ELECTRONIC SUPPLEMENTARY INFORMATION (ESM) FOR *ON NATURE OF CULTURAL TRANSMISSION NETWORKS*

CONTENTS

THEORETICAL BACKGROUND

Understanding cultural evolution and the evolution of cultural adaptations requires considering both how cognitive processes influence the micro-level details of cultural transmission and how these micro-level processes aggregate up to generate population-level patterns of cultural variation. In this section, we first summarize work showing how evolutionary theory can be used to develop hypotheses about the kinds of cues people use to figure out from whom to learn. Then, we briefly discuss how formal models allow researchers to cobble up from these psychological learning biases to broader patterns of cultural variation. With an eye to our main empirical findings, this second subsection emphasizes how evolved biases in our cognitive mechanism for cultural learning can give rise to population-level patterns of cultural adaptation.

MODEL-BASED BIASES IN CULTURAL LEARNING

The application of evolutionary theory to understanding who learners should pay attention to for cultural transmission and how they should integrate information from different people has generated a wide range of hypotheses about human cognition, many of which have found empirical support [reviewed in 1]. Hypotheses about *model selection biases* propose that learners should preferentially attend to those individuals in their social world ("models") deemed most likely to possess adaptive information that can be acquired by learners. To locate these *preferred models*, learners should give weight to a variety of cues that indicate which individuals are most likely to be worthy of imitation (i.e., possess adaptive information that could be learned). Sets of proposed cues include (1) skill, knowledge, success and prestige, (2) health and happiness, (3) age and (4) self-similarity (e.g. sex, ethnicity, personality, physical attributes). We deal with each of these in term.

Acquiring skill, knowledge, and success in locally important behavioral domains is crucial for survival in small-scale societies [2-4]. Learners can use a variety of cues to figure out who in their group is likely to have the best acquirable skill or knowledge. To assess skill or knowledge, learners can directly observe it (e.g., a hunter adeptly shooting an arrow and bringing down a fast moving prey), assess it indirectly with cues of success (e.g., the amount of meat the hunter brings back to camp) or use cues of prestige. Using cues of prestige here means that learners exploit the fact that others are also evaluating potential models based on observations of skill and success. By observing the ethological cues (including verbal expressions) associated with prestige evaluations, and prestige-biased imitation, learners can use the behavior of others to improve their own estimates of who is a good model. Extensive field and laboratory evidence from across the social sciences supports these hypotheses. Theory and evidence are laid out in Henrich and Gil-White [5] .

An important aspect of these predictions—that individuals will preferentially focus their cultural learning efforts on models deemed higher in skill, success, and prestige—is that such models will impact domains well beyond those obviously directly related to the model's success or skill. This occurs for two reasons. First, it's often difficult to tell what makes someone successful or skilled in some arena. If a learner seeks to imitate the best hunter he knows, does he copy (1) how the hunter makes his arrows, (2) the fact that the hunter gets up earlier than others, (3) the hunter's taste for carrots, or (4) the meditative prayers the hunter says before departing on the hunt. Any or all of these may contribute to the hunter's success. Thus, assuming they aren't particularly costly to imitate, the learner should be inclined to acquire as many of the model's traits as possible. Second, being highly successful in an important domain, especially in small-scale societies where a lack of division of labor prevents substantial specialization, may be a cue of being a good cultural model in general [6, 7: Chapter 2],[1] or of having strategies or practices that favor success across many domains. People unconsciously think that if a model is good to copy in one domain then they are probably good to copy in other domains. This kind of effect helps explain why Michael Jordan can persuade people to buy Haines underwear and why Tiger Woods could sell Buicks.

Health is also obviously related to genetic fitness. Healthier individuals in ancestral environments could have more children and invest more heavily in their offspring. If being healthy reveals itself in appearance or activity, learners ought to be sensitive to this, such that, *ceteris paribus*, they differentially attend to, and prefer to learn from healthier models. If nothing else, learners should avoid learning form sickly-appearing models. Since positive affect, or more simply happiness, correlates with health outcomes (including long life [8]), learners may use positive affect as a cue of whom to learn from [for evidence, see 9].

Age provides an important cue for learners for two reasons. First and most relevant for our arguments below, age is a good cue of possessing useful/adaptive information because (1) merely by getting to be old (and not dying) these individuals are demonstrating an ability to survive and (2) they have had more years to acquire adaptive information, both culturally and via individual experience. *Ceteris paribus*, learners should prefer senior members of the community. Since old age may bring reduced mental faculties, learners will likely show a decline in preference for very old community members (if any are still around), due to a decline in mental alertness.[2]

Second, at the other end of life history spectrum, children can scaffold themselves up to increasingly complex skills by focusing on same-sex models who are somewhat older than themselves. Using our hunting example, a six year-old would likely not learn particularly much by imitating the best hunter in the community (who is likely about 36), since the difference in skills is too great. Instead, this child would do better to focus on learning from the most successful eight to ten year old. By continually

[1] In more complex societies a division of labor favors skill-specialization to a degree not observed in smaller-scale societies, where most people have highly overlapping skill and knowledge sets.

[2] Elsewhere, Gil-White and Henrich [5] explain how the rate of cultural change in a society influences the prestige attributed to the elderly. If a society is changing rapidly, elderly will be devalued relative to societies changing more slowly.

focusing on somewhat older models, learners are more able to tune their cultural input to their relevant level of skill. This is particularly true in the small-scale societies of human evolutionary history [10, 11].

Since learners have evolved to seek and acquire those cultural traits most likely to be adaptive for them in their own attributes and their likely future roles in society, learners should also weight some assessment of the similarities between themselves and their potential models. Candidate dimensions of similarity, which have likely been relevant for a long time, include sex, ethnicity (using cues of language or dialect), personality and physical attributes.

1) Sex: if there has been a division of labor between males and females during much of human history, then humans should have evolved a tendency to learn from people of their same sex (i.e., males copy males, females copy females). This gives learners the best chance to acquire those mental representations (practices, skills, and beliefs) suitable to the role they are likely to occupy later in life.

2) Ethnicity: culture-gene coevolutionary models predict that learners should focus their learning efforts on models who share their 'ethnic markers' (cues of dialect, language, dress) because this gives them the best chance to acquire the mental representations (social norms, values, and expectations) that will permit them to effectively coordinate, exchange and cooperate with others in their social group [7: Chapter 9, 12]. Recent laboratory work with children and infants supports these predictions [13, 14]. Using extensive field data from several ethnic groups in the Ituri Forest (Republic of Congo), Aunger [15] provides evidence that individuals preferentially acquire their food avoidance from models who share their ethnic markers

3) Personality and physical attributes: provide cues that permit learners to select models likely to possess mental representations that are suited to the learners' endowments.

The accurate acquisition of some mental representations from preferred models (those selected based on success, age, prestige, etc.) will sometimes require the cooperation, or at least the consent of the model, and may require substantial time with the model. The consent and cooperation of the model may be the only way to guarantee that learners will observe or understand key elements of behaviors, beliefs or practices. The model may also facilitate learning by modifying their behavior in a manner that facilitates effective transmission.[3] In many cases these *access costs* may be high when preferred models (1) do not care much about the learner (no kinship or reciprocal ties, etc.), (2) do not live in the learner's immediate locale, and (3) are preferred by many other individuals such that learners end up competing for access to the most preferred models.

Theory predicts, and the empirical record supports, that learners deal with the problem by, essentially, paying for access with what we call prestige-deference [5]. Prestige-deference is all the small benefits that learners pay, often continuously, to their preferred models. This includes responsiveness to

[3] There is also the possibility of active teaching. However, since current evidence suggests that active teaching appears rarely in ethnographic record of small-scale societies, it may not be an important element of ancestral human environments [10, 11, 16]. Active teaching, however, must be distinguished from the existence of non-verbal communicative ("pedagogical") cues [17].

requests (for help), small gifts and public praise. Learners' tendencies to pay prestige-deference are generally unconscious and driven by feelings of respect, admiration, and a desire to affiliate, or remain in proximity to their preferred model(s).

This line of evolutionary reasoning suggests that learners, before submitting to paying the access costs to the preferred models, ought to first learn as much as they can from models that (1) live in proximity and are easily accessed , and (2) care about the learner, or are otherwise incentivized to aid the learner. Candidates are family and household members, including especially older siblings, parents, and grandparents. Even among family members, the above model-based cues will still apply, so learners will learn from older, more similar (e.g., same sex), more skilled family members.

Then, having learned what they can from these low-cost models, learners must decide (unconsciously) whether to "update" their mental representations from their preferred models, or stick with what they acquired from their low-cost models. This decision should depend on (a) the relative difference in preferences between the low-cost models and the preferred models (based on the model-based cues), (b) an assessment of one's self using the cues (having acquired representations from the low-cost model) vis-à-vis one's preferred models, and (c) any readily-observable cues that indicate whether preferred models hold different mental representations than those acquired from the low-cost models. If the available observations indicate that the preferred models hold similar mental representations (i.e., employ similar practices or expresses like beliefs) or if little difference exists in the relative degree of preference between low and high cost models, then there may be no need to update.

With these theoretical issues in mind, we examined the role of access costs in two ways. First, we tested if individuals were more likely to choose models from their immediate locale (i.e. same household and same village) which would require less travel time, and would be easier to observe. Second, we tested if individuals were more likely to choose models that they are genetically related to and therefore, have inclusive fitness incentives to teach the learner.

ETHNOGRAPHIC BACKGROUND FOR YASAWA ISLAND

The research presented here was conducted in three villages on the eastern coast of Yasawa Island, which lies in the northwest corner of the Fijian archipelago (177° 32'E 16°48'S). This island is roughly 20km long and 2km wide at its widest point. The island experiences distinct wet-hot (October-March) and dry-mild seasons (April-September) and is probably the driest island in Fiji. There are 6 villages on the island, with between 100 and 250 people per village. Most of our data collection was done in the villages of Teci and Dalomo, at roughly the mid-point of the island, though our main advice network and demographic interviews were also conducted in the village of Bukama.

Politically, the villages of Teci and Dalomo comprise a single kinship-based political unit (called a *yavusa* in Fijian), while the village of Bukama is its own *yavusa*. *Yavusa* are the largest kin-based political units in the Fijian system. *Yavusa* are typically composed of several *mataqali*, or clans. A hereditary chief, in council with the senior male members of his *mataqali* and the senior male members of each of the other *mataqalis*, govern the community. For each village, an elected *turaga ni koro* is charged with handling relations with government ministries and external organizations (those outside the traditional systems of chiefs, clans, etc.). This elected leader may have important influences in political decision-making within the villages; however, he is usually subservient to the Chief and his council. Christian churches in these villages, and their pastors, often influence political decision-making. Although in these particular villages at this time, churches play only a minor role in political decisions.

Economically, households subsist principally on horticultural production, littoral gathering, fishing, and some purchased foods (e.g., flour, sugar, tea). Male members of households maintain subsistence gardens that supply yams, cassava, bananas, coconuts and other fruits, which supply the bulk of the calories consumed. Men also fish, using hook-and-line, nets, and both surface and underwater spears. Underwater spear fishing is a primary source of male prestige. Fish plus other marine species supply the bulk of the protein. Women collect fire wood, prepare food, clean, fish with hook-and-line, and gather shellfish, mollusks, and the like on the littoral. In Teci and Dalomo most cooking is done on open kitchen fires, while some in Bukama use gas stoves.

The two *yavusa* are economically distinct because Bukama leases some of its land to an exclusive luxury hotel (the only one on the island at the time of the study), which employs many of its villagers. Teci and Dalomo, in contrast, supply only 3-6 workers to the hotel at any one time, and these jobs are ephemeral. In Teci and Dalomo, there is one radio phone, which works occasionally, no electricity, no vehicles, and no commerce (except for in-home “stores”). Most houses in Teci and Dalomo are made from traditional materials and there are only two small motorized boats. Bukama has mostly concrete block houses, and is serviced by a mini-bus from the hotel (to pick up employees). Hotel workers can access a small, expensive hotel store. Some houses in Bukama have limited electricity, which is generated by the hotel.

Social and economic life is largely organized by a complex kinship system that extends the nuclear family into an *itokatoka* (extended household) and governs more distant relationships with a cross-parallel distinction. Each clan, *mataqali*, is composed of two or more *itokatoka*. The system expands the nuclear family by extending parental and sibling relationships while creating linkages of various kinds to other *itokatoka*. One's father's older brother is "big father" (*tata levu*) and his younger brother is "small father" (*tata sewasewa*). The eldest male is usually the decision maker of the *itokatoka*. The head of the *mataqali* is the senior male member of the leading *itokatoka*. All parallel cousins are referred to as siblings, as are first degree cross-cousins (this differs from elsewhere in Fiji). Parallel cousins are one's mother's sister's children and father's brother's children. Cross-cousins are one's mother's brother's children and father's sister's children. Opposite sex siblings (including parallel cousins) are *tabu* (meaning no direct social interaction is permitted—a taboo), as are one's same-sex siblings' spouses (who are literally referred to as *tabuqu*, or "my taboo"). Second degree cross-cousins are *tavale*. Opposite sex *tavale* are preferred marriage partners, while same-sex *tavale* maintain easy-going joking relationships.

METHODS

The larger project mixes in-depth ethnographic observation and participation with extensive interviews and experiments. The data used in the analysis presented here was collected at several different intervals between 2003 and 2008. The methods used to collect each of the measures will be discussed in turn. All data was collected by trained Fijian interviewers (fluent in Fijian and English), who do not have kin or local connection in these communities. Interviewers were initially trained by the authors, and one of us would frequently accompany interviewers to ensure that proper protocols were being followed. Since all villagers above the age 6 are fluent in both standard Fijian and the local village dialect, interviews were conducted in standard Fijian. Survey and interview questions were developed using back-translation to ensure that important meaning was not lost in the process of translation. Interviews about preferred models and perceived success networks were conducted in a private setting with only the researcher and the participant present (with the exception of the occasional presence of babies and young children).

Demographic and Attribute Measures: One of the key components of the ongoing project in Fiji is maintaining an accurate and up-to-date database of who is present in the communities and their demographic information (e.g. gender, age, years of education, etc.) This allows us to assign a unique identifier to each member of the community that can link their responses across a wide variety of tasks, and is essential for constructing the networks analyzed in this study. This demographic information is updated approximately every year. Researchers visit each house and ask questions about all the individuals that are currently living there. When possible, each member is asked directly, but when not possible the male and/or female head of household is asked instead. The measures obtained from these surveys used in the analysis presented here are: age, gender, and years of education.

Cultural Transmission Networks: This interview, conducted in 2008 with everyone in the communities over the age of 6, was used to construct the cultural transmission networks that serve as the primary outcome variables. These networks are estimated by asking who individuals would go to for advice if they had a question in a given domain. Although these are not direct measures of actual cultural transmission, which would likely be infrequent events that would be difficult to observe, we make the assumption that who individuals would go to for advice accurately reflects models that they would target for learning.

The questions that were administered were designed to elicit names of individuals who the participant would talk to if they had a question in a given domain. For example, in the domain of medicinal plants the question asked was: "Who would you go to if you had a question about using a plant as medicine?" Participants were allowed to free-list names, after which they were asked "is there was anyone else?" Participants had to respond that, "no, there was no one else", before the interviewer would move on to the next question. The individuals that a participant named were then matched to unique identifiers. This allows for the analysis of the network structure as well as merging with attribute data.

Teci-Dalomo Sample Networks: For two of the communities represented in this study (Teci and Dalomo), we used additional interview and survey data collected in previous years to explore other factors of interest. The measures discussed from this point forward will only apply to the sample labeled (*Teci-Dalomo Sample*).

Kinship Measures: In 2003, while updating the demographic database, the research team constructed kinship diagrams of genetic relatedness for each household in Teci and Dalomo. All of the kinship data collection was spear-headed by Joan Silk while she was living in the village. In-depth interviews were conducted with heads of each household across the village, and researchers recorded parents, grandparents, and great-grandparents for every individual. This was then used to construct one large kinship diagram for the entire village. The data from this diagram was entered into a database in the computer program Descent [18]. This program converts the graphic kinship diagram into a matrix, in which cells represent the relatedness coefficient (*r)* between any two individuals in the communities [19, 20].

Time Allocation Measures: Since 2003, when researchers are present in the communities, a random sampling approach is used to obtain a variety of measures about how villagers spend their time. Each day, several individuals are randomly selected to be sampled at a random time during that day. It is important to emphasize that this is **NOT** a convenience sample, but rather a random number generator is used both for the selection of the individual to be sampled and selection of the time when the sampling will occur. Researchers locate the selected individual at the specified time, and record what that individual is doing, and who they are with. For the analysis presented here, we looked at all observations between 2003 and 2008. From this data, we generated a matrix where a cell in row *i,* column *j,* would contain the proportion of times that individual *j* was present when individual *i* was sampled.

Perceived Success and Knowledge Measures: In 2006, the research team conducted an interview with villagers over the age of 10 that was designed to measure the perceptions of community members about who the most prestigious (successful/ knowledgeable) individuals were in a variety of domains. All of the questions followed a similar format as exemplified by the following question about fish knowledge: "Who knows the most about fish and fishing in this *Yavusa*?" (*Yavusa* is a Fijian term corresponding to the largest kin-based units in the Fijian political system). What is of relevance here is that both of the communities included in this sample, Teci and Dalomo, are members of only one *Yavusa.*) After they finished responding, participants were always asked if there was anyone else besides those listed, and if anyone else was mentioned they were added to the list. Participants were then asked to look at the list and rank the individuals that they nominated, placing the best person first. Beyond giving us a general community perception as to which individuals were the most successful in these domains, it also provides us with individuals' perceptions of who was the most successful, which might not fit with the rest of the community's perception. In the data presented here, we used participant responses from the questions about: 1) who knew the most about fishing, 2) who the best line fishers were, 3) who the best spear fishers were, 4) who the best yam growers were, 5) who knew the most about growing yams, and 6) who knew the most about medicinal plants. This data was used to construct perceived success/knowledge networks, where a directed tie from individual *i* to individual *j* would be present if *i* nominated *j* as one of the best in a given domain. Using these networks as predictors allows a direct exploration of the effects of each individual's perception, as opposed to simplifying these responses to general rankings for the community as a whole.

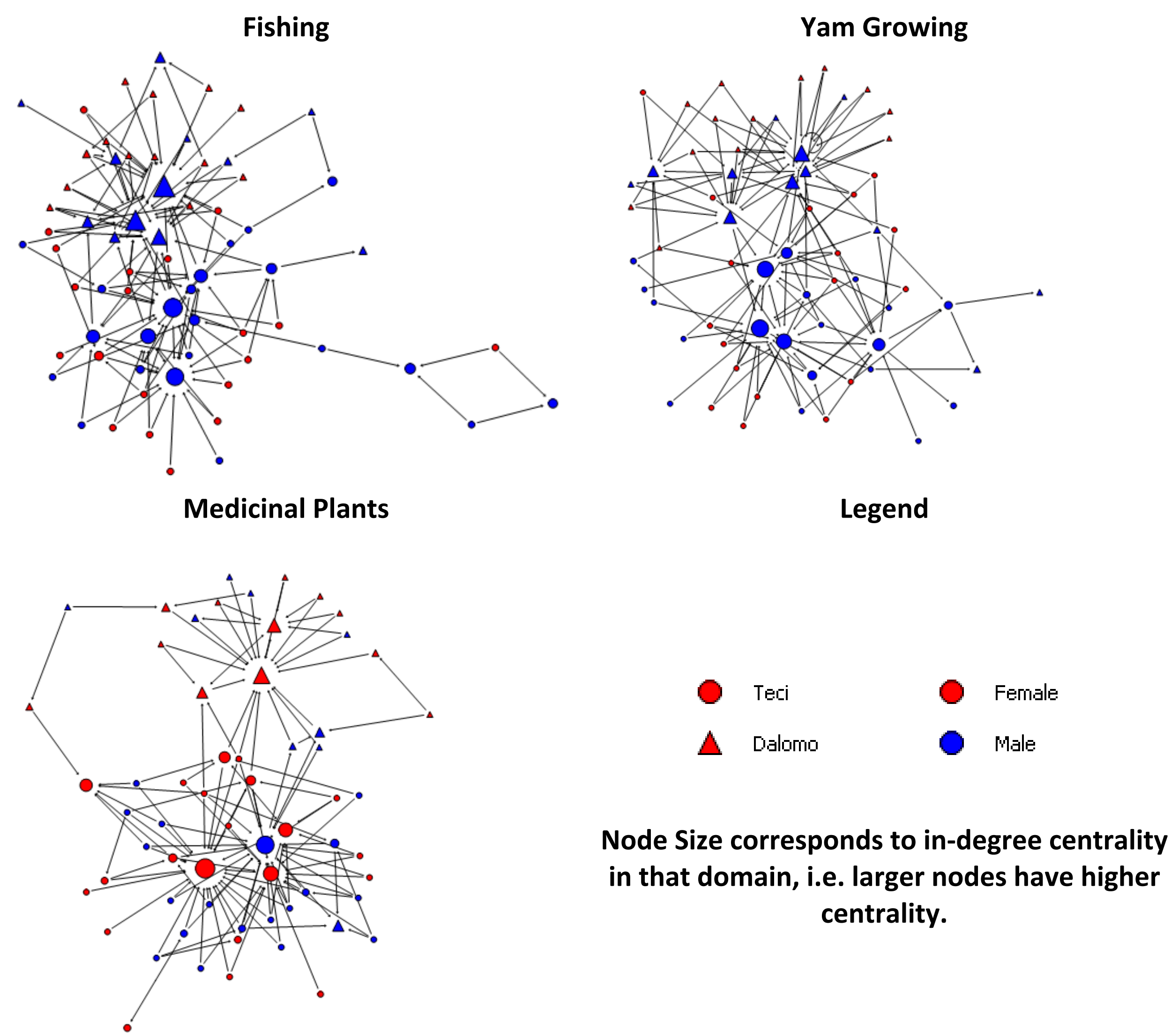
It is important to note that this interview was conducted two years prior to the cultural transmission network interview that serves as the primary dependent variable. If these surveys were conducted at the same time, or with a relatively short delay, it is possible that participants might be responding similarly to both sets of questions because they were thinking about their prior responses. However, given the long delay between interviews, it is unlikely that participants would recall their responses to the success/knowledge interviews when responding to the cultural transmission network questions.

Measures of actual efficiency in spear-fishing: Over the course of several years, we recorded the folkspecies and sizes of the catches from a sample of fishermen in Teci and Dalomo. In gathering these data, we took advantage of the fact that on Saturdays most of the fishermen in the villages go spear fishing (underwater) as a group. Once they are in the water, they separate and don't see much of each other until they go ashore 2-3 hours later. These data come from measurements of 1082 fish (66 different folk generic kinds) caught by 26 fisherman on 12 different Saturdays between July 7th, 2005 and July 1st, 2006 (including measurements in the months of July, August, November, December, April, and May). Since these data are principally from underwater spear fishing, they do not represent an accurate picture of all fishing, but they do provide a unique opportunity to compare skill among spear-fishers.

SUPPORTING EMPIRICAL FINDINGS AND DETAILED RESULTS

Before discussing the results of the statistical analysis of this data, it is beneficial to discuss the qualitative characteristics of these networks. Diagrams of the *Teci-Dalomo Sample* cultural transmission networks are presented in Figure 1, the diagrams of the full networks are in the main text. First, notice that these networks tend to be centralized, such that a few individuals receive many more nominations than the rest of the network. In Figure 1, more central individuals are those with many lines pointing toward them, and are represented by nodes of larger size (the size is proportional to in-degree centrality in these figures). For the *Fishing* and *Yam Growing* transmission networks, men are more likely to be chosen as models than women (as evidenced by more large blue shapes), while the opposite is true for medicinal plants. Statistical analyses confirming this observed are provided below, and highlighted in the main text.

Figure 1. Network Diagrams for Teci-Dalomo Samples



The main text refers to the centralities of these networks. Table 1A provides the details for aggregate centrality measures, and for in-degree. A brief description of centrality is provided in the main text. For details see Wasserman and Faust [21]. Table 1B provide the centrality and in-degree measures for our domains of success and knowledge.

Table 1A. Centrality and Indegree Statistics for the Cultural Transmission Networks					
Teci-Dalomo	Number of Nodes	Mean In-Degree Centrality	SD In-Degree Centrality	Max In-Degree	Network Centralization
Medicinal Plants	62	2.21	5.264	27	41.31%
Fishing	67	2.075	4.556	21	29.11%
Yams	69	2.145	4.534	17	22.17%
Full Network					
Medicinal Plants	192	2.698	7.31	46	22.79%
Fishing	216	2.602	7.141	47	20.75%
Yams	215	2.558	6.462	37	16.17%

Table 1B. Centrality and Indegree Statistics for the Success and Knowledge Networks (Teci-Dalomo Sample)					
Success Measures	Number of Nodes	Mean In-Degree Centrality	SD In-Degree Centrality	Max In-Degree	Network Centralization
Best Line Fisher	67	0.871	2.07	11	15.57%
Best Spear Fisher	67	2.278	6.03	28	39.65%
Best Yam Grower	69	2.07	4.83	23	31.23%
Knowledge Measures					
Medicinal Plants	62	1.55	4.712	26	40.80%
Fishing	67	0.871	1.809	9	12.56%
Yams	69	1.65	3.657	18	24.39%

EXPONENTIAL RANDOM GRAPH (ERG) MODELS ANALYSES OF CULTURAL TRANSMISSION NETWORKS

To statistically examine the relationship between the dependent and independent variables, we constructed exponential random graph (ERG) models using the statnet package in R [22]. R Scripts for importing data, along with model specifications are available upon request from James Broesch. A simplification of how ERG models are constructed and estimated is presented here, but readers interested in the mathematical and statistical considerations are encouraged to consult our references [23-25]. As discussed in the main text, the ERG models assume every tie between every possible pair of nodes (individuals in this case) in the network to be a random variable that can take a value of 1 (if the tie is present) or 0 (if it is not). Under this assumption it is possible to construct all of the possible network configurations that have the same number of nodes as the observed network. We placed further constraints on the networks that were considered to be possible so that only networks with the same number of total ties and where the maximum number of nominations that one individual can give is 5, had a non-zero probability. If one specifies that a given set of variables should be used to estimate the probability of a tie existing between two individuals, it is possible to compare the observed network to the distribution of possible networks and estimate variable coefficients (parameter estimates) that maximize the probability of generating networks that are similar to the observed network [25]. The starting values for parameter estimates are obtained through a maximum pseudo-likelihood estimation (which is equivalent to the MLE in the case of the models discussed, which are dyad-independent). The estimation of the model fit, and corresponding standard errors for each parameter estimate, is accomplished through the use of a Markov Chain Monte Carlo Maximum Likelihood Estimation which simulates a probability distribution of the potential networks based on the starting parameter values, and then updates those parameter values to maximize the fit between the proposed model and the observed network [22].

The statnet package allows researchers to specify each variable's influence on tie formation. For example, in the case of the cultural transmission networks measured here, the researcher might hypothesize that being from the same community, or from different communities, influence the likelihood that an individual would nominate someone else (dyad effect). In this case, the variable "village" would be included as a *nodematch* term. If the coefficient estimate for this variable is significant and positive, then being from the same village significantly increases the likelihood of an individual nominating another individual as someone they would go to for information. If it is negative and significant, then individuals are more likely to go to someone from another community for this kind of information. However, an alternative hypothesis is that individuals from one particular village (say, Teci) are more likely than all other villages to be sought for advice about fishing (main effect). In this case the researcher might include the variable "village" as a *nodefactor* term. This type of model term explores the effects of being from each particular village on the likelihood of an individual having more connections coming to them or leaving from them. Additional specification of the direction of connections can be achieved through using the term *nodeifactor* for connections coming in (being nominated in this example), or *nodeofactor* for connections going out from an individual.

For each of our cultural domains, we ran our Baseline Model, which is highlighted in the main text, and five modifications of the Baseline Model. These additional models are the (1) No Success Measures Model, which is our Baseline Model with our success and knowledge measures dropped, (2) Cross-Domain Success Model, which is our Baseline Model with our Cross-Domain Success measures added, (3) Kinship Only, which is our Baseline Model with our measure of Household membership dropped, (4) Household Only, which is our Baseline Model with our measures of Relatedness dropped, and (5) Time Allocation Model, which is our Baseline Model with our Time Allocation measures added. Tables 2 (Fishing), 4 (Yams) and 5 (Medicinal Plants) provide our six models for each domains. Table 3 supplies regressions using both our Full Sample, which includes both Teci-Dalomo and Bukama, using our Baseline Model with our Success, Knowledge, and Relatedness measures dropped.

Predictor variables were entered simultaneously for each regression model, meaning that the reported effects of each variable are independent of one another. However, we wanted to be sure that the observed cross- domain prestige effects, for example being perceived as a successful yam grower on being sought after for advice about fishing, were above and beyond any effect that might be due to the same individuals being successful at both yam growing and fishing. We assessed this by comparing the coefficient estimates for the within-domain success measures between the Cross Domain Success Model and the Baseline Model (Tables 2, 4 and 5, below). Since the coefficient estimates for the within domain variable do not change significantly when including the cross-domain success/knowledge variables, we can be relatively confident that these two variables are not explaining the same variance in tie formation. Including cross-domain success measures captures additional variance not explained by our within-domain success measures.

In performing these regressions we also worried a lot about the effects of correlations among our predictors. In cases in which the correlations among predictors were high, we performed regressions with one of the highly correlated predictors dropped and compared the resulting coefficients to the model with both predictors in.

Fishing Cultural Transmission Network (Table 2)

Dyad Specific Predictors: The strongest predictor of ego nominating another individual as someone they would go for advice about fishing was if ego also mentioned that person as being one of the best spear fishers in the two communities. Individual *i* was 9.85 times more likely to go to individual *j* for advice if *i* also nominated *j* as one of the best spear fishers in the village. Perceived success at line fishing was also predictive of nominations, but to a lesser degree (OR=2.22). Individuals were 1.8 times more likely to go to someone else from their own village than someone from another village. Interestingly, ego's perceptions of others' fishing knowledge was not predictive of who they would go to for advice. There is evidence that perceived success in a domain not related to fishing, growing yams (from success in all domains model), was also positively correlated with who ego would go to if they had a question about fishing (OR= 2.19). Individuals were 1.6 times more likely to go to individuals of the opposite gender for advice. However, when this effect is split by gender (analyses not shown in the tables) it is evident that while women are significantly more likely to report that they would go to men (OR= 2.51, SE=.67 p<.001), men are equally likely to go to either sex. Genetic relatedness and perceptions of being knowledgeable about growing yams were both negatively related to receiving a nomination. The proportion of time that individuals were observed together during random point samples (from Time Allocation Model) was not significantly related to who individuals would go to for advice.

Main Effects: It is clear that fishing information networks are highly gender biased, with males being 3.5 times more likely to receive a nomination as a person someone would go to for advice about fishing, compared to females. Years of formal education that an individual received is negatively correlated with being sought after for advice. If two individuals varied only in their level of schooling, one who completed 10 years of schooling would be 30 times less likely to be sought after for advice than an individual who had no formal schooling. Age was not significantly related to how many nominations an individual received.

Comparison with Full Sample: The results for the full sample were very similar, see Table 3. However, in the full sample, individuals were significantly more likely to go to other members of the same household for advice. This was a non-significant predictor for the Teci-Dalomo sample. There is also a significant positive correlation between age and the number of nominations an individual received, which was not observed in the Teci-Dalomo sample.

Table 2. Teci-Dalomo Regressions for Cultural Models of in the Domain of Fish and Fishing

Variable	Stat	No Success Measures	Baseline	Cross-Domain Success	Kinship Only	Household Only	Time Allocation
Same Gender	Log-Odds	-0.51**	-0.51**	-0.52**	-0.51**	-0.51**	-0.50**
	SE	0.19	0.20	0.20	0.20	0.20	0.19
Same Village	Log-Odds	0.76***	0.63**	0.66**	0.64**	0.61**	0.63**
	SE	0.19	0.20	0.21	0.21	0.20	0.20
Same Household	Log-Odds	-0.03	0.32	0.35		-0.32	0.40
	SE	0.43	0.42	0.42		0.42	0.41
Age Difference	Log-Odds	0.000022	0.0033	0.0031	0.0042	0.0041	0.0043
	SE	0.0057	0.0061	0.0058	0.0061	0.006	0.0059
Sex	Log-Odds	1.43***	1.25***	1.27***	1.25***	1.22***	1.25***
	SE	0.25	0.26	0.26	0.25	0.24	0.25
Age(yr)	Log-Odds	-0.00074	-0.0015	-0.0018	-0.0019	-0.00086	-0.0019
	SE	0.0075	0.0078	0.0077	0.008	0.0076	0.0079
Education(yr)	Log-Odds	-0.31***	-0.34***	-0.35***	-0.34***	-0.34***	-0.34***
	SE	0.032	0.034	0.033	0.033	0.033	0.034
Genetic Relatedness	Log-Odds		-2.32***	-2.45***	-1.87		-2.36***
	SE		0.37	0.41	1.08		0.38
Most Fishing Knowledge	Log-Odds		0.27	0.25	0.28	0.27	0.26
	SE		0.17	0.18	0.17	0.22	0.16
Best Line Fisher	Log-Odds		0.80***	0.70***	0.79***	0.76***	0.80***
	SE		0.19	0.19	0.18	0.18	0.19
Best Spear Fisher	Log-Odds		2.29***	2.31***	2.30***	2.30***	2.29***
	SE		0.089	0.094	0.092	0.098	0.094
Most Yam Knowledge	Log-Odds			-1.038***			
	SE			0.18			
Best Yam Grower	Log-Odds			0.79***			
	SE			0.13			
Proportion Observed Together	Log-Odds						-0.67
	SE						0.61

Table 3. Full Sample Regressions

Variable	Stat	Medicinal Plants	Fishing	Yams
Same Sex	Log-Odds	-0.8***	-1.09***	-1.13*
	SE	0.17	0.11	0.53
Same Village	Log-Odds	0.99***	0.86***	0.80***
	SE	0.15	0.086	0.19
Same Household	Log-Odds	1.23**	0.99***	1.32
	SE	0.38	0.20	1.14
Age Difference	Log-Odds	-0.0074	-0.0011	-0.00049
	SE	0.0041	0.003	0.024
Sex	Log-Odds	-2.53***	0.28**	0.27
	SE	0.16	0.11	0.54
Age (yr)	Log-Odds	0.026***	0.02***	0.031
	SE	0.0058	0.0034	0.026
Education(yr)	Log-Odds	-0.29***	-0.22***	-0.31**
	SE	0.015	0.013	0.10

In considering whether these kinds of selective psychological biases can generate adaptive cultural evolution, it is important to know whether our participants' subjective evaluations of people success or knowledge in various domains are accurate. We only have data to evaluate this in the domains of fishing, and specifically spear-fishing. As described above, we have measures of fish catches from 24 spear-fishermen, based on the measurements of 1,703 fish over six years. The correlation between our in-degree measure for success in fishing (number of times cited as one of the best fisherman) and our estimate of their actual fish rates, in kilograms of fish per minute in the water is 0.84. Figure 2 shows the data. This is consistent with decades of work measuring hunting success, both objectivity and using local perceptions, among the Ache. This work indicates that local perceptions are incredibly accurate on such measures [26].

Yams Cultural Transmission Network (Table 4)

Dyad Specific Predictors: Like the fishing networks, perceived success in the domain in question is strongly related to who individuals report that they would go to for advice. If ego reported a given alter as being one of the best yam growers in the village, they were 7.25 times more likely to say that they would go to them for advice. Perceived success at spear fishing was also positively correlated with who individuals would go to for advice (OR=2.39), as was perceived knowledge about growing yams (OR=2.23), although to a lesser degree than perceived success at growing yams. Proportion of times that two individuals were observed together during random point samples (Time Allocation Model) was positively related, such that a 10% increase in the proportion of times individual *j* was observed with individual *i* would equal a 20% increase in likelihood of *i* going to *j* for advice. Difference in age, being from the same household, genetic relatedness and perceived fishing knowledge were all not significantly related to who individuals report they would go to for advice.

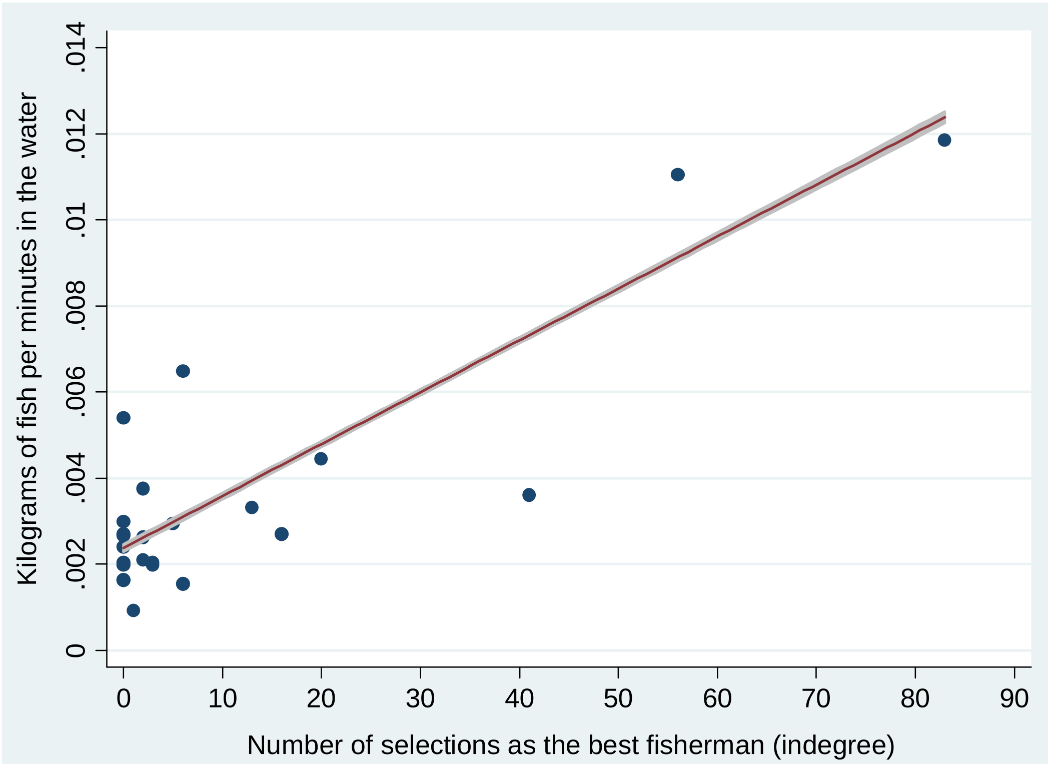


Figure 2. Relationship between measure of actual fishing efficiency and perceptions of who is the best fisherman.

Main Effects: To whom individuals would go if they had a question about growing yams, like fishing, is highly gender biased, and men were much more likely to receive nominations (OR=2.62). Older individuals were more likely to be gone to for advice. An individual who is 20 years older than another would receive 2.5 times more nominations on average. Education was strongly negatively correlated with nominations, with each year of schooling resulting in a 25% decrease in the number of nominations received. A person who attended school for 10 years would tend to receive 20 times fewer nominations than an identical individual who never attended school.

Comparison with Full Sample (Table 3): The results for the full sample were very similar. The only significant difference in parameter estimates were for the main effects of gender and the main effects of age, which were of similar magnitude and direction but non-significant in the full sample.

Table 4. Teci-Dalomo Regressions for Cultural Models of in the Domain of Growing Yams

Variable	Stat	No Success Measures	Baseline	Cross-Domain Success	Kinship Only	Household Only	Time Allocation
Same Gender	Log-Odds	-0.66***	-0.62	-0.63**	-0.63*	-0.62*	-0.62**
	SE	0.19	0.38	0.24	0.32	0.27	0.23
Same Village	Log-Odds	0.61*	0.57	0.55*	0.60*	0.57*	0.56
	SE	0.19	0.44	0.26	0.39	0.29	0.33
Same Household	Log-Odds	0.56	0.50	0.37		0.30	0.11
	SE	0.41	0.80	0.58		0.54	0.58
Difference In Age	Log-Odds	0.0011	0.016	0.016	0.018	0.018	0.017
	SE	0.0057	0.017	0.01	0.01	0.014	0.015
Sex	Log-Odds	1.11***	0.96*	0.91*	0.96**	0.95*	0.96**
	SE	0.25	0.45	0.36	0.37	0.38	0.33
Age(yr)	Log-Odds	0.028***	0.047*	0.051***	0.045***	0.05**	0.045**
	SE	0.0079	0.019	0.014	0.012	0.015	0.017
Education(yr)	Log-Odds	-0.32***	-0.29***	-0.30***	-0.29***	-0.29***	-0.29***
	SE	0.034	0.067	0.042	0.054	0.048	0.06
Genetic Relatedness	Log-Odds		-0.72	-0.55	-0.032		-0.58
	SE		0.72	0.38	1.40		1.01
Most Yam Knowledge	Log-Odds		0.80***	0.75***	0.83***	0.81*	0.80***
	SE		0.15	0.13	0.17	0.33	0.14
Best Yam Grower	Log-Odds		1.98***	1.88***	1.98***	1.98***	1.98***
	SE		0.15	0.091	0.12	0.1	0.18
Most Fishing Knowledge	Log-Odds			0.00099			
	SE			0.32			
Best Line Fisher	Log-Odds			0.025			
	SE			0.17			
Best Spear Fisher	Log-Odds			0.87***			
	SE			0.15			
Proportion Observed Together	Log-Odds						2.56***
	SE						0.64

Medicinal Plants Cultural Transmission Networks

Dyad Specific Predictors: In the case of medicinal plants, we have no direct measure of perceived success at using medicinal plants. However, we did ask individuals who they perceived to be most knowledgeable about using plants as medicine. Ego's perception of which individuals knew the most about using plants as medicine was a very strong predictor of who ego said they would go to for advice in this domain. When individual *j* was nominated by individual *i* as being one of the most knowledgeable individuals about medicinal plants, *j* was 24 times as likely to also be named as a person that *i* would go to for advice. Although we could not include perceptions of fishing success, due to co-linearity, there is a positive relationship between perceived success at growing yams and cultural transmission networks for medicinal plants. The proportion of times *j* was observed in *i*'s presence during activity samples was positively correlated with nominations such that a 10% increase would result in *i* being 1.5 times more likely to go to *j* for advice. Individuals tend to go to other members of the same village (OR=2.76). Perception of knowledge about fishing, was negatively correlated with who individuals would go to with a question about using plants as medicine (OR=.21).

Main Effects: The network is highly gendered, such that a woman would receive 4.8 times as many nominations as a man all other things being equal. Age was positively associated with nominations, and a 20 year increase would roughly double the number of nominations received. Like the other two networks, there is a negative association between formal schooling and nominations. For each year of schooling individuals would tend to receive 25% fewer nominations. If two individuals were identical except one of them attended school for 10 years, and the other never attend school, the more schooled individual would receive 20 times fewer nominations on average.

Comparison with Full Sample: Like the previous two domains, we observed very similar results for the full sample compared to the Teci-Dalomo sample. The only substantive difference was that individuals were significantly more likely to go to someone of an opposite gender, which was not a significant predictor in the Teci-Dalomo sample. When we look at that effect separately for each gender in the Full Sample, we observed that the effect is significant for both men (OR= 1.82, SE=.22, p<.001) and women (OR= .28, SE=.09, p<.001). So while the effect is stronger for men, i.e. men are more likely to go to women than women are to go to men, it is significant for both. This indicates that men and women may have different skill sets when it comes to using plants as medicine, but further examination is needed to make any definitive conclusions.

Table 5. Teci-Dalomo Regressions for Cultural Models of in the Domain of Medicinal Plants

Variable	Stat	No Success Measures	Baseline	Cross-Domain Success	Kinship Only	Household Only	Time Allocation
Same Gender	Log-Odds	-0.06	-0.012	-0.0081	-0.021	-0.011	-0.013
	SE	0.19	0.22	0.23	0.20	0.25	0.22
Same Village	Log-Odds	1.11***	1.02***	1.04***	1.04***	1.01**	1.01***
	SE	0.22	0.30	0.30	0.25	0.35	0.25
Same Household	Log-Odds	0.76*	0.58	0.51		0.40	-0.21
	SE	0.39	0.43	0.57		0.76	0.50
Age Difference	Log-Odds	-0.0091	0.013	0.014	0.015	0.016	0.011
	SE	0.0057	0.0086	0.0095	0.012	0.015	0.0079
Sex	Log-Odds	-1.76***	-1.56***	-1.62***	-1.55***	-1.57***	-1.58***
	SE	0.23	0.32	0.35	0.26	0.37	0.26
Age(yr)	Log-Odds	0.030***	0.036	0.035**	0.034**	0.034*	0.035***
	SE	0.0082	0.0086	0.012	0.012	0.015	0.0091
Education(yr)	Log-Odds	-0.33***	-0.31***	-0.32***	-0.31***	-0.31***	-0.32***
	SE	0.043	0.055	0.057	0.055	0.066	0.052
Genetic Relatedness	Log-Odds		-0.63	-0.55	0.16		-0.26
	SE		0.80	0.41	0.92		0.73
Most Plant Knowledge	Log-Odds		3.20***	3.23***	3.22***	3.19***	3.27***
	SE		0.11	0.11	0.1	0.30	0.11
Most Fishing Knowledge	Log-Odds			-1.54			
	SE			0.62			
Most Yam Knowledge	Log-Odds			0.45			
	SE			0.27			
Best Yam Grower	Log-Odds			0.93**			
	SE			0.30			
Proportion Observed Together	Log-Odds						3.86***
	SE						0.40

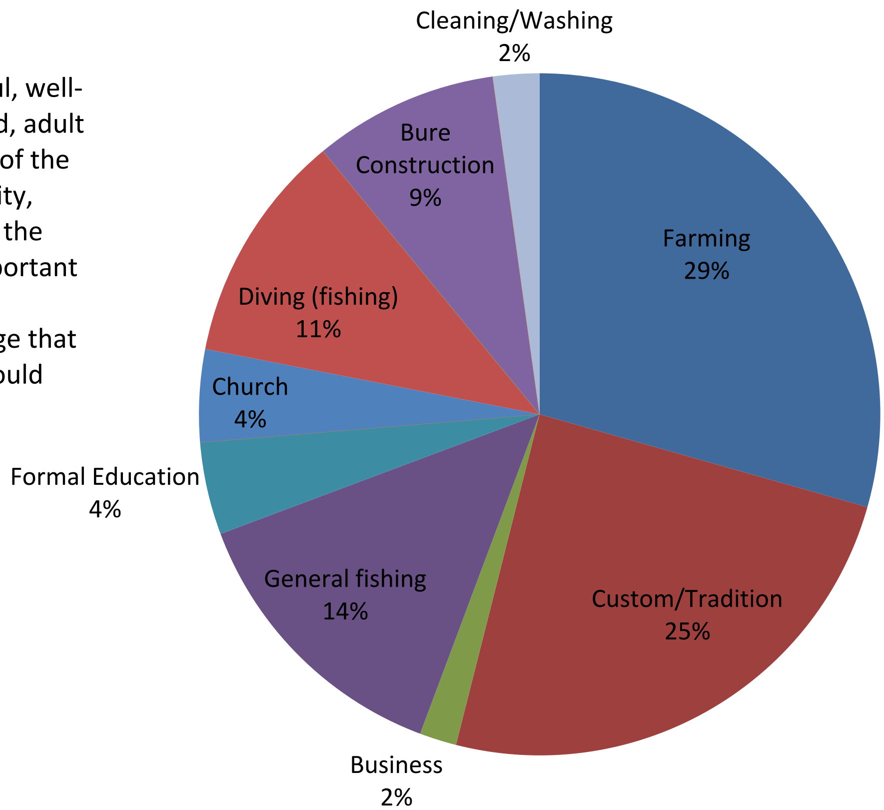
WHAT ARE THE VALUED DOMAINS OF SUCCESS?

In our cross-domain success analyses, we wanted to select variables that captured success in *valued* local domains [5]. To determine this, we conducted interviews with 72 randomly selected adults from Teci, Dalomo and Bukama. Among other questions, we asked (1) “To be a successful, well-respected, adult member of the community, what are the most important skills or knowledge that a **boy** should learn? [List them]” (Na cava soti na vuku se kila e bibi vua e dua na gonetagane me vulica me rawa kina ni rawaka vakavinaka ka dokai e na gauna sa qase mai kina e na i tikotiko vakoro? [Tuvana mai]) and (2) “To be a successful, well-respected, adult member of the community what are the most important skills or knowledge that a **girl** should learn? [List them]” (Na cava soti na vuku se kila e bibi vua e dua na goneyalewa me vulica me rawa kina ni rawaka vakavinaka ka dokai e na gauna sa qase mai kina e na i tikotiko vakoro? [Tuvana mai]).

For present purposes, we analyzed these data merely by aggregating all the responses and calculating the frequencies of different responses. Figure 3 shows these calculations. For the question about what boys should learn, if we clump answers of fishing (*qoli*) and spear-fishing (*riu*) together, the top three responses are farming , fishing and traditions (village rules and etiquette).Growing yams is central to farming. Thus, both growing yams and fishing emerge as important local domains.

For girls, the top three domains are weaving mats, cooking and washing/cleaning. Medicinal plants did not come up. Since our ethnographic experience in these villages does suggest that people respect those with knowledge of medicinal plants, and it is part of the expertise of an *yalewa vuku*, which is an prestigious informal role filled by some women (literally “wise woman”; these women act as a mid-wives, among other things), we suspect that medicinal plants are not a domain that every women is expected to know about.

To be a successful, well-respected, adult member of the community, what are the most important skills or knowledge that a **boy** should learn?



To be a successful, well-respected, adult member of the community, what are the most important skills or knowledge that a **girl** should learn?

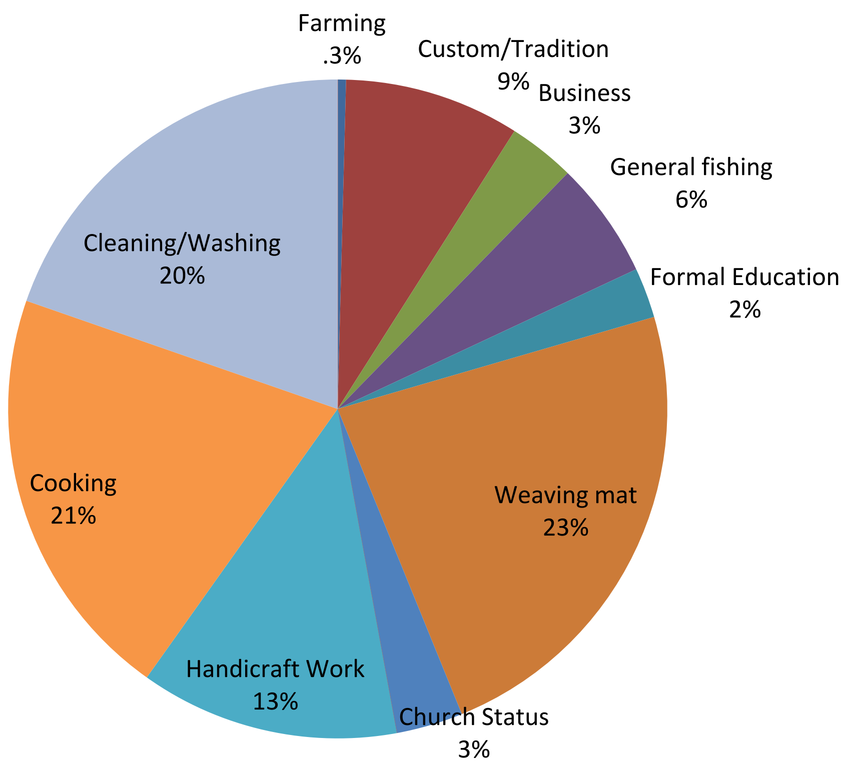


Figure 3. Domains of Success Results

CENTRALIZATION DOES NOT MEAN HIGH CULTURAL RELATEDNESS

The relatively centralized nature of our cultural transmission networks (Table 1) might lead some to suspect that these networks support the notion that the similarity within social groups might result principally from the effects of one or a few dominant transmitters on the entire group. Such transmission patterns create a kind of ‘cultural relatedness’ akin to genetic relatedness. This is relevant to recent debates about the origins of cooperation, as theorists have recently emphasized that cultural relatedness may be relevant to explaining human cooperation [27, 28]. To examine this question, we used our cultural transmission network data to calculate cultural coefficients of relatedness (k) using both our 2008 (analyzed herein), and a parallel set of data collected in 2003 using the same methods, but only in Teci and Dalomo (illustrated in Figure #). Using both sets of data allow us to verify the temporal stability of our calculations. We calculate k by asking what is the probability that two individual share the same cultural traits by having learned it from the same person. We then sum up over all possible individuals. Since we ignore errors in transmission, these calculations represent upper bounds. Table 6 shows these values, which can be interpreted like Hamilton’s r (based on kinship), vary from 0.034 to 0.053. This is not much higher than the genetic coefficient of relatedness (r) for these communities, 0.018, calculated from a detailed genealogy. Also, because for groups of this size k is approximately equal to Fst, this implies that roughly 5% or less of total cultural variation would be between-group variation. Thus, despite the relative centrality of our networks, these findings provide no support for the notion that cultural relatedness can account for human cooperation, or for the patterns with within group similarity we find in many cultural domains [29].

Table 6. Coefficients of Cultural Relatedness (k)

Cultural Domain	2003	2008
Fishing	0.043	0.040
Yams	0.053	0.043
Medicinal Plants	0.053	0.034

LINKS WITH SOME FIELD STUDIES OF CULTURAL TRANSMISSION

Prior work on cultural transmission has suggested that both vertical and oblique transmission pathways are important. In the main text, we propose that our work builds on this prior research by revealing how oblique transmission is patterned in predictable way that illuminates the origins of cultural adaptations. Reyes-Garcia et al. [30], for example, attempted to tease apart which routes of cultural transmission best explain the distribution of ethnobotanical knowledge and skills among Tsimane’ horticulturalists in Bolivia. The authors examined the relationship between an individual’s ethnobotanical knowledge and skills and the ethnobotanical knowledge and skills of: 1) their same sex parent, 2) their peers (cohort of individuals that are born + or – 4 years of one another), and 3) older community members (born 20 to 40 years earlier, excluding parents). The authors find a significant positive association between individuals’ own knowledge and the knowledge and skills of their parents and older community members, but no association with the knowledge and skills of peers. They conclude that there is evidence for both oblique and vertical transmission of ethnobotanical knowledge and skills, but that the differences in effect size suggest that the transmission of ethnobotanical knowledge and skills is primarily oblique among the Tsimane'.

Similarly, Tehrani and Collard [31] used ethnographic work and cladistic analysis to determine if variations in weaving patterns between Iranian tribal populations are better explained by vertical transmission in childhood combined with subsequent oblique transmission in adulthood, or by between-group transmission of weaving techniques and patterns. In their ethnographic work, they asked individuals from whom they learned their techniques at various life stages. From these reports, they conclude that vertical transmission is the primary mode in childhood, followed by subsequent oblique transmission among other routes as individuals grow older. Because contact between women of different groups is limited due to social norms in the region, these processes can lead to between-group differences. In their cladistic analysis, they compared weaving patterns and techniques from different tribes to determine if there was significant sharing and blending of ideas between groups which was responsible for between group differences. The cladistic analysis supports their ethnographic findings that between-group differences are likely the result of descent with modification, rather than blending of techniques through between-group transmission.

We think our findings, and our two-stage model more generally, is consistent with older findings that have been used to emphasize the important of vertical transmission. Hewlett and Cavalli-Sforza show that Aka foragers in the Ituri forest report learning their most of their traditional skills from their parents (80%), usually their same-sex parents. However, consistent with our approach, Aka also reported substantial learning from skilled, knowledgeable, or successful people in the two areas, both of which seem likely candidates for the stage-two updating. For making cross-bows, a newly introduced technological skill not at equilibrium yet, people reported having learned from “skilled males” (p. 929). For hunting elephants and healing, specialized skills presumably with great variation in the perceived competence, people reported paying special attention to the *ntuma* (great elephant hunter) and *nganga* (traditional healer), in addition to their parents.

EXTENDED DISCUSSION

Looking at the results across all models and samples, there is evidence that both supports and challenges the predictions that we set out to evaluate. The strongest piece of evidence in support of the predictions is that across all domains, perceived success/knowledge in the domain in question was the strongest predictor of to whom individuals would go for advice in that domain. The effect sizes were substantially larger than all other predictors. This directly supports one of the main hypotheses—that individuals’ perception of success should be the strongest predictor of whom they choose as models for cultural learning. With domains in which we have measures of both perceived knowledge and perceived success, there are stronger effects for perceived success. Although we cannot definitively conclude why that may be the case, we hypothesize that it may be in part due to the way individuals assess success vs. knowledge. There are two primary differences between success and knowledge that we believe may be relevant. First, assessing success can be accomplished by paying attention to outcomes (e.g. who brings home the largest catch of fish). It is our impression from ethnographic observations that not only are these outcomes salient to individuals, but they are also socially transmitted among community members. For example, when someone comes back to the village with a large fish catch, the rest of the community quickly finds out either by direct observation, or by talking with others. This provides individuals with frequent, salient signals of success which can in-turn lead to social and fitness benefits for more skilled individuals [32]. Another possibility is that knowledge is not as direct of an indicator of skill as success, and may in fact not be related to actual skill [33]. An individual can be very knowledgeable but unsuccessful, and what the learner should care about is success.

Another area where there evidence supporting the initial hypotheses, was in the relationship between proxies for success (age, and success in another domain) and cultural transmission networks. In the full sample for all three domains, and in the Teci-Dalomo sample for yams and medicinal plants, there is a positive correlation between an individual’s age and the number of community members that would go to that individual for advice. This fits directly with the predictions from models of cultural evolution [5]. It is important to keep in mind that this relationship should be strongest when there are not other clear indicators of success available to learners, and thus we might expect to be diminished in domains where learners are able to assess models’ success. For example, this may explain why there was not a significant relationship between age and the number of nominations that an individual receives for fishing advice in the Teci-Dalomo sample. It is our impression from living in these communities that fishing success is fairly easily observed and salient to learners, and may be more salient than the other two domains. However, this hypothesis would need to be empirically validated.

In the two domains in which men received more nominations than women (fishing and yam farming advice), perceived success in either domain was predictive of being sought after for advice in the other. There are at least two reasons that this might be observed. The first, drawn from cultural evolutionary theory, is that in the absence of full information, learners may use prestige in another domain as a cue for success in the specified domain. These effects should be strongest when success information in the specified domain is unavailable or noisy. An alternative explanation is that individuals who are successful at growing yams are also more successful at fishing, or vice versa. This could be because of related skills necessary for each task, or individuals who invest heavily in learning about fishing also invest heavily in learning about growing yams. We are unable to discern which of these two competing explanations may be correct. However, given that perceived success at growing yams also resulted in individuals being sought after for medicinal plant advice suggests that this may be a cross domain prestige effect.

An interesting result is that across all samples, there is a consistent negative relationship between years of formal schooling and the likelihood that an individual would be sought after for advice in these three domains. While our initial hypotheses made no predictions about formal education per say, some readers may view formal education as a general proxy for knowledge/skills, and think that these results are inconsistent with the hypotheses related to prestige effects. While formal education may be equated with knowledge and skills in some domains (e.g. running a business), it is our perspective that for the domains under study here, that the inverse is true. As some anthropologists have noted, while formal education does promote skills that are valued in the developed world, the hours spent in school may result in fewer opportunities for learning other life skills that are not taught in schools [10, 34]. The hours that are spent in school are hours that would otherwise be spent observing other members of the community going about their daily life, and perhaps learning skills that are more typical of a traditional lifestyle (fishing, farming, using plants as medicines). For example, in a detailed study among the Maasai, Galaty [34] demonstrated that boys who attended school exhibited less mastery of Maasai cattle taxonomy (in terms of descriptive terms which are an important domain in Maasai culture and language).

Individuals who invest in obtaining formal education may envision themselves working in the market economy rather than living a subsistence lifestyle as an adult. In fact, during our time in these communities, this was frequently mentioned by villagers as something that does occur. May individuals go to urban centers on the main island in Fiji (Viti Levu) for secondary education, with the intention of securing wage labor when they finish. However, due to lack of opportunities, among other factors, many individuals end up returning to their home communities where they live a primarily subsistence lifestyle. While formal education prepares them for wage labor opportunities, it may actually be detrimental for learning other skills that are important for a subsistence lifestyle. This is a potential explanation for our observed results in these domains, but further research is needed.

Finally, in the case of access costs to models, there were results that were both consistent and inconsistent with our initial expectations. Results that support the models are (1) across all models, individuals report that they would go to other members of the same village more frequently than individuals from other villages and 2) for advice about growing yams and using plants as medicine, individuals tend to nominate others with whom they were frequently observed. While individuals reported that they would tend to go to other individuals who live in the same house for medicinal plants and fishing in the full sample, we did not observe this effect for the Teci-Dalomo sample when we included perceived skill as a predictor, contrary to the predictions from cultural evolutionary models. Further, genetic relatedness was either non-significant, or negatively related to who individuals go to for advice in the case of fishing. However, as we discuss in the main text, these findings may be the result of asking questions to participants who are in the second stage of the two stage learning process. One way to test this hypothesis would be to replicate this study with younger children (under the age of 10) that would be more likely to still be in stage one of the two stage learning process.

There is one potentially important control that we did not include in our analyses. In Fiji, social norms specify the type of contact that is allowed between certain types of classificatory kin, and some of these norms prevent direct communication between certain cross-sex relatives. For example, a man is prohibited from speaking directly with his sisters and classificatory sisters (parallel cousins), and to his brothers' wives [35]. It is highly plausible that emic kinship systems may bias who individuals choose as potential models in meaningful ways. Future studies should attempt to control for these factors when possible.

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