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# Modernization and culture loss: A natural experiment among native Amazonians in Bolivia

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Abstract (321 words)

*Aim*. The loss of culture of indigenous groups has been central to cultural anthropologists because it represents the irreversible loss of humanity's heritage and diversity, but convincing evidence has been hard to amass given the absence of long-term data, selection bias, and the endogeneity of culture loss. We exploit a natural experiment to assess secular (long-term) change in culture in a native Amazonian society of foragers-farmers in Bolivia (Tsimane'). The experiment consists of an exogenous, unexpected arrival of foreigners (e.g., missionaries) into the Tsimane' territory during the late 1940s and early 1950s. We estimate and compare rates of cultural change before and after the arrival of outsiders to the Tsimane' territory to assess the hypothesis that modernization erodes the local culture of native Amazonians.

*Methods*. 547 Tsimane' over 16 years old were asked eight questions about their orientation to Tsimane' cultural values (e.g., preference for cross-cousin marriage) during 2007. We computed an overall index of attachment to Tsimane' values based on the responses to the questions. We estimated the secular change in culture by regressing a person's index against decade of birth while conditioning for age, sex, and maximum schooling. We used different regression techniques to compare rates of change among people born during 1911-1980, particularly people born before and after the arrival of outsiders.

*Results*. We found no significant secular change in cultural values among Tsimane'. People who reached adulthood or who were born before the arrival of outsiders did not differ in their cultural index from those born after the arrival of outsiders.

*Conclusions*. The absence of a secular loss in the overall index of cultural values might be related to the fact that (a) modernization can produce countervailing effects on cultural orientation, eroding orientation to some aspects of local culture and strengthening orientation to other aspects of local culture and (b) Tsimane' have been able to retain a high degree of autonomy in how they take part in national society.

*Key words*: Bolivia, Tsimane', Tsimane' Amazonian Panel Study (TAPS), secular trend, culture, acculturation, culture loss

> Cada visión del mundo que se extingue, cada cultura que desaparece, disminuye la posibilidad de vida.
>
> Octavio Paz, *El Laberinto de la Soledad*, 1950

## Introduction

Since the nineteenth century cultural anthropologists have debated the definition and measure of culture (Stocking 1982; Brumann 1999; Kuper 1999; Keesing 1972; Bowen 1995; Shweder 1993; Steedly 1999; Marcus and Cushman 1982). Cultural anthropologists have equated culture with one or more of the following: values, shared knowledge, observed behavior, social organization, language, and technology (Kluckhohn and Kroeber 1963; O'Meara 1997; Harris 2001a, 2001b; Murphy and Margolis 1995). Over time, definitions of culture have focused more on values or on norms, than on observed behavior or on material items (Harris 2001a; Boyd and Richerson 1994).

The loss of culture of minority groups or acculturation has played a pivotal role in cultural anthropology, in part because the loss represents the irreversible loss of humanity's heritage and diversity, as Octavio Paz's epigraph suggests. Boas stressed the imminent loss of North American Indian languages, values, and material culture to gain public support for salvage ethnography (Stocking 1982; Godoy 1977), and years later Boas's students put acculturation at the center stage of the academic and policy agenda of cultural anthropology (Linton 1940; Redfield et al. 1936). The meaning of acculturation has varied over time within and outside of cultural anthropology (Rudmin 2003; Chun et al. 2003), but at present the term connotes the loss of culture of a minority group and its replacement by the culture of the majority group. In this paper we use the terms *acculturation* and *culture change* interchangeably to mean the change (typically loss) in the culture of a minority group from interactions with the culture of a majority group.

Acculturation has been singled out as pervasive among native Amazonians. Murphy (1960: 179) spoke of Mundurucú society of Brazil "hurrying to its own demise" and blamed the "technology of the industrial world" for ultimately destroying Mundurucú society (Murphy and Murphy 1985: 24). Harner (1971: 210-211) spoke of the Jívaro of Ecuador as one of the "few cultures in the history of the world that have been so rapidly and significantly disintegrated by the simple introduction of centralized 'law and order'" and went on to say that "the traditional culture and society of the Jívaro are on the wane". Writing about the Sharanaua of Peru, Siskind (1975: 188) said she was "sad to see another culture vanish, another variety ground into the homogeneity of Western culture". Wagley (1977: 289) forecasted that the Tapirapé of Brazil would "become acculturated in the direction of the demographically and politically dominant national society", and said that it would only be "a generation or so until the Tenetehara [became] peasants and Brazilians" (Wagley and Galvão. 1949: 183). Steward and Faron (1959: 469) lamented that the lure of "innumerable knickknacks and baubles produced by the factories of civilized nations" started an "irreversible trend" of culture loss among native Amazonians.

The conclusion that native Amazonian societies face an imminent loss of culture from continual contact with the Western world is questionable for at least two reasons. The first reason has to do with the lack of a tight fit between the conclusion and the empirical evidence, and the second reason has to do with methodological requirements necessary to make valid inferences about culture loss.

Before discussing the two reasons, one must recognize that, like species, most cultures will likely disappear over the broad swath of human history (Richerson and Boyd 2004), but in the short run some types of exposures to the outside world and the market might accelerate or depress the rate of cultural change. Clearly the debate about culture change in relation to contact with the rest of the

world centers chiefly on how culture changes in the short run. Cultural change is an individual and a collective process; in contact with other cultures, individuals will tend to adopt new behaviors or ideas from other cultures if borrowing increases the probability of survival and if individuals recognize similarities between themselves or their original culture and the new culture (Boyd and Richerson, 2005:107). Cultural change and culture extinction are difficult to measure because they require at least three types of information from the groups that disappeared: "the number of extinctions, the number of years over which the extinctions took place and the number of groups among which the extinctions took place" (Boyd and Richerson, 2005: 209). Outside of archaeology, Boyd and Richerson provide some of the best evidence to show that culture changes at a geologic tempo. Studies in Papua New Guinea with more than 20 ethnic groups suggest that cultural change can take 11-200 generations to happen, and that this change depends on intrinsic and extrinsic factors specific to each group and culture. For these reasons, Boyd and Richerson (2005: 219) conclude that the rate, trajectory, and end point of culture change are difficult to determine.

The claim that continual exposure to the outside world erodes the culture of native Amazonians does not mesh well with the historical and with the ethnographic literature. These literatures suggest that native Amazonians have used a wide range of strategies to retain their culture. One strategy took the form of utopian movements to hold on to aspects of their local culture (Brown and Fernandez, 1991; Lehm 1991; Varese 1973). For example, in the Bolivian lowlands two groups of native Amazonians, the Mojeño and the Yuracaré, gave up the trappings of the modern world and withdrew farther into the backlands (Lehm 1991) . Other Amazonian groups had no messianic movement, but still withdrew farther into the backlands to avoid the onslaught of foreigners (Milton 1992; Shepard 2002; Montenegro and Stephens 2006; Johnson 2003; Wagley 1977: 275; Cormier 2003: 4-5; Rival 2002: 43-44). Johnson (2003: 36) notes that even at present,

the Matsigenka of the Peruvian Amazon reduce exposure to missionaries, whites, and researchers by "locating away from the river," hiding, escaping, and by "disguising their trails".

Another strategy used by some native Amazonian "refractory societies" (Rival 2002: 43) to retain their culture consisted not in retrenching, but in fighting intruders (Ferguson 1989, 1990; Warren et al. 1989; Brown 1994; Brown and Fernandez 1991; Reeve 1994). Holmberg (1950: 63) notes how the "unwarlike" nomadic Sirionó of eastern Bolivia killed whites, other Indians, and rubber tappers in retaliation for encroachment. Maybury-Lewis (1965: 17) said that as "more and more colonists poured" into the territory of the Shavante in Brazil, the Shavante "withdrew westwards and disappeared into the unmapped wilderness of Mato Grosso". Elsewhere he describes the history of Shavante resistance to outsiders (Maybury-Lewis 1967: 3-4), including the killing of missionaries and officials from Brazil's Indian Protection Service. Yolanda and Robert Murphy (1985) document how the Mundurucú fought missionaries, white Brazilians, and traders to repel them from the land of the Mundurucú.

The mix of resistance, utopian movements, and withdrawal from intruders partly explains why despite efforts by missionaries and outsiders to change the culture of native Amazonians, the efforts often produced weak results. Writing about the Cubeo of northwest Amazon, Goldman (1979: 16-17) noted that after many years of proselytizing, missionaries had "left only a vague imprint in native religious practices", and went on to hypothesize that the "resistance" (his word) of the Cubeo to cultural loss and breakdown reflected their relative isolation, cosmopolitanism, and their ability to "adopt foreign objects and foreign customs without losing their sense of identity as Indians". Wagley and Galvão echoed the finding of Goldman in writing about the Tenetehara of Brazil. Tenetehara culture, they (1949: 178) said, survived centuries of onslaught owing to the ability of the Tenetehara to incorporate selected aspects of Brazilian culture.

These strands of evidence – resistance against intruders, retreat into the hinterlands, selective incorporation of the culture of outsiders, utopian movements, and an ecological setting that made it hard for westerners to settle permanently in the Amazon and change the local culture (Hemming 2008; Lockhart and Schwartz 1983: 279) – all likely contributed to the preservation of some native Amazonian cultures, raising doubts about the generalization that sustained contact with Western society inevitably erodes the culture of native Amazonians.

Next consider the many methodological difficulties of testing the hypothesis that sustained exposure to Western culture abrades the culture of native Amazonians. First, to test the hypothesis requires systematic observations of culture over time, which, to our knowledge, is rare in cultural anthropology and in Amazonia (Leonard and Godoy 2008). Ethnographies of native Amazonian societies routinely include a section on culture change drawn from historical research or from people's recollection of events in the past, but these ethnographies, including the occasional re-study (Burkhalter and Murphy 1989), lack systematic observations over one or more generations to be fully convincing. Second, the change of culture in one native Amazonian society from exposure to Westerners might not be unique to that society. Even societies without much contact also experience culture change. Thus, to estimate the effect of outside exposure on culture change requires a control group or a counterfactual – a benchmark against which one can compare the observed cultural change. A third methodological difficulty has to do with selection bias. Native Amazonian societies that disappeared from epidemics or from enslavement by outsiders (Diamond 1999; Hemming 2008) are not observed by the researcher, fall outside of the sample used in the analysis, and so might bias inferences about how exposure to Westerners affects culture change since the inferences draw only on a sub-sample of the population. Ideally, one would want to first

estimate the probability of a culture being observed by the researcher, and then estimate the effect of contact on culture change conditional on the probability of being in the sample of observed data.

A fourth methodological difficulty has to do with the endogeneity of contact. That is, native Amazonian societies exercised some choice on the amount of exposure to the culture of outsiders. As noted earlier, some fought, some withdrew, but some also voluntarily moved closer to the culture of outsiders. Guss (1989: 10-11) notes that this might have happened because Europeans sometimes brought peace to areas that had experience internecine conflict before their arrival. But movement closer to the culture of outsiders could also reflect traits of individuals, not just inter-ethnic conflicts. As in any society, among native Amazonians one sees traditionalists or those who cling obstinately to the old ways, and modernists or those who seek change (Hill and Hurtado 1996; Murphy 1960: 51). Writing about the Mundurucú in Brazil, Murphy (1961) long ago hypothesized that modernists were people at the "edge of society" who saw in the outside world new opportunities and a way to free themselves from the shackles of superannuated customs (Ehrenreich 1990). Contact with the outside world, he implied, simply allowed a native Amazonian society to split, with some people sidling to outsiders with others recoiling from the modern world. If so, then empirical estimates of the effects of contact, trade opening, modernization, or market exposure on culture change will be biased unless one controls for adventuresomeness or for the propensity to seek novelty and change or, more broadly, unless one controls for the endogeneity of exposure to outsiders.

In this article we contribute to the empirical literature on the direction, magnitude, and rate of culture change among minority groups that form part of larger, stratified societies, but do so from a novel empirical and methodological angle that allows us to overcome many (but not all) of the methodological difficulties just noted. Specifically, we exploit a natural experiment that allows us

to estimate the amount of cultural change in a native Amazonian society from exposure to outsiders. We equate the term *outsiders* with the rest of the world, except for other native Amazonians. Until the late 1940s and the early 1950s, the Tsimane', a native Amazonian society of foragers and slash-and-burn farmers in Bolivia, had only sporadic contact with *mestizos* (people of mixed Indian and European heritage) and with foreigners. Nevertheless, during the late 1940s and the early 1950s, Protestant missionaries from the USA arrived in the Tsimane' territory and settled permanently to convert Tsimane' to the Protestant faith (Huanca 2008). Soon after the arrival of missionaries, the Bolivian government built roads cutting through the Tsimane' territory and highland farmers started to pour into the region drawn by government incentives to settle in the lowlands. Later we describe the activities of the Protestant Missionaries in the Tsimane' territory and the history of contact with outsiders from the 1950s onward, but for now we simply note that the unexpected arrival of missionaries and outsiders, and their permanent presence thereafter, provides a nearly ideal natural experiment to examine the change in cultural values among Tsimane' between those who were born and reached adulthood before the onslaught of outsiders, and those who were born and reached adulthood afterwards.

The use of natural experiments (also known as quasi-experiments) to estimate causal effects is common in neighboring disciplines (Card 1990; Angrist and Krueger 2001; Meyer 1995; Rosenzweig and Wolpin 2000), but is rare in cultural anthropology (Durrenberger 1999; Bernard 2001). In cultural anthropology the term natural experiment is sometimes used as a synonym for a controlled comparison (Fox 2002), but we use the term here as it is used in public health, economics, history, and in other disciplines to describe changes in an outcome from an unexpected, exogenous shock. The shock allows one to estimate the rate of change in the outcome before and

after the shock, and compare the rate of change against a benchmark or group that did not experience the shock.

The natural experiment: The analytics

The ideal natural experiment contains baseline information on the outcome for a control and for a treatment group, or for the group subject to the exogenous shock. Ideally, both treatment and control groups are nearly identical in the outcome at baseline; the only difference between the treatment and the control group is the exogenous shock affecting the treatment group. The outcome is measured on one or more occasions before and after the shock among both the treatment and the control group. The difference in the rate of change between the treatment and the control group captures the net effect of the intervention.

The case study discussed here fits well with most but not all of the requirements of an ideal natural experiment. The treatment group, the Tsimane', is exposed to the intervention, which consists of the sudden arrival of outsiders -- continuously from the middle of the twentieth century onward. The intervention includes exposure to many different types of actors, including: (i) missionaries, (ii) traders, (iii) representatives of the government and other organizations, (iv) encroachers, and (v) researchers. In addition, the intervention also includes exposure to the media (mainly radio). Because the intervention includes many different types of actors, one cannot identify the specific aspect of the intervention affecting the outcome. The shortcoming works in our favor since we want to estimate the net effect of all exposure to outsiders on the rate of cultural change of Tsimane'.

The outcome – core cultural values of Tsimane' internalized before adulthood (described later) – is assumed to be relatively fixed after people reach adulthood (Inglehart and Wezel, 2005), so one can estimate secular (long-term) trends in the outcome using birth periods, and compare

outcomes between people who reached adulthood before sustained contact with outsiders took place, with people who reached adulthood after sustained contact with outsiders took place. We use the word *contact* loosely, to describe continuous exposure to *outsiders*. The approach just describe is routinely used to study secular trend in outcomes that do not change much after adulthood, such as standing height, language skills, or maximum schooling (Dufour et al. 1994; Borjas 2005; Godoy et al. 2006, 2009a; Malina et al. 2004).

This said, the natural experiment we are about to describe is deficient in one respect: it lacks a control group. The ideal control would have been a nearly identical native Amazonian society without exposure to outsiders, only a theoretical possibility in the area surrounding our research site and rare in Amazonia. The use of natural experiments without a control group is common in many fields either because there is no convincing control, or because the trend in the counterfactual – even if it existed – can be assumed to be negligible (Fishman and Miguel 2007; Feyrer and Sacerdote 2009). Cognizant of this shortcoming, we later try to address it in two ways. First, we use piecewise linear regressions to assess if there is a large break in the secular trend of cultural orientation between the two periods. Second, we turn to the World Values Survey (WVS) – an international, repeated cross-sectional comparative study of cultural values -- to examine secular trends in cultural values in neighboring nations to Bolivia, and use those trends as a control.

## Hypotheses and their rationale

*H1: Sustained exposure to outsiders does not erode local cultural values of native Amazonians*. Among the Tsimane', reasons for cultural preservation include one or more of the following factors described in the next section. *(a)* Rugged and ample terrain at the foothills of the Andes, which allowed Tsimane' the option of retreating toward less accessible regions in response

to encroachment. Even at present, Tsimane' will sometimes leave their villages near towns and move farther into the backlands to have access to more wildlife. *(b)* We know of no study of utopian movements among the Tsimane', but the neighboring Yuracaré and Mojeño had messianic movements well into the twentieth century (Lehm 1991), so it is possible that the Tsimane' drew inspiration from neighboring native Amazonian cultures (with whom they sometimes inter-marry) to abstain from the allure of Westerners. *(c)* Near market towns, the presence of outsiders has been constant over the last half century, but farther away in the backlands, the presence of outsiders has been intermittent. *(d)* Results from other developing nations suggests that "there is little evidence of intergenerational change in cultural values in low-income societies" (Inglehart and Welzel, 2005: 111).

*H2: Sustained exposure to outsiders erodes local cultural values*. Continual exposure to outsiders could erode local cultural values if national society devalues local culture and if Tsimane' depend on employment and are stuck having to interact everyday with outsiders. The lure and prestige of goods from the modern world could set in motion cultural loss, a line of thinking consistent with the views of cultural anthropologists discussed in the introduction.

## The Tsimane': History of contact with outsiders

The Tsimane' number ~8,000 persons and live in ~100 villages, mostly in the department of Beni (Government of Bolivia 1995). Only 7.15% of Tsimane' live outside of the department of Beni (Instituto Nacional de Estadística 2003). Most Tsimane' live in villages of ~20 households, with an average of ~6 persons/household. Like many native Amazonian societies, Tsimane' practice preferential cross-cousin marriage, and for their subsistence they rely on a combination of

hunting, fishing, plant collection, and slash-and-burn farming, with cash cropping of rice becoming the dominant economic activity of households (Vadez et al. 2004).

The first recorded contact of Tsimane' with westerners goes back to the seventeenth century (Huanca 2008), but continual exposure to westerners dates back only to the late 1940s. Mobile, scattered, decentralized, and politically acephalous, Tsimane' avoided sedentary living in Catholic missions or in Spanish towns from the sixteenth century until the twentieth century. Tsimane' history from the seventeenth century until the eighteenth century is peppered with attacks against Catholic missionaries and Spanish towns (Chicchón 1992; Ellis 1996). We do not have information to assess how the rubber, quinine, and mineral booms of the nineteenth and early twentieth century in Bolivia affected the Tsimane', but they probably had a weaker effect than among neighboring native Amazonian groups because Tsimane' lived in small, scattered, and mobile settlements, making it hard for employers to recruit Tsimane' laborers (Chicchón 1992); also, the Tsimane' territory lacks rubber trees. During the 1920s and 1930s, some Tsimane' worked sporadically in cattle ranches and in the farms of *mestizos* who had moved to the area (Huanca 2008) The boom in pelts (1940-1970) affected some Tsimane' communities, but not enough to cause dislocation of settlements or modes of production; Tsimane' acquired firearms, but continued to sell pelts and to buy goods in their villages rather than relocate to towns (Jones 1995).

The late 1940s and early 1950s produced a torrent of socioeconomic changes in parts of the Tsimane' territory. The changes included the establishment of permanent Catholic and Protestant missions, the expansion of cattle ranches, and the building of roads across the Tsimane' territory as part of a government policy to thin out the highlands by encouraging the migration of smallholders from the highlands to the lowlands (Riester 1993; Jones 1995).

Agents of change have included Catholic and Protestant missionaries, traveling traders, encroachers, and many types of private and public organizations (Godoy et al. 1998). Encroachers and traders hire Tsimane', buy crops and forest goods from them, and supply Tsimane' with commercial goods and credit. Non-government organizations started working in the area during the late 1980s in development projects related to health, education, farming, land demarcation, and to the sale of forest goods.

To earn monetary income Tsimane' work as unskilled laborers in cattle ranches, logging camps, and in the homestead of colonist farmers, or else sell goods from the forest or from their farms. Sale of goods take place in villages when traveling traders arrive to the village, or in towns when Tsimane' take goods to sell (Godoy et al. 2007b).

The work of Protestant missionaries in the Tsimane' territory took off during the 1950s when the Bolivian Government gave missionaries the responsibility of schooling remote lowland native Amazonian populations such as the Tsimane' (Castro Mantilla 1997). The agreement lasted from 1954 until 1985. As part of the agreement, missionaries in 1955 set up a center in the town of Tumichuco, several days away from the Tsimane' territory, to train Tsimane' to become bilingual school teachers and to translate the Bible into the Tsimane' language. Protestant missionaries offered scholarships to promising Tsimane' young men so they could attend Tumichuco for three months each year to work as consultants for missionary linguists. In Tumichuco missionaries taught Tsimane' academic and practical skills (e.g., modern hygiene) and the Scriptures so Tsimane' could proselytize in the Tsimane' language when they returned to their villages. After 27 years of operating in Tumichuco, missionaries transferred their training center to the outskirts of the town of San Borja (population ~19,000), in the main Tsimane' territory. After receiving training, schooled Tsimane' returned to their villages, where they worked as lay missionaries and as teachers

using instructional materials in the Tsimane' language prepared by missionaries. In 1985, when the agreement with the Bolivian Government ended, the government took over the responsibility for educating the Tsimane', which meant keeping Tsimane' as schoolteachers and paying their salary.

Protestant missionaries left the Tsimane' territory in 2008. Until their departure, they produced the textbooks used in Tsimane' classrooms, ran training seminars for Tsimane' teachers, and offered courses in reading and writing twice a year for Tsimane' adults. In 1989, Protestant missionaries "mobilized the bilingual teachers they had trained" (Chicchón 1992) to create the Great Tsimane' Council to represent Tsimane' against the rest of the world and to help Tsimane' fight illegal encroachers in court. The Great Tsimane' Council acts as the umbrella government for all Tsimane' in official business with the outside world. All these activities of missionaries – preparing school material in the Tsimane' language, training teachers to instruct in the local language, helping to create the umbrella government for all Tsimane' – likely helped to preserve Tsimane' culture.

But paralleling this line of work of missionaries, one finds a second line of work that explicitly eroded Tsimane' culture. Protestant missionaries inveighed against shamans, the use of myths and legends, particularly those dealings with human origins, and the traditional drinking of fermented *chicha*. Among native Amazonians, the drinking of *chicha* is the preferred ways of displaying sociability or conviviality (Overing and Passes 2007; Godoy et al. 2009b); these activities of missionaries likely helped to erode Tsimane' culture.

Despite five decades of intermittent exposure to outsiders, Tsimane' retain a high degree of autarky or economic self sufficiency. Goods bought in the market account for only 2.68% of the total value of household consumption of goods. About half (49.70%) of adult women, 77.86% of adults in the bottom income quintile, and 45.30% of adults living far from the market town did not

earn any monetary income during the two weeks before the day of the interview (Godoy et al. 2007b).

## Materials and variables

### *Materials*

The study builds on an annual panel or longitudinal study in progress among the Tsimane' in 13 villages along the Maniqui River, department of Beni (Leonard and Godoy 2008). The panel study started in 2002 and continues to this day. We selected the 13 villages to capture geographic variation in closeness to the market town of San Borja (mean village-to-town distance=25.96 km; standard deviation [SD]=16.70), the only town along the Maniqui River. The panel study includes all the people in the 13 villages. For this article we draw on the 2007 survey because it included a module on cultural orientation, described later, which we gave to people over the age of 16.

Five hundred and forty seven people (women=280; men=267) from 239 households answered the 2007 module on cultural orientation. We included people younger than 16 years of age if they headed a household. We selected 16 years of age to define an adult because Tsimane' usually set up their own households by the time they reach this age. At about 16 years of age they are responsible – depending on their gender -- for their own farm plots and are in charge of fishing, hunting, plant collection, and other activities that go with maintaining a household. The 13 Tsimane' villages of the study mirror well the rest of the Tsimane' population in a variety of outcomes (e.g., anthropometric indicators of nutritional status, income). Unfortunately, we have no way of assessing how representative the measures of cultural values from the 13 villages of this study are of the rest of the Tsimane' population. The 2007 survey lasted about one hour/adult and usually took place in the home of the study participant. Four Bolivian university graduates

conducted the surveys and four Tsimane' who worked in the panel study from its inception served as translators.

*Variables*

The two main variables in the analysis include a person's attachment to Tsimane' cultural values (outcome variable) and a person's birth date, the chief explanatory variable.

*Orientation to Tsimane' Cultural values – outcome variable*. We equate culture with values to be consistent with the way most cultural anthropologists at present define culture. Furthermore, by narrowing the definition of culture to values we facilitate the measure of culture. An omnibus definition of culture would make it hard to attain precision in measurement.

To create the variable for culture, we drew on our long-term research among the Tsimane' and identify eight topics and questions that capture core cultural values of the Tsimane' (Huanca 2008). The topics have to do with agriculture, spirituality, and daily activities that differentiate the culture of Tsimane' from the culture of outsiders. We asked study participants eight questions to elicit how much importance they attached to the following events: cross-cousin marriage, communal fishing with plant poison (Pérez 2001), farming rituals, use of medicinal plants, and rituals related to the use of forest resources. Appendix 1 contains the survey questions.

We asked study participants to rank on a scale from one to five how much importance they attached to a value. We pilot tested the questions during the summer of 2006 and found that culturally appropriate visual cues and references to known Tsimane' individuals enhanced respondent's understanding of the questions. The visual cue we used was a ladder with two scenes, one at the bottom and one at the top of the ladder. Ladders are familiar objects to Tsimane' because they make them to reach the upper portions of their houses, where they often store crops and tools. We showed study participants a ladder with five steps, and two drawings at each end of the ladder.

The two drawings at the ends of the ladder represented a "traditional" Tsimane' and a "modern" Tsimane'. For example, the drawing of a "traditional" Tsimane' included a man with a bow and arrow carrying a locally made cotton bag. For each respondent, we randomized the location in the ladder of the "traditional" and of the "modern" scene, so each respondent always saw the "traditional" or the "modern" scene in the same place in the ladder when answering the eight questions about cultural values. We selected at random whether to put the "traditional" or the "modern" scene at the bottom or at the top of the ladder just in case there was a bias for the top (or for the bottom) of the ladder as being more (or less) desirable. Of the 547 surveys, 349 (63.80%) had the "traditional" scene at the top of the ladder and 198 (36.20%) had the "traditional" scene at the bottom of the ladder. For any one question, we showed study participants the ladder and asked them to point to where they would place themselves in the "traditional"-to-"modern" continuum in the ladder. We prefaced the question by making reference to Tsimane' who are well known to be "traditional" or "modern". Since each step of the ladder had an implicit number from one to five, surveyors could code the answer of the respondent after the respondent had pointed to the step in the ladder.

We next illustrate the procedure with the question of preference for cross-cousin marriage. First we showed the study participant the ladder, with, say, the traditional scene at the top of the ladder and the modern scene at the bottom of the ladder, with the choice of location of the modern and of the traditional scene having been selected at random for each study participant before the interview. We then said: "Some Tsimane' such as ..… [(a) surveyor provides the name of some well-known Tsimane'] in the village of …. [(b) surveyor names village of current residence of people named under (a)] like to marry their cross cousin [surveyor points to the scene at the top of the ladder], but other Tsimane' such as … [(c) surveyor provides the name of some well-known

Tsimane' who do not appear under (a) ] in the village of …. [(d) surveyor names village of current residence of people named under (c)] marry people who are not their cross-cousin [surveyor points to the scene at the bottom of the ladder]. How important is it for you that your children marry their cross cousin? Are you more like…. [surveyor names people and points to the relevant part of the ladder] or are you more like … [surveyor names people and points to the relevant part of the ladder]?" With these prompts, study participants pointed to a step in the ladder that best captured their preference for cross-cousin marriage.

Because we randomized the placement of the traditional scene in the drawing, a higher score sometimes could represent greater orientation to Tsimane' culture, but sometimes a higher score could reflect lower orientation to Tsimane' culture. Recall from the earlier discussion that answers to each question could range from one to five. To harmonize answers we transformed values so higher numbers always captured stronger orientation to Tsimane' culture.

To create the variable of orientation to Tsimane' cultural values we added the transformed raw scores of the eight questions. Values for the new variable ranged from a minimum of eight to a maximum of 40, with a mean of 23.05 (SD=6.94; median=23). We refer to this variable as *culture test score*. To facilitate the interpretation of regression results when using *culture test score* as an outcome variable, we took the natural logarithm of this variable.

*Birth date - main explanatory variable*. We asked people to estimate their age in years. Because many adults did not know their exact age, they guessed when answering the question. Guessing introduces random measurement error in the estimate of the age variable (Godoy et al. 2006). Besides guessing, another potential source of measurement error with the age could have been misreporting of a person's last digit of age (rounding error). To test if Tsimane' rounded their

age (particularly with values ending in the digits five or zero), we computed Whipplex's Index and found no evidence of rounding error (Whipplex's Index=95.76).

During 2007-2008 a team of translators and surveyors re-appraised questionable age estimates by comparing the questionable age with the age of people of roughly similar ages with known birth records. We use the survey year (2007) and our best estimate of the participant's age during 2007 to create dummy variables for the following eight birth decades: 1911-1920, 1921-1930, 1931-1940, 1941-1950, 1951-1960, 1961-1970, 1971-1980, and 1981-1990. The dummy variables for birth decade took the value of one if the person was born in the indicated birth period (e.g., 1921-1930, inclusive) and zero otherwise. Using a person's birth date we also created the variable *born before 1934*, which took the value of one if the person was born before 1934. These people would have been ≥16 years of age by the time the treatment started (1950). The variable *born before 1934* took the value of zero if the person was born during or after 1934; these people are the post-treatment group.

As shown in the row "*Born before 1934*" and under the column "% of total population", Table 1, 5.37% of the sample was over 16 years old by the time missionaries arrived (i.e., born before 1934); they form part of the pre-treatment group. Over half (55.18%) of the sample was born between 1971 and 1990. The uneven distribution of the sample between the pre-treatment and the post-treatment periods, and the small sample size for the pre-treatment group lowers the statistical confidence one can place on parameter estimates if one has to use only one dummy variable for birth period (1=person born before 1934; 0=person born during or after 1934). Owing to the small sample size of the pre-treatment group, we also report results using the full vector of dummy variables for birth decades and stress the general trend of these coefficients.

INSERT TABLE 1 ABOUT HERE

*Control variables*

Control variables included the person's sex (1=male; 0=female), maximum school attainment, and age in years. The age variable captures the effect of the normal life cycle on the outcome, while the variables for birth period discussed earlier captures cohort effects (Godoy et al. 2009a). Table 2 contains definition and summary statistics of the variables used in the regression analysis.

INSERT TABLE 2 ABOUT HERE

Analysis

The analysis unfolds in three sequential, linked, and logical phases. First, we provide descriptive and figural analysis of secular trends in culture. Second, we carry out ordinary least squares (OLS) regressions with *culture test score* as the outcome variable and the covariates just discussed as explanatory variables. Third, we do sensitivity analysis of the main results. For the statistical analysis we use Stata for Windows, version 10 (Stata Corporation, College Station, Texas).

We ran a total of three regressions, shown below and numbered 1 to 3. For simplicity, we omit the three controls variable from the equations (age, sex, and maximum schooling). The subscript *i* stands for person i, and $\mu_i$ is the error term with standard properties. In regression (1), we use the full (n=5) set of dummy variables for birth decade for people born between 1941 and 1990 (1941-1950, 1951-1960, 1961-1970, 1971-1980, 1981-1990), but exclude people born on or before 1940. Regression (1) allows us to assess the percentage effect of the passage of time, decade-by-decade, on the cultural variables compared with people born before 1941. Regression (2) is identical to regression (1) except that in regression (2) we include only one dummy variable for

birth period; that dummy variable takes the value of one if people were over 16 years of age during 1950 (i.e., born before 1934) and zero otherwise. Regression (2) allows us to estimate the magnitude of the break or change in the cultural variables between two broad periods of time -- specifically, between people who reached adulthood before the arrival of outsiders and those who reached adulthood afterwards. In equation (3) we used a piecewise regression to test for significant cultural change after continuous exposure to the outside world. In equation (3) DOB stands for decade-of-birth and takes the value of 1 for the first birth decade (1911-1920), 2 for the second birth decade (1921-1930), and so on. DOB* stands for 4, and captures the decade of birth of the 1940s, or first birth decade of the treatment group. The variable $D_i$ is a dummy variable that takes the value of one if the person was born during or after 1941 and zero if the person was born before 1941. Regression (3) allows us to compare the difference in the rate of cultural change before and after the treatment or arrival of outsiders. $\beta_1$ captures the rate of change in culture for the pre-treatment period, and the coefficient of the interaction term, $\beta_2$, captures the difference in the rate of change in culture between the two periods. The three econometric models include:

(1) $Y_i = \beta_0 + \beta_1(\text{born 1941-1950})_i + \beta_2\ (\text{born 1951-1960})_i + \beta_3\ (\text{born 1961-1970})_i + \beta_4\ (\text{born 1971-1980})_i + \beta_5\ (\text{born 1981-1990})_i + \mu_i$

(2) $Y_i = \beta_0 + \beta_1\ (\text{over 16 years old in 1950})_i + \mu_i$

(3) $Y_i = \beta_0 + \beta_1 DOB_i + \beta_2\ (DOB\text{-}DOB^*)D_i + \mu_i$

The number of the equations above corresponds to the number of the columns in Table 3.

## Results

### *Descriptive and figural analysis*

In Figures 1-3 we plot *culture test score* on the Y-axis against decade of birth on the X-axis for the pooled sample (Figure 1), for females (Figure 2), and for males (Figure 3). We draw a vertical line in the year 1950 to signify the approximate date of the start of the influx of outsiders and we draw another vertical line in the year 1934 to signify the birth date of the youngest cohort of adults when outsiders arrived.

INSERT FIGURES 1-3 ABOUT HERE

The most striking result of the three graphs is the absence of any clear secular trend in cultural values. To estimate the secular trend for the entire period shown in Figure 1 we ran OLS regressions (not shown) with robust standard errors with *culture test scores* as the outcome and one explanatory variable that captured consecutive decades of birth (e.g., 1=born 1911-1920; 2=1921-1930, etc.). The trend for the entire period suggests a secular increase in *culture test scores* of about 0.38 points/decade ($p=0.04$) or 1.96%/decade ($p=0.03$). Because they rely on bivariate regressions, these results are only suggestive, but they hint at the idea that cultural values did not undergo large and obvious change over the period under study.

Figure 1 shows no obvious break in mean *culture test score* between pre and post-treatment groups for the pooled sample of women and men combined. To explore the idea in a more formal way, we ran regression (3) with the dichotomous variable for threshold break defined as the decade of 1930s in a first regression, 1940s in a second regression, and 1950s in a third regression. We used three different threshold break points because the sample size for the pre-treatment period is smaller the farther back in time one goes, and to explore the possibility that the youngest cohorts at the time the treatment started also could be affected by the treatment. The results of those piecewise regressions (not shown) suggest that Tsimane' culture was not significantly affected by the continual presence of outsiders in the Tsimane' territory.

The results of the analysis disaggregated by sex tell essentially the same story as the results for the pooled sample of females and males combined. Among females (Figure 2), starting with women born during 1931 onward, we see again a gradual increase in *culture test scores*. For women, the growth rate in *culture test scores* was 0.37 points/decade (p=0.16) or 1.94%/decade (p=0.11). Among males (Figure 3), we see the same pattern just described for females. The left part of the curve up to 1941 suggests that initial contact with outsiders eroded *cultural test scores*. However, starting among males born during 1941, we see again a gradual increase in mean *culture test scores*. For males during the entire period of observations, we estimate a mean increase in *culture test scores* of 0.35 points/decade (p=0.18) or 1.81%/decade (p=0.16).

We tested whether the secular change in *culture test score* differed between women and men. To do so we interacted the variable for consecutive decade of birth with sex. We then ran an OLS regressions (not shown) of *culture test score* (outcome variable) against the variable for consecutive decade of birth, the person's sex, and the interaction variable (DOB*male). We found no significant difference between females and males in the rate of secular change in *culture test score.* Compared with males, females increased their *culture test score* by 0.02 points/decade (p=0.95) or by 0.13%/decade (p=0.94), but results were not statistically significant

Table 1 contains a summary of the average values of *culture test score* by decade of birth and sex. With one exception, women and men born during the same decade had similar *culture test scores*. Among people born during 1971-1980, women scored 25.01 points (SD=5.97) while men scored 22.20 points (SD=7.47), and a t-test comparing the difference between the two mean values produced a p value of 0.01.

In sum, the visual and bivariate analysis suggests no significant change in *culture test score* between Tsimane' born before 1934 and those born during or after 1934. In fact, in the pooled

sample, among females, and among males one generally sees a slight, though statistically non-significant, secular increase in *culture test scores* beginning with people born during the 1930s.

*Main multivariate regression results*

Table 3 contains the main regression results. Two findings stand out. First, cultural values among Tsimane' born between 1941 and 1990 compared with the cultural values of their peers born before 1941 have not change significantly (column 1). Second, the arrival of outsiders starting during 1950 did not produce a significant break or change in cultural values (columns 2- 3).

INSERT TABLE 3 ABOUT HERE

The most important finding of Table 3 is the absence of a secular trend in cultural values, a result consistent with the figural and more descriptive, bivariate analysis presented earlier. The results in column 1 suggest no secular change in culture values for people in any one birth decade compared with people born before 1941. For instance, after controlling for sex, age, and maximum years of schooling, people born during 1941-1950, 1951-1960, 1961-1970, 1971-1980, and 1981-1990 scored 2%, 12%, 9%, 15%, and 19% higher in *culture test scores* than their peers born before 1941. Furthermore, the results of the test for joint significant for all the dummy variables related to birth decade, shown at the bottom of Table 3, also suggest no significant joint effect of all decade of birth dummies on *culture test scores*. The test of joint significance of the variables for birth decade in column 1 implies we cannot reject the null hypothesis that all the coefficients of the birth decades are equal to zero (column 1: $F_{(5, 491)}=0.33$, $p>F=0.89$). This test confirms the first hypothesis -- that after conditioning for sex, age, and years of schooling -- there is no significant cultural loss from one birth cohort to the next, at least not between the births cohorts studied.

In column 2 of Table 3 we show the regression results to test formally whether the arrival of outsiders is associated with a change in cultural values. Column 2 in Table 3 shows results using

only one dichotomous variable for birth period, with people born during or after 1934 as the reference group. Results shown in column 2 suggest that keeping all other variables constant, being born before 1934 was associated with an increase of 9.02% in the *culture test score* (Column 2), but the result was not statistically significant (p=0.30).

The results of column 3, Table 3, again suggest no break in *culture test scores* after the arrival of outsiders. Results in column 3 suggest that after controlling for sex, age, and maximum schooling, the mean *cultural test score* decreased by 0.24%/decade (p=0.97) among people born before 1941. Put differently, replacing in equation (3) the values of DOB and DOB* in column 3 of Table 3, among people born before 1941, *culture test scores* decreased by 0.24%/decade, and among people born during or after 1941, *culture test scores* increased by 1.69%/decade. As before, none of the variables related to birth period in column 3 were statistically significant.

*Sensitivity analysis*

The analysis presented so far is subject to at least two critiques: the absence of a counterfactual or control proper and the possibility that results may change depending on the way one estimates *culture test scores*. We next address each of the two concerns.

In relation to the first concern, there are no nearly identical, nearby, isolated native Amazonian societies, so we have no convincing control. The nearby Yuracaré and Mojeño have a long tradition of contact with Spaniards and other outsiders dating back to Colonial times. This said, we try to address the first concern by drawing on data from the World Values Survey as an indirect proxy for what is happening in the rest of the world, and more specifically in the Latin American region adjacent to Bolivia. To address the second concern we created two variables to measure orientation to different aspects of Tsimane' culture. For this end, we used principal

component factor analysis, and we used the new variables as outcome variables in regressions 1-3 to assess if the main results of Table 3 are sensitive to the way we measured orientation to Tsimane' cultural values.

*Sensitivity analysis using neighboring countries as control group.* The motivation behind this additional analysis is to estimate the secular trend in cultural orientation toward a "traditional culture" of nearby nations and compare this trend with the trend observed among the Tsimane'. One could read the secular trend in cultural orientation of neighboring nations as the secular trend of the Tsimane' treatment group if this group was actually affected by the culture of outsiders. In other words, if the treatment or contact with outsiders generated a cultural loss in Tsimane', the secular trend in cultural orientation among the Tsimane' born after the arrival of outsiders should move in parallel fashion with the cultural orientation of people in neighboring nations. One would not expect a similar trend in cultural orientation among Tsimane' unaffected by the treatment.

The World Values Survey consists of repeated cross-sectional surveys using the same surveys. The surveys are done in 81 nations (Inglehart and Welzel 2005). The purpose of the World Values Survey is to elicit information about cultural orientation using the same format, so researchers can detect trends through time. The World Values Survey has been done five times between 1981 and 2007. Of the countries in the World Values Survey, the ones nearest to Bolivia include Peru, Brazil, Colombia, Chile, and Argentina. Of these, Peru, Brazil, and Colombia most closely resemble Bolivia in economic development and in the existence of native Amazonian populations. Chile and Argentina were ranked as 40 and 46 in the Human Development Index of 2006. These two countries are relatively high in the Human Development Index compared with Brazil (70), Peru (79), Colombia (80) and Bolivia (111) (United Nations Development Program 2008), so including Chile and Argentina in the comparison would have biased the results since

these two nations differ considerably from Bolivia in socioeconomic characteristics. The indigenous population in each of the three countries chosen varies. In 2001 Bolivia and Peru had the largest share of indigenious people, with 62% and 32% of the total population classified as indigenous. The indigenous populations of Colombia (2005) and Brazil (2000) reached only 2% of the population (Guzmán et al. 2006). For each nation we used the most recent survey. The final sample sizes used here were as follow: Peru (survey year=2008; n=1500), Colombia (survey year=2005; n=3,025), and Brazil (survey year=2006; n=1,500).

The sample was stratified by province, location (rural vs. urban), sex, age, and socioeconomic status. The sample of Peru, Colombia, and Brazil includes mostly people in urban area, captures different ethnics groups within each nation, and is limited to people over 18 years of age.

To compare Tsimane' cultural change with the cultural change in the three neighboring nations we ran regression (1) using the information from the World Values Survey but added dummy variables for country of survey. The main variables from the World Values Survey include a culture variable (described in the next paragraph) used as an outcome and the same explanatory variables as those used in Table 3.

We selected the following four variables from the World Values Survey to capture cultural orientation: (1) importance of family, (2) importance of religion, (3) attitude toward technological change, and (4) self-reported religiosity. We selected these variables because they come closest in spirit to the definition of culture used in this article among the Tsimane'. Recall that the questions about cultural orientation among the Tsimane' centered on domains such as family and spirituality. Also, we chose these variables because they were available in the three countries during the last survey wave. The first three variables were coded from one to three (3=most traditional; 1=least

traditional). The question about religiosity was coded with one and zero, one when people considered themselves religious and zero otherwise. Appendix 2 contains the exact wording of the questions used in the World Value Survey.

We added the scores and created the *culture test score* for the three countries. The summary variable for culture for the three countries varied from three to ten, with a mean of 7.89 (SD=1.19). We used principal component factor analysis to determine whether the four cultural variables reflected an underlying dimension, but found that they did not. Estimates of Chronbach's alpha for each country separately also yielded low values (Peru=0.15; Brazil=0.25; Colombia=0.25). Consequently, to facilitate the comparison, we normalize separately the *culture test scores* of both the Tsimane' and the neighboring nations. For neighboring nations we calculated separate Z scores for each nation.

In Figure 4 we compare the secular change of culture test score among the Tsimane' with the secular change of culture test scores in neighboring nations, with culture test scores expressed as Z scores or as standard deviations from the mean value for each culture. As Figure 4 shows, neighboring nations started with slightly higher values in standardized cultural test scores, but over time the values decreased at the rate of 0.07 standard deviations/decade ($p<0.01$). In other words, neighboring nations have become less traditional with the passage of time. On the other hand, Figure 4 suggests that Tsimane' started with a lower value in the standardized culture test score, but the value increased at the rate of 0.05 standard deviations/decade ($p=0.04$), consistent with some of the analysis presented so far. Figure 4 suggests that during the early 1960s the rates of cultural change converged, and started to divert thereafter, with Tsimane' showing a trend toward a more traditional culture, and neighboring nations showing a trend toward a less traditional culture.

INSERT FIGURE 4 ABOUT HERE

In Table 4 we compare the coefficients of birth decade among Tsimane' (column b) with the coefficient of birth decade among people of three neighboring Latin American nations (column c). To calculate the coefficients we use equation (1) with Z scores as dependant variables and schooling, age, and sex as control variables. (Control variables are omitted in Table 4). Results suggest that compared with people born before 1941, Tsimane' had higher culture test scores than their same age and sex peers in neighboring nations. The average increment/decade of Tsimane' culture test score was 0.39 standard deviations. Among neighboring nations, the average increment/decade in culture test score was only 0.12 standard deviations (column c); the average difference in the decennial growth rate of orientation to local culture was 0.27 standard deviations higher for Tsimane' than for people in neighboring nations. In other words, Tsimane' born during or after 1941 had become more traditional by 0.27 standard deviations per decade faster than people in neighboring nations. These results are only suggestive because they are not statistically significant at the conventional 95% confidence interval or higher.

INSERT TABLE 4 ABOUT HERE

*Sensitivity analysis using different measures of orientation to Tsimane' cultural values.* To generate these new variables we used principal component factor analysis to create two Z scores. We first examined whether answers to the eight questions formed part of an underlying cultural propensity or orientation to Tsimane' culture, and found that they did. Chronbach's alpha for the eight questions was 0.74; since we found evidence that the variables correlated with each other, we used principal component factor analysis to create a summary variable. The first factor had an eigenvalue of 2.84, and the second factor had an eigenvalue of 1.14, all other factors presented eigenvalues smaller than one. We refer to the first factor as *practical cultural factor* and to the second as *spiritual culture factor.* By construction, the variables have a mean of zero and a

standard deviation of one. The first factor or *practical culture factor* explains most of the variation for questions [1], [2], [3], [6] and [7] in Appendix I; these questions are related to daily life activities such as marriage, fishing, agriculture, and hunting. The second factor or *spiritual culture factor* relates to questions [5], [4], and [8] in Appendix 1 and have to do with spiritual activities related to crops, use of the forest resources, and traditional medicine.

We used these two factors as outcome variables in regressions (1) to (3). Table 5 contains the results of birth decade coefficients and, at the bottom, we include (when applicable) the results of test of joint significance for the dummy variables for birth decades.

INSERT TABLE 5 ABOUT HERE

Splitting the measure of culture into two different variables produced results similar to the ones discussed so far. Columns (1a-1b) suggest there was no significant secular change in either *practical* or *spiritual culture factors*, with F tests for the joint significance of all decade-of-birth dummy variable of 0.68 (p=0.63) and 0.67 (p=65) for the *practical culture factor* and for the *spiritual culture factor*. Results in columns 2-3 also show no significant effect of the variables for birth period on either *practical culture factor* or *spiritual culture factor*. In sum, the use of principal component factor analysis yielded essentially the same conclusions of no significant secular change in cultural orientation among Tsimane' born in different decades of the 20$^{th}$ century.

## Limitations

### *Threats to internal validity*

There are at least four possible threats to the internal validity of the study. *First*, we may not have measured cultural values well; by focusing on common local cultural values present at the time of the study, we may have made it harder to detect secular changes in values that disappeared. For

instance, Huanca (2008) shows that Protestant missionaries outlawed traditional healers or shamans, the last of whom died about two decades ago. If we had asked about the effectiveness of shamanistic practices, older Tsimane' may have revealed stronger preferences for the practices than younger Tsimane', and so we might have detected a secular decline in orientation toward local cultural values. Though theoretically possible, we doubt mis-measurement of local cultural values is a threat to the internal validity of the study. In another study we show that Tsimane' have also not witnessed a secular change in local knowledge of useful plants (Godoy et al. 2009a). The absence of a secular change in local culture is not unique to the way we defined cultural values; it also likely extends to other domains of culture, such as ethnobotanical knowledge.

*Second*, classical measurement error with the age variable would produce an attenuation bias. Recall from the earlier discussion that many Tsimane', and mostly the aged, did not know their exact age and guess when answering questions about their age or birth date. We tried to correct for age mis-reporting but some random measurement error likely remains.

*Third,* the study might have insufficient statistical power. In particular, we had only 29 study participants born before 1934, so parameter estimates for the dichotomous variable for birth period (1=born before 1934; 0=born after 1934) in column 2 of Table 3 will be imprecise.

*Fourth*, we might have selection bias. If migration or mortality varied in relation to both cultural orientation and birth period, then it is possible that our parameter estimates will be biased in an unknown direction and magnitude. For instance, if older people with stronger orientation to local cultural values were more likely to migrate farther into the backlands or to die – and hence to fall outside of the observed sample– then this would produce the misleading impression of modest secular change in cultural values.

*Threats to external validity*

For at least three reasons, findings from the Tsimane' may not generalize easily to other native Amazonian populations. *First*, the missionaries who arrived in the Tsimane' territory may have differed in fundamental ways from other missionaries. For example, missionaries who proselytized among the Tsimane' may have been more sensitive to cultural nuances and not impose a heavy hand on native populations (or the opposite). *Second*, situated at the foothills of the Andes and over rugged territory, the territory of the Tsimane' may have provided more room for escape from the onslaught of outsiders. Other native Amazonian populations may have been more circumscribed, with higher exit costs and therefore with a greater likelihood of having to deal with outsiders and possibly adopting their ways. *Third*, Tsimane' have been extensively studied by anthropologists relative to many other native Amazonian groups. At least two large multi-disciplinary projects of bio-cultural anthropologists have been studying (and continue to study) a variety of topics among the Tsimane' for a continuous decade. Anthropologists tend to respect local cultures, so the permanent presence of anthropologists might have enhanced orientation to local cultural values. Besides undertaking studies, these researchers have also carried out development projects, some explicitly designed to enhance cultural self worth.

*Other threats*

For reasons discussed earlier, we decided to measure culture through values, but it is an empirical question how the secular change in cultural values maps onto secular change in actual behavior reflecting those values. For instance, one might observe strong attachment to the ideal of cross-cousin marriage across generations, but one might also observe secular changes in actual marriage patterns away from the ideal. Unfortunately, we did not collect behavioral data directly linked to the culture values measured.

Discussion and conclusion

The empirical results presented here tend to support the second rather than the first hypothesis. Column 1, Table 3) shows no statistically significant change in cultural values across birth decades, either for each individual birth decennial, or, joinly, for all five dummy variables for birth decennials. A variety of other analysis supports the main conclusion. For example, people born before 1934 did not differ significantly from their younger peers in scores of orientation to traditional cultural values (column 2, Table 3). Bivariate graphical analysis (Figures 1-3) also suggests no significant change in cultural orientation across birth cohorts. Piecewise regressions (column 3, Table 3) done to detect a break in rates of change of cultural orientation between different birth cohorts suggest that the secular trend in cultural orientation among Tsimane' was similar between people raised before outsiders came and people raised afterwards. Bivariate graphical analysis (Figure 4) comparing secular trends in value orientation between Tsimane' and people from neighboring nations shows Tsimane' becoming slightly more and more 'traditional' with the passage of time in contrast to their peers in neighboring nations who are becoming slightly less traditional, but in neither case were the trends statistically significant in multivariate analysis (Table 4).

The absence of a clear secular change in cultural values among the Tsimane' is not an anomaly. Ethnographers have long ago noted strategies used by other native Amazonians to avoid cultural loss. Wagley and Galvão (1949: 14, 172-173, 178) observed that the Tenetehara of Brazil had been able to preserve their cultural values because the Tenetehara selectively changed aspects of material culture to ensure core aspects of their culture (particularly their religion) persisted. Goldman noted that the Cubeo avoided cultural loss due to a combination of adroitness, cosmopolitanism, and physical isolation (Goldman 1979: 16-17).

Bearing in mind the caveats noted in the previous section, we conclude by discussing possible substantive (rather than methodological) reasons for the absence of a secular change in cultural values among the Tsimane'.

*Nature of treatment*: modernization, globalization, and continuous contact with outsiders might set in motion countervailing forces in relation to the preservation of cultural values. For example, Protestant missionaries simultaneously took steps to destroy aspect of Tsimane' culture, such as shamanistic practices and the drinking of fermented beverages but they also took steps to preserve Tsimane' language and teach skills so Tsimane' could better defend their territorial rights. To protect the Tsimane' culture missionaries also took steps to combat the chicanery of traders who came to the Tsimane' territory to obtain forest and farm goods. Protestant missionaries sent mixed signals about the value of local culture and may have therefore produced ambiguous net effects on the preservation of local cultural values.

*Nature of exposure to market and outsiders*: Despite nearly five decades of continuous contact with outsiders, Tsimane' retain much economic self sufficiency. Most Tsimane' do not face a shortage of land for agriculture. Unlike smallholders pushed to the market by the shortage of natural resources, Tsimane' so far have been able to take part in the market economy at their own will. Continual, forced exposure and contact with outsiders might have eroded their local culture, but so far this has yet to happen. Even with Protestant missionaries, contact was sporadic and intermittent rather than continuous and intense. Contact took place occasionally, when missionaries came to villages, or when Tsimane' went to visit missionaries for medicines or for other needs, but for the most part Tsimane' and missionaries lived and worked at arm's length, apart from each other. This might have made it easier for Tsimane' to continue cultural practices inveighed by missionaries.

*Ethnic politics*: Bolivia has a long tradition of political movements by ethnic minorities. During 1990, Tsimane' took part in the historic march among lowland ethnic groups from the city of Santa Cruz – to the capital city of La Paz, and they have been linked with regional lowland federation of ethnic groups (e.g., Confederación de Indígenas del Oriente, Chaco y Amazonía de Bolivia, CIDOB) and with native Amazonian groups in other nations (e.g., Coordinadora de las Organizaciones Indígenas de la Cuenca Amazónica, COICA) (Yashar 2005). It is possible that exposure to the messages of these movements and institutions has strengthen orientation to local cultural values.

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Table 1. Distribution of sample size and mean *culture test score* by person's birth decade and sex

| **Cohort variables** | **Total (females and males)** | | | **Females** | | | **Males** | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | % of total population | Score | N | % of females | Score | N | % of males | Score |
| Birth decade (inclusive): | | | | | | | | | |
| 1911-1920 | 2 | 0.37 | 16.00 | 0 | NA | NA | 2 | 0.75 | 16.00 |
| 1921-1930 | 19 | 3.52 | 23.63 | 6 | 2.18 | 28.00 | 13 | 4.89 | 21.61 |
| 1931-1940 | 24 | 4.45 | 19.95 | 16 | 5.83 | 21.00 | 8 | 3.01 | 17.87 |
| 1941-1950 | 27 | 5.00 | 21.70 | 15 | 5.47 | 22.33 | 12 | 4.51 | 20.91 |
| 1951-1960 | 65 | 12.04 | 23.60 | 28 | 10.21 | 22.25 | 37 | 13.91 | 24.62 |
| 1961-1970 | 105 | 19.44 | 22.28 | 55 | 20.10 | 22.47 | 50 | 18.80 | 22.08 |
| 1971-1980 | 141 | 26.11 | 23.52 | 66 | 24.09 | 25.01** | 75 | 28.19 | 22.20 |
| 1981-1990 | 157 | 29.07 | 23.68 | 88 | 32.12 | 24.00 | 69 | 25.94 | 23.27 |
| Total | 540 | 100.00 | 23.05 | 274 | 100.00 | 23.54 | 266 | 100.00 | 22.55 |
| Treatment and pre-treatment groups: | | | | | | | | | |
| *Born before 1934* | 29 | 5.37 | 22.37 | 14 | 5.11 | 24.00 | 15 | 5.64 | 20.87 |
| Born after or during 1934 | 511 | 94.63 | 23.10 | 260 | 94.89 | 23.56 | 251 | 94.36 | 22.63 |
| Total | 540 | 100.00 | 23.05 | 274 | 100.00 | 23.54 | 266 | 100.00 | 22.55 |

Notes: *** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.1$ in t-test for difference in mean values for females and males of same birth decade. Under the score columns, the row "total" refers to average values. NA=not applicable.

Table 2. Definition and summary statistics of dependent and control variables used in multiple regressions

| Variable | Description | N | Mean | SD | Min | Max |
|---|---|---|---|---|---|---|
| | **Dependent variables:** | | | | | |
| *Culture test score* | Sum of answers to eight questions about cultural orientation; see Appendix 1 and main text for further discussion | 544 | 23.05 | 6.94 | 8 | 40 |
| | **Control variables:** | | | | | |
| Male | Individual's gender (male=1; female=0) | 547 | 0.48 | 0.50 | 0 | 1 |
| Years of schooling | Maximum years of formal schooling | 506 | 1.99 | 2.28 | 0 | 13 |
| Age | Best estimate of person's age as made by TAPS team | 543 | 36.48 | 16.48 | 16 | 94 |

Table 3. Results of Ordinary Least Square (OLS) multiple regressions: Secular change in cultural values among Tsimane' born 1911-1990, measured in 2007 (n=500)

| | Dependent variable: Natural logarithm of *culture test score* | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| Explanatory variables: | | | |
| Birth decade: | | | |
| 1941-1950 | 0.02 | ^ | ^ |
| | (0.11) | ^ | ^ |
| 1951-1960 | 0.12 | ^ | ^ |
| | (0.15) | ^ | ^ |
| 1961-1970 | 0.09 | ^ | ^ |
| | (0.18) | ^ | ^ |
| 1971-1980 | 0.15 | ^ | ^ |
| | (0.23) | ^ | ^ |
| 1981-1990 | 0.19 | ^ | ^ |
| | (0.28) | ^ | ^ |
| *Born before 1934* | ^ | 0.09 | ^ |
| | ^ | (0.09) | ^ |
| Birth decade | ^ | ^ | -2.43e-3 |
| | ^ | ^ | (0.07) |
| Birth decade*Dummy for period | ^ | ^ | 0.02 |
| | ^ | ^ | (0.05) |
| Male | -0.08** | -0.08** | -0.08*** |
| | (0.03) | (0.03) | (0.03) |
| Age | 2.05e-3 | -1.98e-3 | 7.24e-05 |
| | (5.09e-3) | (1.34e-3) | (5.51e-3) |
| Years of schooling | 5.51e-3 | 5.33e-3 | 5.69e-3 |
| | (9.13e-3) | (9.21e-3) | (9.23e-3) |
| Constant | 2.90*** | 3.17*** | 3.07*** |
| | (0.38) | (0.05) | (0.57) |
| Birth decade joint significance: $F_{(5, 491)}$ and | 0.33 | NA | NA |
| (p>F) | (0.89) | NA | NA |
| R-squared | 0.02 | 0.02 | 0.02 |

Notes: ^ variable intentionally left out. NA=not applicable. Excluded category for birth decade is people born before 1941. Robust standard errors are in parenthesis. *** p≤0.01, ** p≤0.05, * p≤0.1.

Table 4. Comparison of change in culture test score by birth decade among Tsimane' and people in Brazil, Peru, and Colombia. Results of Ordinary Least Squares (OLS) multiple regressions with robust standard errors

| Birth Decade | Tsimane' | Brazil, Peru and Colombia | Difference Tsimane'-Latin America |
|---|---|---|---|
| (a) | (b) | (c) | (d)=(b)-(c) |
| **1941-1950** | 0.07 | 0.03 | 0.04 |
| **1951-1960** | 0.47 | 0.08 | 0.39 |
| **1961-1970** | 0.32 | 0.19 | 0.13 |
| **1971-1980** | 0.49 | 0.23 | 0.26 |
| **1981-1990** | 0.62 | 0.09 | 0.53 |
| **Average/decade** | 0.39 | 0.12 | 0.27 |

Notes: *** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.1$. Dependent variable is Z score of cultural orientation using principal component factor analysis. Data for Brazil, Peru, and Colombia comes from World Value Survey; these Z scores were calculated separately for each country. Regression for Latin America from World Value Survey also includes dummy variables for countries. Controls variables (not shown) include age, sex, and maximum schooling. Excluded category for birth decade is people born before 1941.

Table 5. Results of Ordinary Least Square (OLS) multiple regression: Secular change in cultural values among Tsimane' born 1911-1990, measured in 2007 (n=500)

| | Dependent variable (Z score from principal component factor analysis): | | | | | |
|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | |
| | (a) | (b) | (a) | (b) | (a) | (b) |
| Birth decade: | Practical | Spiritual | Practical | Spiritual | Practical | Spiritual |
| 1941-1950 | -0.25 | 0.44 | ^ | ^ | ^ | ^ |
| | (0.33) | (0.32) | ^ | ^ | ^ | ^ |
| 1951-1960 | 0.09 | 0.68 | ^ | ^ | ^ | ^ |
| | (0.41) | (0.42) | ^ | ^ | ^ | ^ |
| 1961-1970 | -0.18 | 0.83 | ^ | ^ | ^ | ^ |
| | (0.51) | (0.53) | ^ | ^ | ^ | ^ |
| 1971-1980 | -0.18 | 1.11* | ^ | ^ | ^ | ^ |
| | (0.63) | (0.67) | ^ | ^ | ^ | ^ |
| 1981-1990 | -0.19 | 1.37* | ^ | ^ | ^ | ^ |
| | (0.75) | (0.80) | ^ | ^ | ^ | ^ |
| Born before 1934 | ^ | ^ | 0.21 | 0.18 | ^ | ^ |
| | ^ | ^ | (0.27) | (0.28) | ^ | ^ |
| Birth decade | ^ | ^ | ^ | ^ | -0.21 | 0.22 |
| | ^ | ^ | ^ | ^ | (0.20) | (0.21) |
| Birth decade*Dummy for period | ^ | ^ | ^ | ^ | 0.06 | 0.03 |
| | ^ | ^ | ^ | ^ | (0.14) | (0.16) |
| Birth decade joint significance: $F_{(5, 491)}$ and (p>F) | 0.68 | 0.67 | | | | |
| | 0.63 | 0.65 | NA | NA | NA | NA |
| R-squared | 0.03 | 0.01 | 0.02 | 2.50e-3 | 0.02 | 6.30e-2 |

Notes: *** p≤0.01, ** p≤0.05, * p≤0.1. ^ variable intentionally left out. NA=not applicable. Robust standard errors are in parenthesis. Dependent variable is Z score of cultural orientation among Tsimane' created using principal component factor analysis. Control variables (not shown) include age, sex, and maximum schooling. Excluded category for birth decade is people born before 1941.

Figure 1. *Culture test score* measured in 2007 by birth decade among Tsimane' over 16 years of age (females and males)

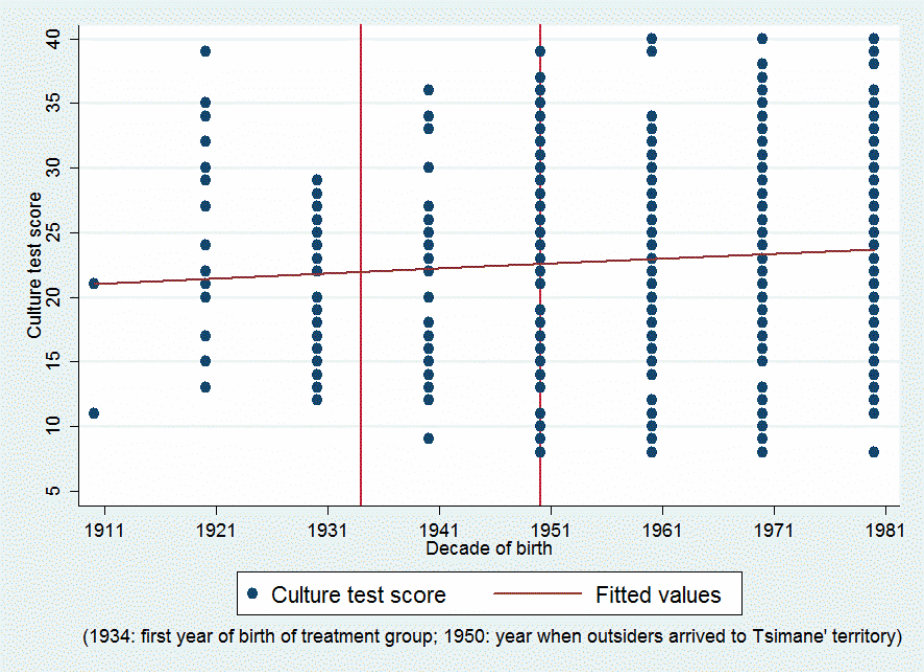
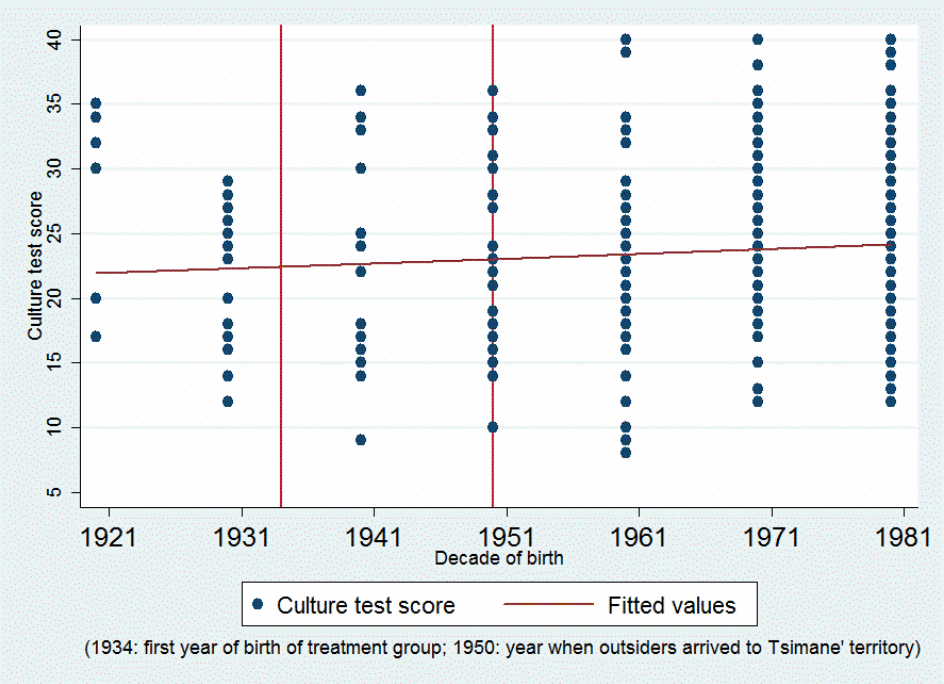


Figure 2. *Culture test score* measured in 2007 by decade of birth among Tsimane' females over 16 years of age



Culture – secular trend

Figure 3. *Culture test score* measured in 2007 by decade of birth among Tsimane' males over 16 years of age

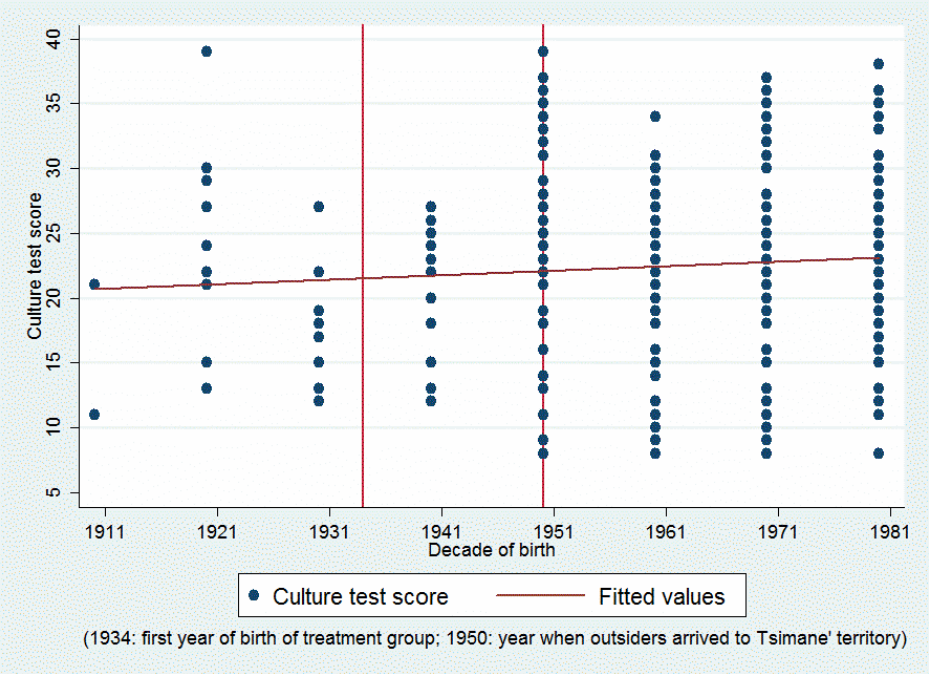
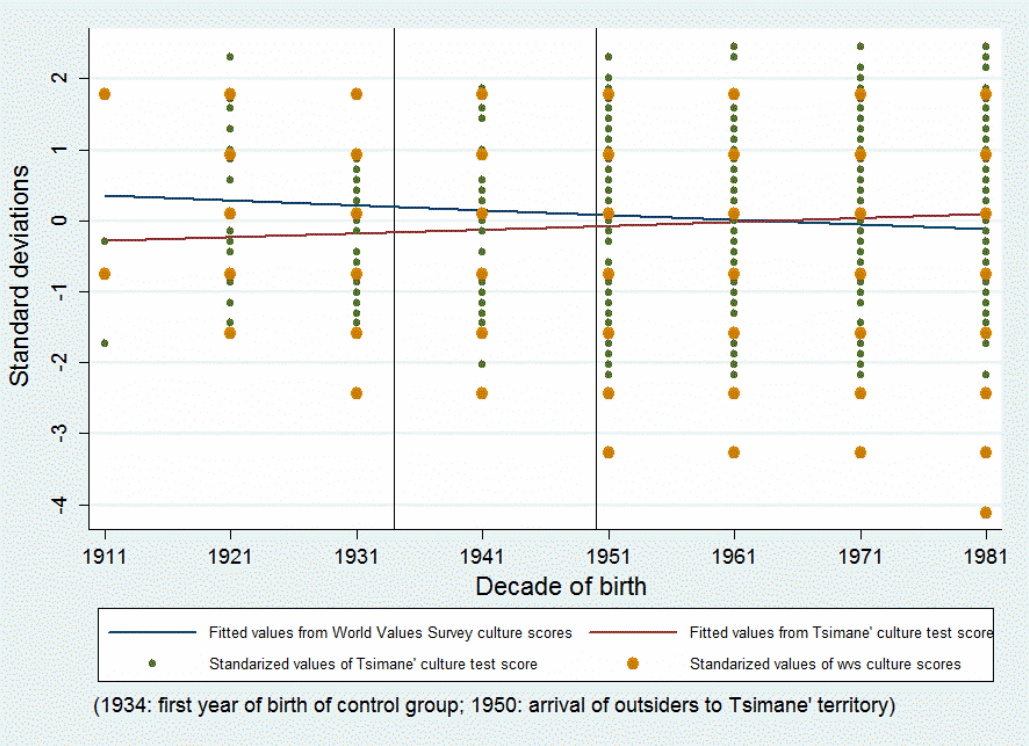


Figure 4. Secular trend in Z score of culture test score: Tsimane' and neighboring Latin American nations (Colombia, Brazil, Peru) compared by decade of birth, 1911-1981



## Appendix 1: Questions used to estimate cultural orientation

All the questions were rated on a scale of 1 (not important) to 5 (important), but see text for the context of how we asked the questions.

**[1]** The elder Tsimane' in the village of Jamanchi it is important that their children marry their cross cousin. On the other hand, for the Tsimane' in the town of San Borja it is not important that their children marry their cross cousin. How important is it for you that your children marry their cross cousin? Where would you put yourself on the ladder or scale?

**[2]** The elder Tsimane' in the village of Jamanchi like to fish communally with plant poison (*barbasco*). On the other hand, the Tsimane' in the town of San Borja rarely fish communally with plant poison. How important is it for you to fish communally with plant poison? Where would you put yourself on the ladder or scale?

**[3]** The elder Tsimane' in the village of Jamanchi work a lot in their fields. On the other hand, the Tsimane' in the town of San Borja work for loggers and do not work in their fields any more. How important is it for you to work in the fields. Where would you put yourself on the ladder or scale?

**[4]** When the elder Tsimane' in the village of Jamanchi plant manioc, they do not touch their hair. On the other hand, the Tsimane' in the town of San Borja do not follow this custom. How important is it for you to observe this custom? Where would you put yourself on the ladder or scale?

**[5]** The elder Tsimane' in the village of Jamanchi ask permission of the spirit of large trees before cutting down the tree. On the other hand, for the Tsimane' in the town of San Borja it is not important to ask permission of the spirit of large trees before cutting down the tree. How important is it for you to ask permission of the tree spirit before cutting down a tree? Where would you put yourself on the ladder or scale?

**[6]** For the elder Tsimane' in the village of Jamanchi it is important to finish the *vaij* ritual. On the other hand, for the Tsimane' in the town of San Borja rarely follow the ritual. How important is the vaij ritual to you? Where would you put yourself on the ladder or scale?

**[7]** The elder Tsimane' in the village of Jamanchi think that if their bow breaks, they will have bad luck. On the other hand, the Tsimane' in the town of San Borja do not believe a broken bow brings bad luck. Do you think when your bow breaks, something is going to happen to you? Where would you put yourself on the ladder or scale?

**[8]** When the elder Tsimane' in the village of Jamanchi get sick, they cure themselves with plants. On the other hand, when the Tsimane' in the town of San Borja get sick, they cure themselves with medicines from the pharmacy. Do you

prefer to cure yourself with plants or with medicines from the pharmacy? Where would you put yourself on the ladder or scale?

## Appendix 2: Selected questions from World Values Survey used to estimate cultural orientation

We used four questions from the World Values Survey. Questions were recoded from 1 (less traditional) to 3 (more traditional). The original questions were as follow:

**[1]** For each of the following, indicate how important it is in your life. Would you say it is (read out and code one answer for each). Family: Very important (1), rather important (2), not very important (3)

**[2]** For each of the following, indicate how important it is in your life. Would you say it is (read out and code one answer for each). Religion: Very important (1), rather important (2), not very important (3)

**[3]** All things considered, would you say that the world is better off, or worse off, because of science and technology? Please tell me which comes closest to your view on this scale: 1 means that "the world is a lot worse off," and 10 means that "the world is a lot better off." (Code one number).

**[4]** Independently of whether you attend religious services or not, would you say you are (read out and code one answer): A religious person (1), not a religious person (2), an atheist (3). Religiosity was recoded as follow: 1=religious, 0=not religious or atheist.

Reference List

Angrist, J. D., and Krueger, A. B. 2001. Instrumental variables and the search for identification: From supply and demand to natural experiments. Journal of Economic Perspectives 15: 69-85.

Bernard, H. R. 2001. Research Methods in Anthropology: Qualitative and Quantitative Approaches. Walnut Creek, CA: Altamira Press.

Borjas, G. J. 2005. Labor Economics. New York: McGraw-Hill.

Bowen, J. R. 1995. The forms that culture takes: A state-of-the-field essay on the anthropology of Southeast Asia. The Journal of Asian Studies 54: 1047-78.

Boyd, R. and Richerson, P. J. 1994. The evolution of norms: An anthropological view. Journal of Institutional and Theoretical Economics 150: 72-97.

Boyd. R and Richerson, P.J. 2005. The origin and evolution of cultures. New York: Oxford University Press.

Brown, M. F. 1994. "Beyond resistance: Comparative study of utopian renewal in Amazonia," in Amazonian Indians from prehistory to the present: Anthropological perspectives. Edited by A. Roosevelt, pp. 23-57. Tucson, Arizona: University of Arizona Press.

Brown, M. F. and Fernandez, E. 1991. War of the shadows: The struggle for utopia in the Peruvian Amazon. Berkeley: University of California Press.

Brumann, C. 1999. Writing for culture: Why a successful concept should not be discarded. Current Anthropologogy 40: 1-27.

Burkhalter, B. B., and Murphy, R. F. 1989. Tappers and sappers: Rubber, gold and money among the Mundurucu. American Ethnologist 16: 100-116.

Card, D. 1990. The impact of the Mariel boatlift on the Miami labor market. Industrial and Labor Relations Review 43: 245-57.

Castro Mantilla, M. D. 1997. La viva voz de las tribus: El trabajo del ILV en Bolivia, 1954-1980. La Paz, Bolivia: Ministerio de Desarrollo Sostenible y Planificacion, Vice Ministerio de Asuntos Indigenas y Pueblos Originarios.

Chicchón, A. 1992. Chimane resource use and market involvement in the Beni Biosphere Reserve, Bolivia. 1992. Department of Anthropology, University of Florida, Gainesville.

Chun, Kevin M., Organista, Pamela B., and Marin, Gerardo. 2003. Acculturation: Advances in theory, measurement and applied research. Washington, D.C.: American Psychological Association.

Cormier, Loretta A. 2003. Kinship with monkeys. The Guajá foragers of Eastern Amazonia. New York: Columbia University Press.

Diamond, Jared. 1999. Guns, Germs, and Steel. New York: W.W.Norton.

Dufour, D. L., Staten, L. K., Reina, J. C., and Spurr, G. B. 1994. Anthropometry and secular changes in stature of urban Colombian women of differing socioeconomic status. American Journal of Human Biology 6: 749-60.

Durrenberger, E. P. 1999. The weak suffer what they must: A natural experiment in thought and structure. American Anthropologist 101: 783-93.

Ehrenreich, J. D. 1990. Shame, witchcraft, and social control. Cultural Anthropology 5: 338-45.

Ellis, R. 1996. A taste for movement: An exploration of the social ethics of the Tsimanes of lowland Bolivia. 1996. St. Andrews University, Scotland.

Ferguson, B. R. 1989. Game wars? Ecology and conflict in Amazonia. Journal of Anthropological Research 45: 179-206.

Ferguson, B. R. 1990. Blood of the Leviathan: Western contract and warfare in Amazonia. American Ethnologist 17: 237-57.

Feyrer, J. and Sacerdote, B. I. 2009. Colonialism and modern income -- islands as natural experiments. Review of Economics and Statistics In press..

Fishman, R. and Miguel, E. 2007. Corruption, norms, and legal enforcement: Evidence from diplomatic parking tickets. Journal of Political Economy 115: 1020-1048.

Fox, R. G. 2002. "The study of historical transformation in American anthropology," in Anthropology, by comparison. Edited by A. Gingrich and R. G. Fox, pp. 167-84. New York: Routledge.

Godoy, R., Leonard, W.R., Reyes-García, V., Goodman, E., McDade, T. W., Huanca, T., Tanner, S., and Vadez, V. 2007a. Physical stature of adult Tsimane' Amerindians, Bolivian Amazon in the 20th century. Economics and Human Biology 4: 184-205.

Godoy, R. A. 1977. Franz B. and his Plans for an International School of American Archaeology and Ethnology in Mexico, 1910-1914. Journal of the History of Behavioral Sciences 13: 228-42.

Godoy, R. A., Goodman, E., Levins, R., Caram, M. and Seyfried, Craig Jr. 2006. A comparison of secular trends in height between men in Puerto Rico and the USA mainland, 1886-1930. Economics and Human Biology. 5:82-92.

Godoy, Ricardo A., Jacobson, Marc, De Castro, J., Aliaga, V., Romero, J. and Davis, A. 1998. The role of tenure security and private time preference in neotropical deforestation. Land Economics 74: 162-70.

Godoy, R. A., Reyes-García, V., Broesch, J., Fitzpatrick, I. C., Giovannini, P., Martinez-Rodriguez, M. R., Huanca, T., Leonard, W., MCDade, T. W., Tanner, S. and TAPS, Bolivian R. T. 2009a. Long-term (secular) change of ethnobotanical knowledge of useful plants: Separating cohort and age effects. Journal of Anthropological Research 65: 51-67.

Godoy, R. A., Reyes-García, V., Leonard, W. R., Huanca, T., MCDade, T. W., Tanner, S., Seyfried, C. and TAPS, Bolivian R. T. 2007b. On the measure of income and the economic unimportance of social capital. Evidence from a native Amazonian society of farmers and foragers. Journal of Anthropological Research 63: 239-60.

Godoy, R. A., Zeinalova, E., Reyes-García, V., Huanca, T., Kosiewicz, H., Leonard, W. R. and Tanner, S. 2009b. Does civilization cause discontentment among indigenous Amazonians? Test of empirical data from the Tsimane' of Bolivia. Journal of Economic Psychology. In press.

Godoy, R., Reyes-García, V., Tanner, S., Leonard, W., McDade, T., and Huanca, T. 2008. Can We Trust an Adult's Estimate of Parental School Attainment? Disentangling Social Desirability Bias and Random Measurement Error. Field Methods 20: 26-45.

Goldman, I. 1979. The Cubeo Indians of the Northwest Amazon. Urbana: University of Illinois Press.

Government of Bolivia. 1995. Censo Indígena del Oriente, Chaco y Amazonía. La Paz, Bolivia: Secretaría de Asuntos Etnicos, de Genero y Generacionales, Ministry of Human Development, Government of Bolivia.

Guss, David M. 1989. To Weave and Sing. Art, Symbol, and Narrative in the South American Rain Forest. Berkeley, California: University of California Press.

Guzmán, J. M., Rodríguez, J., Martínez, J., Contreras, J. M. and González, D. (2006, Sep-Dic). The Demography of Latin America and The Caribbean since 1950. Population , 519-575, 577-620.

Harner, M. J. 1971. The Jivaro: People of the Sacred Waterfalls. Berkeley: University of California Press.

Harris, M. 2001a. Cultural Materialism: The Struggle for a Science of Culture. New York: Random House.

Harris, M. 2001b. The Rise of Anthropological Theory: A History of Theories of Culture. New York: Thomas Y. Crowell Company.

Hemming, J. 2008. Tree of rivers. The story of the Amazon. London: Thames and Hudson.

Hill, K. and Hurtado, M. A. 1996. Ache Life History. The Ecology and Demography of a Foraging People. New York: Aldine de Gruyter.

Holmberg, Allan R. Nomads of the long bow. 1950. The Siriono of eastern Bolivia. Washington, D.C., Smithsonian Institution. Institute of Social Anthropology.

Huanca, T. 2008. Tsimane' oral tradition, landscape, and identity in tropical forest. La Paz: Wa-Gui.

Inglehart, R. and Welzel, C. 2005. Modernization, Cultural Change and Democracy. New York: Cambridge University Press.

Instituto Nacional De Estadistica, Bolivia. 2003. Bolivia: Caracteristicas sociodemograficas de la poblacion indigena. La Paz: INE.

Johnson, A. 2003. Families of the forest. The Matsigenka Indians of the Peruvian Amazon. Berkeley: University of California Press.

Jones, J. 1995. "Environmental destruction, ethnic discrimination, and international aid in Bolivia," in The Social Causes of Environmental Destruction in Latin America. Edited by M. Painter and W. H. Durham, pp. 169-216. Ann Arbor, Michigan: University of Michigan Press.

Keesing, R. M. 1972. Theories of culture. Annual Review of Anthropology 3: 73-97.

Kluckhohn, C. and Kroeber, A. L. 1963. Culture: A Critical Review of Concepts and Definitions. New York: Vintage Books (originally published 1952).

Kuper, A. 1999. Culture, The Anthropologists' Account. Cambridge, MA: Harvard University Press.

Lehm, Z. 1991. Loma Santa: procesos de reducción, dispersión y reocupación del espacio de los indígenas Mojeños.

Leonard, W. R. and Godoy, R. A. . 2008. Tsimane' Amazonian Panel Study (TAPS): The first five years (2002-2006) available to the public. Economics and Human Biology 6: 299-301.

Linton, R. 1940. Acculturation in Seven American Indian Tribes. New York: D. Appleton-Century.

Lockhart, J. and Schwartz, S. B. 1983. Early Latin America. A history of Spanish America and Brazil. Cambridge: Cambridge University Press.

Malina, R. M., Peña Reyes, M. E., Tan, S. K., Buschang, P. H., Little, B. B. and Koziel, S. 2004. Secular change in height, sitting height and leg length in rural Oaxaca, southern Mexico: 1968-2000. Annals of Human Biology 31: 615-33.

Marcus, G. E., and Cushman, D. 1982. Ethnographies as texts. Annual Review of Anthropology 11: 25-69.

Maybury-Lewis, D. 1965. The savage and the innocent. New York: The World Publishing Company.

Maybury-Lewis, D. 1967. Akwe-Shavante society. New York: Clarendon Press Oxford.

Meyer, B. 1995. Natural and quasi-experiments in economics. Journal of Business and Economic Statistics 13: 151-61.

Milton, K. 1992. Civilization and its discontents. Natural History 3: 37-42.

Montenegro, R. A. and Stephens, C. 2006. Indigenous health 2. Indigenous health in Latin America and the Caribbean. Lancet 367: 1859-69.

Murphy, M. and Margolis, M. 1995. Science, Materialism, and the Study of Culture. Gainesville, Florida: University Press of Florida.

Murphy, R. F. 1960. Headhunteter's heritage: Social and economic change among the Mundurucú Indians. Berkeley: University of California Press.

Murphy, R. F. 1961. Deviancy and social control. Kroeber Anthropological Society Papers 24: 55-61.

Murphy, Y. and Murphy, R. F. 1985. Women of the forest. New York: Columbia University Press.

O'Meara, T. 1997. Causation and the struggle for a science of culture. Current Anthropology 38: 399-410s.

Overing, J. and Passes, A. 2007. The anthropology of love and anger. The aesthetics of conviviality in native Amazonia. London: Routledge.

Perez, E. 2001. Uso de la ictiofauna por dos comunidades Tsimane': San Antonio y Yaranda (T.I. Tsimane', Depto. Beni) bajo diferente influencia del mercado. Biology Department, Universidad Mayor de San Andres, La Paz, Bolivia.

Redfield, R., Linton, R., and Herkowitz, M. J. 1936. Memorandum on the study of acculturation. American Anthropologist 56: 973-1002.

Reeve, M.. 1994. Regional interaction in the Western Amazon: The early colonial encounter and the Jesuit years: 1538-1767. Ethnohistory 41: 106-38.

Richerson, P. J. and Boyd, R. 2004. Not by Genes Alone: How Culture Transformed Human Evolution. Chicago: The University of Chicago Press.

Riester, J. 1993. Universo mítico de los Chimane. La Paz: Talleres Gráficos HISBOL.

Rival, Laura M. 2002. Trekking Through History. The Huaorani of Amazonia. New York: Columbia University Press.

Rosenzweig, M. R., and Wolpin, K. I. 2000. Natural 'natural experiments' in economics. Journal of Economic Literature 38: 827-74.

Rudmin, F. W. 2003. Critical history of the acculturation psychology of assimilation, separation, integration, and marginalization. Review of General Psychology 7: 3-37.

Shepard, G. H. 2002. Three days for weeping: Dreams, emotions, and death in the Peruvian Amazon. Medical Anthropology Quarterly 16: 200-229.

Shweder, R. A. 1993. Cultural psychology: Who needs it? Annual Review of Psychology 44: 497-523.

Siskind, J. 1975. To Hunt in the Morning. New York: Oxford University Press.

Steedly, M. M. 1999. The state of culture theory in the anthropology of Southeast Asia. Annual Review of Anthropology 431.

Steward, J. H. and Faron, L. C. 1959. Native peoples of South America. New York: McGraw-Hill.

Stocking, G. W. JR. 1982. Race, culture, and evolution. Essays in the history of anthropology. Chicago: The University of Chicago Press.

United Nations Development Program. 2008. Human Development Indices. Retrieved May 28, 2009, from United Nations Development Program Web site: http://hdr.undp.org/en/media/HDI_2008_EN_Tables.pdf

Vadez, V., Reyes-García, V., Godoy, R. A., Apaza, L., Byron, E., Huanca, T., Leonard, W. R., Wilkie, D. and Perez, E. 2004. Does integration to the market threaten agricultural diversity? Panel and cross-sectional evidence from a horticultural-foraging society in the Bolivian Amazon. Human Ecology 32: 635-46.

Varese, S. 1973. La sal de los cerros. Lima: Retablo de Papel.

Wagley, CH. 1977. Welcome of tears. The Tapirape Indians of Central Brazil. New York: Oxford University Press.

Wagley, CH. and Galvão, E. 1949. The Tenetehara Indians of Brazil. A culture in transition. New York: Columbia University Press.

Warren, D. M., Slikkerveer, L. J., and Titilola, S. O. 1989. Indigenous knowledge systems: implications for agriculture and international development. Studies in Technology and Social Change 11 Iowa State Universit.

Yashar, D. J. 2005. Contesting citizenship in Latin America. Cambridge: Cambridge University Press.