monetary value of a basket of traditional and modern physical assets owned by the household, in Bolivianos	1,212		3138.41		2387.45	
Household size	Number of people in the household	1,230		6.26		2.86	
Household plantain consumption	Kilograms of plantains consumed by the household the week before the interview	1,212		49.84		28.98	

Cells contain the aggregate of the research period (2002–2006, inclusive).

cant correlation ($P < 0.0001$) between measures of cultural consonance for the same individual taken in different years. Cultural consonance score did not change significantly across years of the survey for the sample of males ($P = 0.5$), but the passage of a year increased female's cultural consonance score by 2.6% ($P = 0.06$). Thus, our measure of cultural consonance displays relatively low variation across individuals, interpersonal consistency across years, and no significant change over the study period for the male sample, and a slight improvement for the female sample.

Tsimane' in our sample fall in the normal range of BMI. The average male had a BMI of 23.56 (SD = 2.27), whereas the average female had a BMI of 23.59 (Table 1), both within the normal or healthy range of BMI (Shetty and James, 1994). We examined the association among the three anthropometric measures and found that they were associated in a positive and statistically significant way ($r = 0.75$, $P < 0.0001$ for BMI and waist circumference; $r = 0.89$, $P < 0.0001$ for BMI and weight). We observed an increase in two of our anthropometric measures over the duration of the study. Weight increased by 0.8%/year for the female sample and by 0.5%/year for the sample of men, whereas BMI increased by 0.6 and 0.5%/year ($P < 0.001$ in all cases). In contrast, waist circumference decreased among women and did not change significantly among men in our sample.

Tables 2 and 3 show the results of the multivariate regressions of cultural consonance in lifestyle (explanatory variable) and the three anthropometric measures for the sample of males and females. When using OLS multivariate regressions with the sample of men (Table 2, columns [a], [c], and [f]), we find the expected positive association between cultural consonance in lifestyle and measures of body size and composition. However, the real effect of the association is low. A 1% increase in the measure of cultural consonance is associated with about a 0.017% increase in men's waist circumference ($P = 0.05$), 0.025% increase in men's weight ($P = 0.04$), and 0.026% increase in men's BMI ($P = 0.03$). The association implies, for example, that a 10% increase in the measure of cultural consonance would result in an increase in men's BMI of $\sim 0.26\%$. Additionally, we found that schooling bears a positive and statistically significant association with two of the three outcomes measured (weight and BMI). Household income and household wealth are associated in a positive way with our measures of body morphology, but the coefficient of the association is low in real terms and insignificant in statistical terms.

We also found a positive association between cultural consonance in lifestyle and our three measures of body composition for the sample of women (Table 3, columns [a], [c], and [f]). However, the magnitude of the associations for the sample of women is lower than for the sample of men and statistically significant only when using waist circumference as the outcome variable. Specifically, a 1% increase in the measure of cultural consonance is associated with a 0.016% increase in women's waist circumference ($P = 0.05$). Schooling had a negative and statistically significant ($P = 0.05$) association with women's waist circumference but not with weight or BMI. The other two indicators of socioeconomic status, household income and household wealth, were not significant predictors of body morphology.

Columns [b], [d], and [f] show results of the individual fixed-effects regressions for the sample of men (Table 2) and women (Table 3). Once we control for fixed attrib-

TABLE 2. OLS and individual fixed-effect linear regressions of cultural consonance in lifestyle (explanatory variable) and measures of adult body morphology (outcome)

	Waist circumference, log		Weight, log		BMI, log	
Number of observations	963		965		968	
Number of individuals	347		347		350	
	[a]	[b]	[c]	[d]	[e]	[f]
	OLS	Fixed effects	OLS	Fixed effects	OLS	Fixed effects
Cultural Consonance, log	0.017* (0.009)	0.009 (0.006)	0.025** (0.012)	0.002 (0.005)	0.026** (0.012)	0.004 (0.005)
Age	0.002*** (0.0002)	0.001 (0.0003)	0.0006* (0.0003)	−0.001** (0.003)	0.0006* (0.0003)	−0.0007** (0.0003)
Schooling	0.002 (0.002)	−0.002 (0.002)	0.007** (0.003)	−0.0001 (0.001)	0.007** (0.003)	−0.002 (0.002)
Stature	0.004*** (0.0007)	0.0001 (0.001)	0.014*** (0.001)	0.004*** (0.001)	^	^
Household size	−0.0006 (0.001)	−0.001** (0.001)	−0.0002 (0.002)	0.0002 (0.0001)	0.0001 (0.002)	−0.0005 (0.001)
Household income	<0.00001 (<0.00001)	<0.00001 (<0.00001)	<0.00001 (<0.00001)	<0.00001 (<0.00001)	<0.00001 (<0.00001)	<0.00001 (<0.00001)
Household wealth	<0.00001 (<0.00001)	<0.00001 (<0.00001)	<0.00001 (<0.00001)	<0.00001 (<0.00001)	<0.00001 (<0.00001)	<0.00001 (<0.00001)
Household plantain consumption	0.00003 (0.00008)	−0.00002 (0.0001)	0.0001 (0.0001)	0.00004 (0.00005)	0.00008 (0.0001)	0.00003 (0.00005)
Home-fermented beer	0.0006 (0.003)	0.0002 (0.0002)	0.004 (0.004)	0.004 (0.002)	0.004 (0.004)	0.005*** (0.002)

Sample of men.Regressions include a full set of dummy variables for villages and years, and a constant (not shown). Standard errors in brackets. ***, **, and * significant at <10, 5, and 1%, respectively.

TABLE 3. OLS and individual fixed-effect linear regressions of cultural consonance in lifestyle (explanatory variable) and measures of adult body morphology (outcome)

	Waist circumference, log		Weight, log		BMI, log	
Number of observations	771		771		772	
Number of individuals	314		314		315	
	[a]	[b]	[c]	[d]	[e]	[f]
	OLS	Fixed effects	OLS	Fixed effects	OLS	Fixed effects
Cultural consonance, log	0.016** (0.008)	0.010 (0.006)	0.011 (0.011)	−0.00003 (0.005)	0.011 (0.011)	0.001 (0.005)
Age	0.001*** (0.0004)	−0.0007 (0.0006)	−0.0005 (0.0006)	0.0001 (0.0004)	−0.0005 (0.0006)	0.0002 (0.0004)
Schooling	−0.006* (0.003)	−0.006 (0.005)	−0.006 (0.006)	−0.003 (0.004)	−0.006 (0.004)	−0.005 (0.004)
Stature	0.003*** (0.001)	−0.003* (0.002)	0.014*** (0.001)	0.001 (0.001)	^	^
Household size	−0.001 (0.002)	0.0006 (0.002)	−0.001 (0.003)	0.003** (0.001)	−0.001 (0.002)	0.001 (0.001)
Household income	<0.00001 (<0.00001)	<0.00001 (<0.00001)	<0.00001 (<0.00001)	<0.00001 (<0.00001)	<0.00001 (<0.00001)	<0.00001 (<0.00001)
Household wealth	<0.00001 (<0.00001)	<0.00001** (<0.00001)	<0.00001 (<0.00001)	<0.00001* (<0.00001)	<0.00001 (<0.00001)	<0.00001*** (<0.00001)
Household plantain consumption	−0.00002 (0.0001)	0.0002** (0.0001)	−0.00006 (0.0001)	0.00005 (0.00006)	−0.00007 (0.0001)	0.00009 (0.00007)
Home-fermented beer	−0.002 (0.005)	−0.007* (0.004)	0.009 (0.007)	−0.003 (0.003)	0.009 (0.007)	−0.006 (0.003)

Sample of women. Regressions include a full set of dummy variables for villages and years, and a constant (not shown). Standard errors in brackets. ***, **, and * significant at <10, 5, and 1%, respectively.

utes of the individual, evidence for the associations between cultural consonance in lifestyle and body morphology becomes insignificant in both real and statistical terms. The lack of significant and meaningful association is consistent for the three measures of body composition both for the sample of men and for the sample of women. Among the three indicators of socioeconomic status used as control, only household wealth bears a positive and statistically significant association with the three outcomes measured, and then only for the sample of women.

Table 4 presents the results of sensitivity analysis to test the robustness of our findings. Regressions in Table 4 resemble those in Table 2 (for men) and Table 3 (for women) except for changes market on the first column. In our first sensitivity analysis, we used raw data (rows [2]). For the results presented in Tables 2 and 3, we used log-transformed outcomes and explanatory variables to ease the interpretation of coefficients. Previous work on cultural consonance has not used such transformations. Therefore, we recomputed the regressions using raw rather than log-transformed data to test the robustness of our findings. We found essentially the same results with one exception. When using raw rather than log-transformed data, we found a statistically significant association between waist circumference and cultural consonance in the fixed-effect model ($P = 0.02$). This association was not evident using log-transformed data ($P = 0.14$).

In rows [3] to [6] (Table 4), we used different definitions of cultural consonance with log transformed (rows [3] and [5]) and raw (rows [4] and [6]) data. In rows [3] and [4], we used a definition of cultural consonance that only includes items from the cultural domain of material lifestyle (versus the cultural domain of lifestyle defined in emic terms used in rows [1] and [2]). We did so because previous research in the topic has focused on material lifestyle (Dressler and Bindon, 2000), and it is possible that items belonging to this domain might have different patterns of associations with body morphology. In rows [5] and [6], we used a more stringent definition of cultural consonance and only included items that exceeded a weighted average of 2.0 (Dressler and Bindon, 2000). The definition provides a very minimalist interpretation of lifestyle, since only includes five items (far fewer than in other studies), but presents a more coherent set of items belonging to a cultural domain. Two findings stand out. First, results using cultural consonance in material lifestyle resemble results from the core mode both when using raw and log-transformed data. Again the only difference is the statistically significant association between waist circumference and cultural consonance for the sample of women. Second, none of the regressions using the stringent definition of cultural consonance on material lifestyle is statistically significant. We return to the significance of those findings in the discussion.

TABLE 4. Robustness analysis: OLS and individual fixed-effect linear regressions of cultural consonance and measures of adult body morphology

	Changes	Waist circumference, log		Weight, log		BMI, log	
		Men					
		[a] OLS	[b] Fixed effects	[c] OLS	[d] Fixed effects	[e] OLS	[f] Fixed effects
[1]	Cultural consonance in lifestyle, log	0.017* (0.009)	0.009 (0.006)	0.025** (0.012)	0.002 (0.005)	0.026** (0.012)	0.004 (0.005)
[2]	Cultural consonance in lifestyle, raw data	0.120* (0.075)	0.044 (0.046)	0.127* (0.075)	−0.007 (0.030)	0.050* (0.029)	0.004 (0.012)
[3]	Cultural consonance in material lifestyle, log	0.15* (0.008)	0.002 (0.006)	0.25** (0.011)	0.005 (0.005)	0.026** (0.011)	0.006 (0.005)
[4]	Cultural consonance in material lifestyle, raw data	0.016* (0.083)	0.023 (0.056)	0.185** (0.087)	0.011 (0.035)	0.074** (0.033)	0.012 (0.014)
[5]	Cultural consonance with items with high consensus, log	0.012 (0.009)	−0.006 (0.006)	0.014 (0.013)	−0.002 (0.005)	0.014 (0.013)	0.001 (0.005)
[6]	Cultural consonance with items with high consensus, raw data	0.156 (0.157)	−0.014 (0.094)	0.134 (0.164)	0.007 (0.061)	0.056 (0.063)	0.016 (0.024)
		Women					
		OLS	Fixed effects	OLS	Fixed effects	OLS	Fixed effects
[1]	Cultural consonance in lifestyle, log	0.016** (0.008)	0.010 (0.006)	0.011 (0.011)	−0.00003 (0.005)	0.011 (0.011)	0.001 (0.005)
[2]	Cultural consonance in lifestyle, raw data	0.287** (0.117)	0.202** (0.087)	0.121 (0.099)	0.010 (0.038)	0.047 (0.044)	0.019 (0.019)
[3]	Cultural consonance in material lifestyle, log	0.016* (0.009)	0.012* (0.006)	0.007 (0.012)	0.001 (0.004)	0.007 (0.012)	0.003 (0.005)
[4]	Cultural consonance in material lifestyle, raw data	0.292** (0.142)	0.170* (0.106)	0.125 (0.124)	−0.003 (0.047)	0.045 (0.053)	0.022 (0.023)
[5]	Cultural consonance with items with high consensus, log	0.011 (0.010)	0.011 (0.008)	0.006 (0.013)	−0.002 (0.005)	0.005 (0.013)	−0.001 (0.005)
[6]	Cultural consonance with items with high consensus, raw data	0.249 (0.182)	0.194 (0.133)	0.092 (0.155)	−0.029 (0.058)	0.030 (0.068)	0.002 (0.029)

Regressions resemble those in Table 2 (for men) and Table 3 (women) except for changes noted on the column "Changes." Regressions include the same controls than in Table 2, a full set of dummy variables for villages and years, and a constant (not shown). Standard errors in brackets. ***, **, and * significant at <10, 5, and 1%, respectively.

DISCUSSION

In this article, we have examined the association between cultural consonance in lifestyle and adult body morphology using panel data from a society of foragers–farmers in the Bolivian Amazon in the early stages of integration with the surrounding market economy. Drawing on previous evidence that mean body size increases with socioeconomic status in societies in the

early stages of economic development (Brown and Konner, 1987; Bindon, 1995; Gremillion, 2005), we expected to find a positive association between adherence to the cultural model, or cultural consonance, and measures of body morphology. Four main findings emerge from the work presented here. First, Tsimane' understanding of the categories that constitute their lifestyle differs from categories used in previous research. Second, once we take into account cultural consonance, measures of socioeconomic status are not associated with measures of body morphology among the Tsimane'. Third, we found the expected positive association between cultural consonance and anthropometric measures mostly for the sample of men. The association was low in real terms. Last, the association found mostly held when using OLS regression models, but not when using fixed-effects regression models. We organize the discussion around those four findings.

Our first finding relates to the construction of the index of cultural consonance in lifestyle. We used an emic perspective to define Tsimane' understanding of lifestyle. Our data suggest that the analytic distinction between material lifestyle and social relations does not apply well to how Tsimane' see the world. When asked to list items associated with a "good life," Tsimane' mentioned items that previous research has integrated in two different analytic categories: "material" and "social" lifestyle. Thus, Tsimane' own definition of lifestyle limits the possibility to test whether the expected association with body morphology follows the patterns found in previous research. Previous research in the topic has focused in "material" lifestyle (Dressler and Bindon, 2000). In our robustness analysis, we test the idea that consonance in material—but not social—lifestyle has a strong association with body morphology. The results, however, should be taken with caution because those definitions present an etic understanding of what represents a "good life" for the Tsimane'. In sum, differences between previously used and Tsimane' own definition of the cultural domain of lifestyle hamper our ability to directly compare our findings with previous findings.

Keeping this methodological caveat in mind, we center the rest of the discussion on three substantive findings from our core model. Previous researchers have proposed that, for societies in the earliest stages of economic development, socioeconomic status is directly associated with body mass because people with high socioeconomic status have ample access to food resources without the associated energy expenditure of heavy physical labor (Brown and Konner, 1987; Bindon, 1995; Gremillion, 2005). Apparently, this pattern does not hold for the Tsimane'. In our OLS estimation models and mainly for the sample of men, we found that cultural consonance is generally associated positively with body morphology, but none the standard indicators of socioeconomic status has a meaningful association with body morphology. A potential explanation for the lack of association is that, as reported for other societies (Ezeamama Amara et al., 2006), insufficient variability in socioeconomic status in the sample and the relatively limited opportunity for upward mobility among the Tsimane' (Godoy et al., in press) attenuate the association between socioeconomic status and fatness. This argument is especially helpful in explaining why for the sample of women none of the standard measures of socioeconomic status, including cultural consonance, is consistently associated with body morphology.

Our third important finding relates to the low real magnitude of the association found for the sample of men. For example, our data suggest that a 10% increase in cultural consonance is associated to a 0.16% increase in waist circumference. One would have to double cultural consonance (an unlikely event due to the low variation in this measure) to observe a not so large 1.7% increase in waist circumference. Thus, although the association is significant in statistical terms, its real magnitude is low.

Our last important finding relates to the contradictory findings in OLS and fixed-effect models regarding the expectation that cultural consonance will be associated to anthropometric measures. Remember that the association discussed before mostly holds for estimations using OLS models and only holds for estimations using fixed effects with the raw data for the sample of women. What accounts for the difference? As explained before, an individual fixed-effect model removes the confounding role of all time-invariant attributes that might bias results of an OLS estimate. Results from our fixed-effect regression suggest that there is no association between cultural consonance and body morphology after conditioning for fixed attributes of the individual. What invariable characteristics of the individual might be associated both with an individual's desire and ability to converge with the norm and with her body morphology? Potential candidates are genes and stable personality traits. For example, some stable personality traits might contribute to both a person's desire to converge to the group cultural norms and also influence her decisions about exercise and diet and—through these paths—affect body composition. It is also possible that the effect of cultural consonance on body morphology was established in childhood or adolescence (for example by associating a given lifestyle with a given body morphology) and thus it is "fixed" for the purpose of our estimations.

The previous explanation, however, leaves unanswered the apparent association between cultural consonance and waist circumference for the sample of women when using fixed-effects models. We do not have a clear explanation for this finding other than waist circumference for women—more than the other two anthropometric measures—might be explained by the number of pregnancies and the proximity of those to the time of measurement. As we did not have information to control for those factors, the association found might be bias for the role of those omitted third variables.

In sum, overall our findings do not provide enough support to the idea that, among the Tsimane', adherence to the cultural model, or cultural consonance, is associated in a positive and meaningful real way to measures of body morphology. When we found such association (i.e., mostly for the sample of men and mostly using OLS estimations) the magnitude was low. Furthermore, our fixed-effect estimations suggest that results from OLS estimations inflate both the level of statistical significance and the magnitude of the parameters estimated by omitting individual fixed attributes that affect both the explanatory and the outcome variables measured. The comparison of estimates from OLS and fixed-effect regressions suggests that previous findings on the effects of cultural consonance on body morphology and other health outcomes using cross-sectional data should be read with caution, because the association might vanish once one takes into account fixed characteristics of individuals.

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