Modeling mate choice in a small-scale community: Applying couple simulation in Conambo, Ecuador

Abstract

The near totality of human mate choice research occurs in large-scale, urban, industrial populations. It is unclear to what extent lessons learned from such populations reflect generalizable features of human mating psychology as opposed to localized responses to the demands of these historically unusual environments. Here, we use couple simulation, an agent-based modeling technique, to compare models of mate choice across both a U.S. sample (n = 1,678) and a sample of k = 15 couples from Conambo, Ecuador—a relatively remote community of horticultural-foragers in the Ecuadorian Amazon. The Conambo sample provides a unique opportunity to evaluate models of mate choice in that (1) this sample represents approximately 50% of the households within this community and (2) all of the participants in this sample are acquainted with one another. Participants in Conambo completed a ranking task in which each participant ranked each opposite-sex adult in the community in terms of their quality as a spouse. We used these rankings to simulate the mating market in Conambo under alternative models of mate choice. We find that these models are able to reproduce Conambo marriages at a high degree of accuracy and perform comparably across both the Conambo sample and U.S. samples. Specifically, the resource allocation model performs best in reproducing mate choices in both the U.S. and Conambo samples. These results suggest that at least some aspects of human mating psychology generalize across both large-scale industrialized and small-scale populations.

Keywords: Mate choice, cross-cultural research, computational modeling

Modeling mate choice in a small-scale society: Applying couple simulation in Conambo, Ecuador

Human mating is one of the largest areas of research in evolutionary psychology (Barrett, 2020). This makes sense: mate choice is central to reproduction and therefore to the selection pressures that have shaped our species; understanding human psychology and human life requires understanding human mating. And human mating researchers have long appreciated that understanding mating requires a cross-cultural perspective (e.g., Buss, 1989; Symons, 1979). Yet even so, the testbeds for theories of human mating have still predominantly been Western, educated, industrialized, rich, and/or democratic ("WEIRD") societies (Henrich et al., 2010). This is reflective of broader trends within psychology at large (Barrett, 2020; Henrich et al., 2010), but may be especially problematic for research on human mating given that WEIRD societies provide mating contexts that are particularly unrepresentative of the historical and cultural diversity of human mating systems, strategies, and norms (Goetz et al., 2019). Testing our theories across more diverse populations is necessary to know whether insights drawn from WEIRD societies represent universal truths about human mating psychology or bounded views of a bigger picture. Here we contribute to the enterprise of studying people across more diverse ecologies to understand human nature by assessing the generalizability of computational models of mate choice developed in U.S. populations to a novel cultural context: Conambo, Ecuador.

Human mating research has long recognized the importance of cross-cultural studies. Symons's (1979) *The Evolution of Human Sexuality* provided the theoretical foundation for much human mating research that followed. Integral to this was an emphasis on distilling out the invariances in human mating psychology from the manifest cultural and temporal variability in human mating behavior. In this spirit, Symons (1979) relied heavily on ethnography and cross-cultural comparisons for sketching a framework to understand the psychology of human mating. Influenced by Symons, Buss (1989) set the paradigm for large-scale, cross-cultural research on human mating which many others later emulated (e.g., Gangestad et al., 2006; Schmitt, 2005; Walter et al., 2020; Zhang et al., 2019). These studies variously focus on proposed universals in human mating psychology (e.g., Buss, 1989; Schmitt, 2005; Walter et al., 2020; Zhang et al., 2019) and/or systematic variation in mating psychology as a function of the interaction between mating psychology and cultural or ecological variables (e.g., Eagly & Wood, 1999; Gangestad et al., 2006; Thomas et al., 2020; Walter et al., 2020; Zhang et al., 2019).

This line of research has been highly influential and has produced some of evolutionary psychology's cornerstone insights. Nonetheless, despite their large sample sizes and broad national scales, these samples are still limited in their cross-cultural breadth in that they still sample heavily or exclusively from relatively WEIRD populations. And even within these populations, these studies often still recruit from undergraduate populations or internet samples that are not representative of the broader local population. Extension of these lines of work into truly non-WEIRD populations is comparatively rare (c.f., Escasa et al., 2010; Pillsworth, 2008; Prall & Scelza, 2022; Scelza et al., 2020; Scelza & Prall, 2018).

These sampling limitations are particularly apparent in research on the psychology of mate choice. Despite being arguably the most consequential element of human mating, work on the psychology of choice *per se*—that is, the decision rules people use to pursue and choose among real potential mates—is relatively rare compared to work on mating strategies, mate preferences, or relationship emotions such as jealousy. Much mating research focused exclusively on abstract ideal preferences or simplified hypothetical choices until roughly the mid-2000s, when studies using speed dating paradigms galvanized research on the nature and process of choice (e.g., Eastwick & Finkel, 2008; Kurzban & Weeden, 2007; Todd et al., 2007; although see Todd & Miller, 1999). While work on ideals is important, work on choice is critical in that exposes important mating problems that are not as evident from abstract or hypothetical scenarios. For example, how should one decide how and for how long to search among their options? Out of a set of partners, how does one decide which to pursue first? How should an individual respond if their first choice chooses a competitor over them? Studies of choice *per se* render these problems explicit and allow exploration of the psychology by which we solve them. Yet, in part due to its technical complexity, work on choice has largely sampled either from undergraduates participating in laboratory studies (e.g., Eastwick & Finkel, 2008; Li et al., 2013) or from community samples in large, urban populations (Campbell et al., 2016; Gerlach et al., 2019; Todd et al., 2007). The cross-cultural breadth of research on preferences, mating strategy, and jealousy (e.g., Buss, 1989; Buunk et al., 1996; Scelza et al., 2020; Schmitt, 2005) has tended to dwarf the breadth of research on choice.

This sampling approach is especially problematic for work on mate choice because participants in typically-studied populations have highly unusual mating markets compared to the markets that would have existed for most of human evolutionary history. Among other things, mating markets in urban, industrialized cities are unfathomably large (on the order of millions), are composed nearly entirely of anonymous partners, and involve a search process that is often mediated through novel technologies (e.g., dating apps). This presents mate seekers with a potentially unusual search task, characterized by unprecedentedly large numbers of outside options, particularly incomplete or uncertain information about potential mates, and technological constraints that force artificial and arbitrary decision rules (e.g., swiping in dating apps forces users to adopt a go/no-go decision strategy that may not be representative of how people otherwise choose partners). It is unclear how the design of human mating psychology interacts with these historically unrepresentative mate choice contexts (Goetz et al., 2019). It is thus hard to know to what extent insights into mating psychology from these populations reflect broadly generalizable aspects of psychological design as opposed to indications of how human mating psychology grapples with the features of mating markets WEIRD societies happen provide.

In the present studies, we take one step toward answering this question by generalizing an approach for studying human mate choice, *couple simulation*, to a novel cultural context: the mating market in Conambo, Ecuador. Couple simulation is an agent-based modeling approach for comparing alternative computational models of human mate choice (Conroy-Beam, 2021). Couple simulation involves collecting data from real-world couples, using this data to parameterize populations of avatar agents who inherit the features of these couples, and running populations of these avatar agents through simulated mating markets governed by hypothesized models of human mate choice. The core intuition is simple: if one can simulate a mating market populated by realistic representations of real-world people, and if the decision rules that govern choice in this simulated market are an accurate reflection of real human decision making, these decision rules should tend to reproduce the mating decisions of the real people upon whom the simulations are based. This approach allows researchers to quantify the relative plausibility of different mate choice models according to the proportion of real-world couples these models are able to reproduce in simulated mating markets.

Prior work has shown that this approach can successfully identify a population's true model of mate choice in simulation studies, can reproduce real-world couples with a high degree of accuracy, and suggests that some models of mate choice are more plausible than others

(Conroy-Beam, 2021; Conroy-Beam et al., 2022). For example, Conroy-Beam (2021) compared four models of mate choice: the Kalick-Hamilton model, the Gale-Shapley algorithm, an aspiration threshold model, and the resource allocation model. These models differ on several axes of theoretical importance for understanding human mate choice (for extensive discussion of these models and their assumptions, see Conroy-Beam 2021). Briefly, the Kalick-Hamilton model is a social psychological model deriving from Kalick and Hamilton's classic model of assortative mating (Kalick & Hamilton, 1986). This is a probabilistic model in which individuals ("agents") pair into dates randomly and probabilistically make permanent offers of commitment proportional to two features: the mate value of their date partner and the length of time the agent has already spent searching for a mate. Agents are more likely to offer commitment to highly desirable partners but also become less selective as the length of their search increases. If two agents make mutual offers of commitment, they permanently pair and exit the mating market. This successfully generates the assortative mating for mate value commonly seen in real-world populations (e.g., Prall & Scelza, 2022), yet assumes a very simple, probabilistic decision rule governs human mate choice.

The Gale-Shapley algorithm hails from economics, where it was devised as a model for matching markets of all types—for instance, matching colleges with applicants (Gale & Shapley, 1962). It differs from the Kalick-Hamilton model in offering a deterministic model of choice. Here, male agents first pursue whichever female agent appeals to them most; female agents temporarily pair with whichever pursuer they most prefer and reject the rest. Unsuccessful males then pursue their most preferred female among those who have not rejected them. If a paired female is ever pursued by outside males, she compares her temporary partner to her pursuers as if he were another pursuer, accepts whichever male she most prefers, and rejects the rest—

dissolving her temporary bond if necessary. If repeated, this model is guaranteed to find all agents a partner and the pairings are guaranteed to be "stable"—no agent will prefer another partner that also prefers them in return. Unlike Kalick-Hamilton, the Gale-Shapley algorithm can accomplish pairing without assuming a probabilistic choice psychology—however, it does require assuming an asymmetric mating market in which one sex (or group) pursues and the other sex (or group) chooses.

The aspiration threshold model, an evolutionary psychological model, in some ways splits the difference between the Kalick-Hamilton and Gale-Shapley algorithms by offering a satisficing model of mate choice (Todd & Miller, 1999). This model assumes that agents have a minimum threshold of mate value that they find acceptable in a potential mate. This threshold is calibrated over time through experience in the mating market: agents encounter potential mates randomly and successful encounters motivate agents to increase their threshold whereas unsuccessful encounters motivate them to decrease it. Once this threshold is calibrated, agents offer commitment to any mate they encounter that exceeds their threshold and pair with any partner who offers them commitment in return. Unlike the Gale-Shapley algorithm, this model does not require an asymmetric market nor does it require each agent to be able to search their mating market exhaustively. Unlike the Kalick-Hamilton model, though, the aspiration threshold model assumes agents make their mate choices using a deterministic decision rule: commitment is offered to potential mates who exceed the learned satisficing threshold.

Despite their differences, each of these models shares one assumption about human mating relationships: they are binary in that a person is either in a mating relationship with someone or not. The fourth model, an evolutionary psychological model called the resource allocation model, relaxes this assumption. This model assumes agents have a finite pool of mate pursuit resources that can be allocated continuously across potential mates. Crucially, these resources are allocated according to a reciprocity algorithm, such that agents allocate more of their limited resources to potential mates who have previously allocated resources to the agent. This means that rather than mate choice being modeled as a discrete “yes/no” decision, agents gradually build relationships over time with mutually interested partners. This model is deterministic like the Gale-Shapley algorithm, but is symmetric like the Kalick-Hamilton and aspiration threshold models.

Each of these models makes differing assumptions about the processes underlying human mate choice. Some of these assumptions surely approximate real world mate choices better than do others—for at least some people, in some times, or in some contexts. Couple simulation allows researchers to identify, for a sample of people, which mate choice model is most plausible as a description of their mate choice. Conroy-Beam (2021) found that, for a sample of married couples from the U.S., the resource allocation model was most successful at reproducing observed couples and therefore was the most plausible model of mate choice for this population overall.

This work provides some insight into the design of human mate choice psychology. However, because it was conducted exclusively on samples of U.S. dyads, it is unclear whether the resource allocation model is merely locally successful or could generalize to mate choice in other populations as well. To examine this, here we extend this approach to model mate choice in the mating market of Conambo, Ecuador. Conambo is a village of roughly 32 households located in the Ecuadorian Amazon, near the border with Peru. The people of Conambo are self-sufficient horticultural-foragers; generally, they belong to one of two ethnolinguistic groups, the Achuar and the Quichua, which roughly correspond to the two local political coalitions. Marriages in

Conambo are initially matrilocal, with men mostly marrying in from other nearby villages. Marriages are mostly monogamous, although with some degree of polygyny, and are relatively stable over time. Importantly, Conambo is relatively geographically isolated, located on the Conambo River which is unnavigable upstream and cut off by the Peruvian border downstream and with no roads leading in or out of the river basin (Bowser, 2000, 2002; Patton, 1996, 2005).

Conambo in many ways provides a superior context to study the design of human mate choice psychologies than do samples from WEIRD populations. Because Conambo is small and relatively isolated, the residents of Conambo tend to be highly mutually acquainted. This means that people in Conambo have relatively high knowledge of both their space of potential mates and their space of competitors including those from the few smaller villages nearby. These are conditions that would have been characteristic of humans living in small groups across the majority of human evolutionary history and that are implicitly assumed by many models of mate choice. However, these conditions generally will not hold for participants from WEIRD populations, who inhabit large, anonymous mating pools that are impossible to search exhaustively. Recreating the high knowledge states that are possible in Conambo in WEIRD participants requires either constructing artificial mating markets (e.g., in the form of speed-dating, which allows for mutual acquaintance but generally not high degrees of knowledge), or assuming that large enough samples of unacquainted people are generally representative of individual participants' local mating markets (e.g., Conroy-Beam, 2021). Either of these approaches threatens the validity and generalizability of mate choice studies from WEIRD populations. The extent to which mate choice models developed and tested in WEIRD populations generalize to Conambo will provide an invaluable perspective largely missing from this broader literature.

2. Methods

2.1. Participants

2.1.1. Conambo Sample

In total, participants were $n = 79$ residents of Conambo, Ecuador. These participants were adult members of the approximately 32 households present in Conambo; at least one adult from each household was present in this sample. Participants ranged in age from 18 to 79, with an average age of $M = 37.67$ ($Mdn = 33.50$) years old. Of these, $n = 55$ participants were Achuar; $n = 23$ were Quichua. Ultimately, because of the data requirements of couple simulation—each person must rate and be rated by other participant in the sample—$n = 49$ participants needed to be excluded from analysis for incomplete data, yielding a final sample of $n = 30$ people. These represented the married adult pairs for 15 households. These participants were $M = 33.96$ years old on average ($Mdn = 32.50$, range = 20 – 64). Of these, $n = 24$ were Achuar and $n = 6$ were Quichua. Data were collected in 2018 by J.Q.P. and B.B.

2.1.2. U.S. Sample

Participants were $n = 1{,}678$ participants who were members of $k = 839$ committed, heterosexual, romantic relationships. Participants were recruited using Qualtrics's survey panel service targeting U.S. participants who were cohabiting with a committed romantic partner. Participants were $M = 52.1$ years old ($Mdn = 50$, range = 18 – 91) and were in their relationships for $Mdn = 20$ years. The majority of participants were married ($n = 1{,}544$), with $n = 56$ participants saying they were dating, $n = 56$ being engaged, and $n = 10$ participants listing a relationship status of "other" (two of which indicating they were "common law" partners, two simply stating "partner", and the remainder not specifying their relationship status further). $N =$

12 participants selected “single” as their relationship status but nonetheless completed the survey with a partner.

2.2. Materials and Procedure

2.2.1. Conambo Sample

Participants completed a photo-ranking task. In this task, each participant was first presented with two photographs of random opposite-sex village members. Participants were asked in Spanish, Achuar, or Quichua to identify which person was a “better spouse” (“mejor esposo/a”, “aliwarmianma/alikarichanma”, ”pengernua/pergeraishmanguashati”). Many adults in Conambo speak some Spanish; all adults speak Achuar or Quichua as a first language, many speak both Indigenous languages, and some additionally speak or remember Sápara, the ancestral Indigenous language of the river basin. Participants were asked to place both photos flat on a table with the photo of the better spouse placed above the photo of the worse spouse. Participants could place the two photos at the same level if the two individuals were equally good spouses. Participants continued to rank all opposite-sex village members in this way, adding one photo at a time to the table in random order. Participants were allowed to create as many or as few tiers as they felt appropriate.

2.2.2. U.S. Sample

Participants completed a 31-item mate preference questionnaire. This questionnaire asked participants to report their mate preferences in an ideal romantic partner across 16 dimensions. Fifteen of these dimensions were measured with two Likert-type questions that asked participants to report the standing of their ideal romantic partner on 11-point scales ranging from very low to very high on that trait dimension. Anchor points were chosen such that a rating of 0 represented a person in the bottom 1 out of 100 people on that dimension; a rating of 5 represented a person average on that trait (top 50 out of 100 people); and a rating of 10 represented a person in the top 1 out of 100 people. The two items for each dimension were averaged together to form a composite preference rating. The ideal age of a romantic partner was reported on a 11-point Likert scale that binned age groups ranging from “Under 20” to “Over 75” with each scale point representing 5-year age bins in between.

Participants additionally rated themselves and their actual long-term partner on the same Likert-type scales for each of the 15 dimensions. Self and partner ratings for each participant were averaged into self-other composites to serve as trait ratings of each participant. Cronbach’s alphas for these composites ranged from $\alpha = 0.798$ to $\alpha = 0.926$.

2.3. Data Processing and Analysis

Couple simulation requires simulating a mating market of avatar agents based on a sample of real-world participants. Creating these simulated mating markets requires estimating the mate value of each participant to each of their potential mates within the sample. These mate value estimates then provide the input to models of mate choice that govern who pursues and chooses whom.

2.3.1. Estimating Participant Mate Values

In the Conambo sample, mate value estimates were derived from the participants’ photo rankings. Each participant’s tier list was converted into a quantitative score by scoring each tier with sequential integer values between 0 and i, where 0 was the participant’s highest tier and i was the participant’s lowest tier. Each tier’s score was then subtracted from and then divided by i. This assigned a score to all photos such that photos in the highest tier received a score of 1, photos in the lowest tier received a score of 0, and photos in intermediate tiers received intermediate scores proportional to the overall number of tiers. These scores served as mate value estimates used for mate choice modeling.

In the U.S. sample, the mate value of each participant to each opposite-sex participant was estimated using a Euclidean distance function. Mate value was computed as the Euclidean distance between a given agent's preference vector and a potential mate's trait vector, rescaled such that a perfect match between preferences and traits received a score of 10 and the worst possible match received a score of 0.

2.3.2. Couple Simulation

Mate value estimates from both the Conambo and U.S. data were used to parameterize agents for use in couple simulation. We simulated mating markets based on random mate choice, the Kalick-Hamilton model, the aspiration threshold model, the Gale-Shapley algorithm, and the resource allocation model following the specification in Conroy-Beam (2021). Briefly, the random choice model paired agents randomly with respect to mate value. In the Kalick-Hamilton model, agents went on random "dates" with opposite-sex partners. On each date, agents probabilistically made permanent offers of commitment to their partners. The probability of an offer was proportional to both (1) the mate value of the agent's date partner and (2) the agent's number of prior dates. Agents were guaranteed to make offers of commitment to any partner after 50 dates. Dating agents permanently paired if they made mutual offers of commitment.

In the aspiration threshold model, agents also went on dates with random opposite-sex partners. For each date, agents made offers of commitment to any potential mate that exceeded a flexible mate value threshold. Agents increased their mate value threshold every time they made a reciprocated offer of commitment and decreased their threshold every time they did not receive a commitment offer from a partner whom they had declined. Agents would also temporarily pair with a date partner if they made mutual offers of commitment to one another, but both would continue to go on dates with other partners. Agents would switch partners if they had a mutual offer of commitment with a date partner who was higher in mate value than their current temporary partner. Agent pairings became permanent if they lasted for 50 dates.

In the Gale-Shapley algorithm, each male made an offer of commitment to the highest mate value female who had not yet rejected him; females temporarily accepted offers from whichever suitor had the highest mate value and rejected all others. This process iterated until all agents paired. Finally, in the resource allocation model, agents allocated a fixed set of abstract resources to potential mates directly in proportion to their mate values. After this initial allocation, agents iteratively re-allocated resources to each potential mate proportional to (1) the resources invested in each potential mate in the prior time step and (2) the resources received from each potential mate in the prior time step. Agents then paired with whichever partner in whom they were most invested provided that partner was also most invested in the agent in return.

Because couple simulation depends on reconstructing existing couples and requires each agent have a mate value estimate for each potential mate, we were only able to use data from dyads in which both partners had mate value estimates for and from every opposite-sex participant. For the U.S. data, this was possible for all participants. However, for the Conambo sample, missing data, either because village members did not complete the rating task, because certain photos were not rated, or because of data transcription errors, prevented incorporating all participants into the couple simulation models. The final sample of participants for whom we were able to conduct couple simulation in Conambo was $n = 30$ participants representing $k = 15$ married pairs. All data and analysis scripts are available on the Open Science Framework (https://osf.io/fxsb9/?view_only=2c90906af7f8459a80131b5be7f26177).

3. Results

Figure 1 shows the results of applying the couple simulation method to the U.S. sample. This exactly replicates the results of Conroy-Beam (2021), albeit with lower overall simulation accuracies owing to the relatively large sample size. Across all models, couple simulation accurately reproduced 14.86% of the real-world couples. The resource allocation model performed best in reproducing the sampled couples, accurately reproducing 29.89% of couples, 95% CI [26.77%, 32.89%]. The second-best performing model was the Gale-Shapley algorithm, which successfully reproduced 27.01% of couples, 95% CI [24.01%, 30.01%]. A paired permutation test revealed that the resource allocation model significantly outcompeted the Gale-Shapley algorithm, $p = .038$. These two best performing models were followed by the aspiration threshold (13.01%, 95% CI [12.27, 13.77]), Kalick-Hamilton (3.465%, 95% CI [3.19, 3.74]), and random choice models (0.92%, 95% CI [0.63, 1.17]).

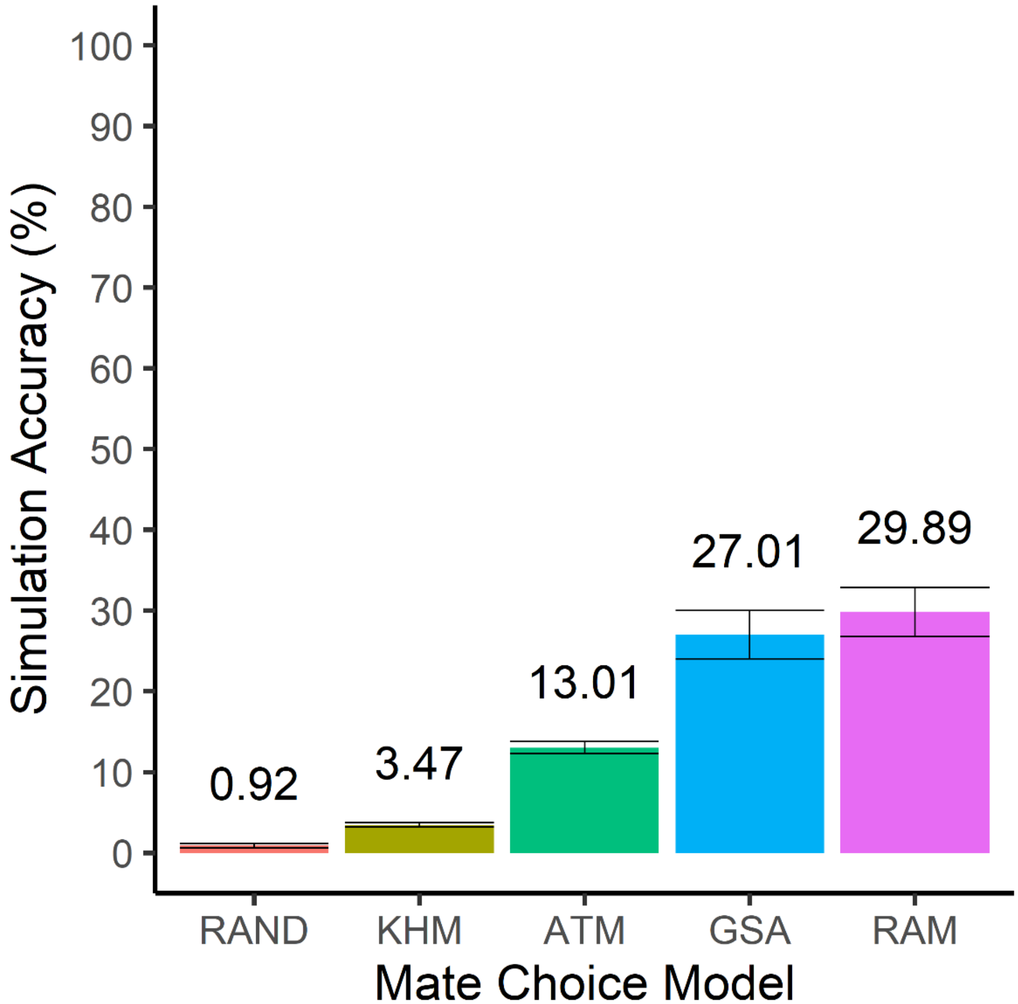

Figure 1. Couple simulation results for the U.S. sample. The resource allocation model performs best of all and significantly outperforms the Gale-Shapley algorithm. Error bars represent bootstrapped 95% confidence intervals. RAND = Random choice model; KHM = Kalick-Hamilton model; ATM = aspiration threshold model; GSA = Gale-Shapley algorithm; RAM = resource allocation model.

Figure 2 shows the same results for the Conambo sample. This sample nearly exactly replicates the pattern of the U.S. data. Couple simulation still reproduces a high proportion of couples across models, accurately reproducing $M = 33.76\%$ of couples across models. Just as in the U.S. sample, the resource allocation model was most accurate in reproducing sampled couples, reproducing 53.33% of couples, 95% CI [26.67%, 80.00%]. However, the Gale-Shapley algorithm underperformed in the Conambo sample relative to the U.S. sample. The aspiration threshold model was the second-best performing model, reproducing 39.29% of couples, 95% CI [28.17%, 49.11%], compared to 33.33%, 95% CI [13.33%, 60.00%] for the Gale-Shapley algorithm. The rank-ordering of the models was otherwise similar to the U.S. sample. However, because of the small sample size, the 95% confidence intervals were generally wide. To compute paired permutation tests, we first calculated the best-likely accuracy for each couple according to the aspiration threshold model (see Conroy-Beam, 2021). We then used these values along with the observed simulation accuracy for each couple from the resource allocation model to conduct a paired permutation test. According to this test, the resource allocation model did not significantly outcompete the aspiration threshold model, $p = .092$.

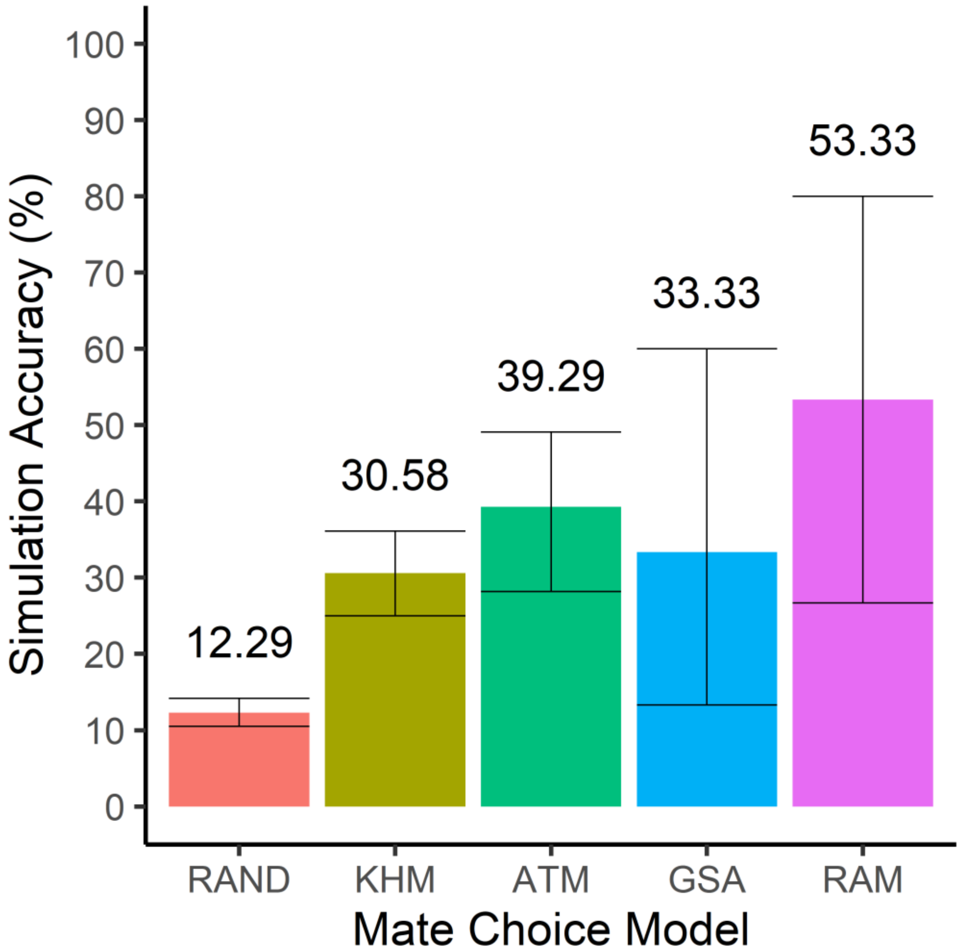

Figure 2. Couple simulation results for the Conambo sample. The resource allocation model still performs best of all; however, the aspiration threshold model outcompetes the Gale-Shapley algorithm and is not significantly different from the resource allocation model. Error bars represent bootstrapped 95% confidence intervals. RAND = Random choice model; KHM = Kalick-Hamilton model; ATM = aspiration threshold model; GSA = Gale-Shapley algorithm; RAM = resource allocation model.

One limitation of these analyses, however, is that they do not take into account the coalitional structure of Conambo. Conambo is divided into Achuar and Quichua coalitions and marriages across coalitional boundaries, although growing in frequency, were historically rare. Yet the models applied in the above analyses do not take coalitional information into account. For this reason, we re-ran each of the mate choice models on the Conambo sample with the added constraint that cross-coalition matches were not permitted. This was accomplished by setting for each agent the mate value of all outgroup agents to 0. The simulation accuracies of this constrained model are presented in Figure 3. This constraint improved simulation accuracy across the board, with an overall accuracy of M = 36.84% across models. In particular, the accuracy of the resource allocation model increased to 60%, 95% CI [33.33%, 86.67%], whereas the accuracy of the aspiration threshold model increased to 41.98% [29.35, 53.55%]. However, these were still not significantly different from one another in a paired permutation test, p = .088.

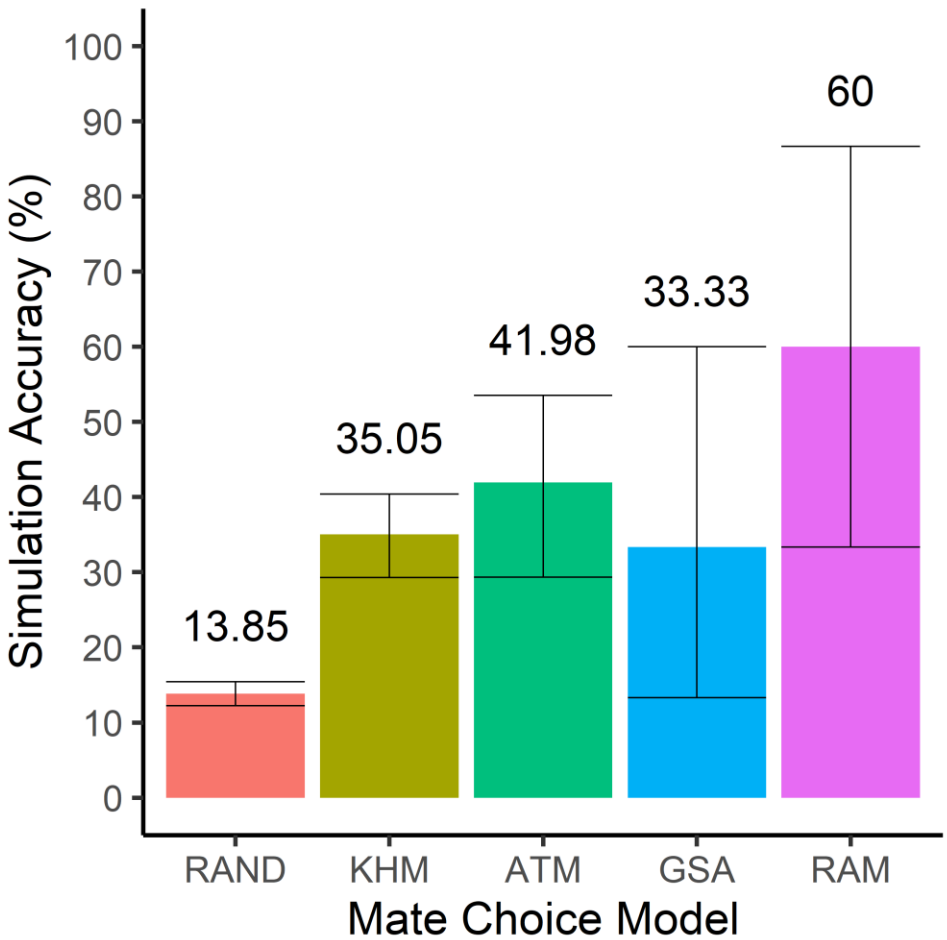

Figure 3. Couple simulation results for the Conambo sample including a constraint preventing cross-coalition marriages. This constraint increases accuracy across the board but does not change the relative performance of models. Error bars represent bootstrapped 95% confidence intervals. RAND = Random choice model; KHM = Kalick-Hamilton model; ATM = aspiration threshold model; GSA = Gale-Shapley algorithm; RAM = resource allocation model.

4. Discussion

Human mate choice is among the most studied topics in all of evolutionary psychology. Mate choice attains this position for good reason: the choice of a romantic partner is among the most important decisions a person makes in their lifetime owing to both its proximity to reproduction and its far-reaching impacts on life and wellbeing (Antonovics & Town, 2004; Holt-Lunstad et al., 2010; Robles et al., 2014). However, despite this great importance and widespread attention, the near totality of research on the process of mate choice has occurred exclusively in WEIRD cultures. This is particularly problematic given that the mating markets posed by WEIRD cultures may be particularly unusual relative to the breadth of markets experienced across cultures and across time (Goetz et al., 2019).

Here we attempted to rectify this by applying computational models of mate choice developed in U.S. samples to model the mating market of Conambo, Ecuador, a small-scale bounded community in the Ecuadorian Amazon. Conambo provides an ideal context for testing models of the decision processes involved in human mate choice given that its relatively small size and relative isolation mean that it is easy to more completely sample the full mating market than is possible in most WEIRD populations. We took advantage of this to apply couple simulation, a technique that simulates real participants as avatar agents inside simulated mating markets and attempts to reconstruct their real-world mate choices using hypothesized decision algorithms.

Overall, results were broadly similar across a large U.S. sample and data from Conambo. The couple simulation method was able to reproduce a large proportion of real-world couples using simulated mating markets in both the U.S. in Conambo—achieving simulation accuracies up to 29.89% in the U.S. and 60% in Conambo, both far above accuracies expected by chance alone. These raw performance values are quite different, however comparing directly across cultures is challenging both because the nature of the mate value estimates differed between the two samples (rankings of specific people in Conambo vs. ratings of abstract ideals in the U.S. sample) and because couple simulation in general tends to perform better in smaller samples

(Conroy-Beam, 2021). Nonetheless, it is noteworthy that the resource allocation model performed best at reproducing sampled couples in both populations, at least descriptively outcompeting the Gale-Shapley algorithm, aspiration threshold model, Kalick-Hamilton model, and random pairings. The rank ordering of the model performance was also generally similar across both populations, albeit with the aspiration threshold model slightly over-performing in Conambo relative to the U.S. sample.

The overall similarity in results across the two populations is quite striking given the differences in the mate choice contexts between these two populations. For example, Conambo provides a small mating market that can be searched relatively exhaustively, meaning all mate seekers are mutually acquainted with one another; in contrast, participants from the U.S. inhabit vast mating markets which they can search only the smallest corners of. These participants are not mutually acquainted and come from distinct mating markets. Nonetheless, the same decision-making algorithms perform similarly well at reproducing the real-world mating decisions of participants from both the U.S. and Conambo. This does echo other important similarities found across mate choice in both WEIRD and small-scale populations (e.g., Prall & Scelza, 2022).

The similarly strong performance of mate choice models in Conambo is also noteworthy given the power of choice afforded by mating markets like Conambo's. It has been rightly noted that, in many traditional and small-scale ecologies, freedom of partner choice *can* be highly constrained by, for instance, limited options in the local ecology (Goetz et al., 2019). In light of this, one might be tempted to conclude that mate preferences and mate choice themselves are WEIRD phenomena, as most people throughout human evolutionary history would have had relatively limited opportunities to express preferences or mate choice algorithms. Nonetheless, the mate choice algorithms tested here did reproduce couples at fairly high levels in Conambo, suggesting that people in Conambo do experience sufficient power of choice despite their relatively small mating market—and that trait-specific preferences both exist and are employed in mate value computations. This underscores that the challenges of finding a suitable mate are not limited to large, anonymous, urban populations, but rather are a cross-culturally recurrent feature of human social life.

Nonetheless, the over-performance of the aspiration threshold model in Conambo relative to the U.S. is a key difference worth highlighting. The aspiration threshold model is one of the few models of mate choice developed specifically with an evolutionary analysis of the constraints and task demands of human mate choice in mind (Miller & Todd, 1998; Todd & Miller, 1999). Chief among these was a recognition that human mate search resources are finite and that decision algorithms that limit search time would likely be favorable over more information-greedy algorithms that search exhaustively but return at best only marginally better outcomes. This contrasts with, for example, the Gale-Shapley algorithm which was developed based on abstract analysis of two-sided pairing problems and without consideration to the potentially limited search budgets of individual mate seekers. In light of this difference in their theoretical considerations, it seems noteworthy that the theoretically-derived aspiration threshold model performs relatively well when applied to a more ecologically valid mate choice context whereas the analytically-derived Gale-Shapley algorithm excels in a large, anonymous, and historically atypical mating market. This result might serve as a caution against developing models of mate choice based exclusively on their theoretical fit to or empirical performance in WEIRD contexts, as these results may not always generalize to other cultural contexts. A researcher familiar only with results from U.S. samples might seek to draw lessons from the Gale-Shapley algorithm in order to improve model performance—perhaps seeking to build more asymmetrical models of mate choice—whereas the results from Conambo would suggest that the aspiration threshold and resource allocation models are more likely to have useful, generalizable insights. This additionally underscores the advantage of testing psychological models across range of cultures, critically including small-scale communities like Conambo.

Despite these valuable contributions, this work does have some noteworthy limitations. Chief among them, it must be stressed that despite offering uniquely distinct insights relative to U.S. samples, Conambo is just one population. Care must be taken to avoid using Conambo as representative of all small-scale populations, all non-U.S. populations, or worse, all ancestral human mating markets. Human cultures and human mating markets vary across a vast array of dimensions. Any given culture represents just one point in the large space of possible and real human cultures and no one of these data points provides a complete window into the human condition (Barrett, 2020). To fully appreciate both the diversity and invariances of human mate choice, future research must continue to expand the range of cultures to which models of mate choice are applied and analyze both the universals and differences in performance across cultures, rather than attempting to use any one culture as an exemplar for others.

Interpreting the results from Conambo also warrants some caution given the necessarily small sample size compared to samples possible from the U.S. Some of this small sample size comes down to population limitations: there are simply fewer marriages to sample from in Conambo compared to the U.S. Others come down to sampling issues—for instance, not all participants were available to complete the photo rating task required for the modeling approach used here. The results from Conambo therefore necessarily have greater sampling error and less statistical power compared to samples from the U.S. For this reason, although descriptively the data from Conambo replicated the U.S. in that the resource allocation model performed best of all, the resource allocation model still did not perform statistically significantly better than the aspiration threshold.

That said, the relevance of sampling error is not quite as obvious in Conambo as it is in the U.S. Our U.S. sample is taken explicitly as a convenient representative of a much larger, theoretical, and impossible-to-observe population of all American mate choices. Here, *p*-values do help answer the clearly relevant question of whether results from this one sample are likely to generalize to the large set of possible alternative samples from this population. However, our sample from Conambo more closely approximates the population in-and-of-itself, because the sample represents a larger percentage of the population, and the population itself is comparably homogeneous. So, he descriptive results are much more of interest from Conambo than they are from the U.S. Nonetheless, to the extent that our Conambo sample is to be taken as representative of a broader hypothetical population (e.g., all possible marriages in Conambo, past and present), the inferential limitations of the small sample size should be kept firmly in mind.

Furthermore, the nature of the mate value estimates from Conambo demands some careful attention. Participants in Conambo were asked to rank opposite-sex people in terms of who was the “better spouse.” This poses two potential issues. First, whereas in the U.S. each participant reported their own personal preferences, in Conambo the ranking left unspecified to whom the target was supposed to be a better spouse—the ranker in particular or in the eyes of people in general? It is possible that participants were reporting their general perceptions of what people desire rather than their own personal preferences. Second, participants provided rank data which we transformed to a continuous scale. However, there is no guarantee that participants viewed potential mates assigned to the same tier as equivalent in mate value to one another, meaning our mate value measure may lack sensitivity. Nonetheless, the fact that the mate choice models nonetheless were successful in reproducing marriages with a high degree of accuracy in Conambo suggests that they were tracking individual mate value assessments to at least some meaningful degree.

Relatedly, in the Conambo sample, it is ambiguous precisely what information participants were using to form their mate value rankings. Whereas in the U.S. sample, participants explicitly reported on a range of specific preferences that were mathematically aggregated into an overall mate value variable, here we analyzed direct assessments of spousal quality from participants in Conambo. In some ways, this is actually an advantage for modeling mate choice: rather than assuming what information matters to mate value assessments and how that information is integrated, the ranking measure directly taps into whatever mate value estimates participants have formed. Nonetheless, how these evaluations are formed is a valuable question in and of itself. Prior work using a similar task has found that judgments of men's attractiveness in this population track age, status, warriorship, and hunting ability (Escasa et al., 2010). However, this study did not explore ratings of women targets or ratings of overall spousal quality. In our sample, a multilevel model confirms that ratings of spousal quality in Conambo did track age gaps between the rater and target (b = .02, $t(30.77)$ = 2.419, p =.022). This suggests that participant rankings from Conambo were tracking variables known from prior research to be important in mate choice across populations (e.g., Kenrick & Keefe, 1992). Nonetheless, further exploration of what information participants in Conambo track with respect to mate value and how these are integrated into overall mate value estimates is an important topic for future research.

Separately, the couple simulation method as applied here has a noteworthy limitation in that it is purely retrospective. That is, we attempted to reproduce existing couples based on preferences and perceptions reported by people who had already made their mating decisions. Given this, it is likely that their preference and mate value perception ratings were to some degree influenced by their mate choices themselves—for example, there is some evidence that people adjust their preferences to more closely match the partners they already have (Gerlach et al., 2019). While prior research has demonstrated that such *post hoc* updating of preferences cannot on its own explain findings like those presented here (Conroy-Beam, 2021), this reverse causality nevertheless inevitably clouds retrospective data sources. The only way to truly resolve this limitation would be for future research to adopt prospective research designs, in which preferences and/or mate perceptions are collected from single people and these are used to predict future mate choices rather than reconstruct choices made in the past.

Overall, our results illustrate that computational models of mate choice developed in WEIRD populations generalize to at least at least one-small scale community: Conambo, Ecuador. Specifically, the resource allocation model performs well in reproducing observed romantic relationships in both a U.S. and Conambo sample, suggesting this model—with its deterministic, symmetric, and continuous choice algorithm—is a good description of human mate choice psychology across these two distinct cultures. This is an important result because, despite its large footprint in evolutionary psychological research, mate choice research samples nearly exclusively from WEIRD populations whose mating markets are not representative of the breadth and diversity of human mating contexts (Goetz et al., 2019). Furthermore, although the resource allocation model performed well at reproducing mate choices both in the U.S. and Conambo, the aspiration threshold model also appeared to perform better in Conambo than it typically does in the U.S. These results highlight some generalizable aspects of human mate choice models but also point to the value in conducting truly broad cross-cultural research in identifying variability in the nature of mate choice. Furthermore, these results underscore the value of data from small-scale communities for testing evolutionary psychological hypotheses as these communities provide unique opportunities to powerfully test hypotheses about variation and universals that are central to evolutionary psychological theory. As such, this research represents an important step in the direction of expanding the cross-cultural breadth of human mate choice research and building a more general and inclusive model of human mating psychology.

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