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Animal behaviour

Driving a hard bargain: sex ratio and male marriage success in a historical US population

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Evolutionary psychologists have documented a widespread female preference for men of high status and resources, and evidence from several populations suggests that this preference has real effects on marriage success. Here, we show that in the US population of 1910, socioeconomic status (SES) had a positive effect on men's chances of marrying. We also test a further prediction from the biological markets theory, namely that where the local sex ratio produces an oversupply of men, women will be able to drive a harder bargain. As the sex ratio of the states increases, the effect of SES on marriage success becomes stronger, indicating increased competition between men and an increased ability to choose on the part of women.

Keywords: evolutionary psychology; marriage; sex ratio; biological markets; socioeconomic status

1. INTRODUCTION

Evolutionary psychologists have documented a widespread preference among women for men of high status and resources as marriage partners (Buss & Barnes 1986; Buss 1989; Buunk *et al.* 2002). Since the preferences expressed in these studies are generally hypothetical, based on fictional vignettes, one might question whether this expressed preference translates into real behaviour. However, studies using data on real marital outcomes tend to confirm that the female preference is operative and influential on behaviour. Men of high status and/or with high resources have relatively increased mating and marital success in contemporary traditional societies (e.g. Kipsigis: Borgerhoff Mulder 1990), historical European populations (e.g. nineteenth-century Sweden: Low 1990) and contemporary developed world populations (e.g. Pérusse 1993; Hopcroft 2006).

In this study, we examine the effect of socioeconomic status (SES) on marriage success in the US population of 1910, using census data. In addition, we test an additional prediction from the theory of biological markets (Noë & Hammerstein 1994). Marriage can be seen as partly involving a trade of female fertility and nurturance for male genes, resources and paternal investment, and, as in any trade, prices are affected by supply and demand. When men are locally abundant, women will be able to demand a higher 'price' in terms of SES for entering a marriage than they can when men are locally scarce. Effects of this type were predicted by Pedersen (1991) who argued that when the sex ratio was male biased, men would have to offer greater commitment to careers promising economic rewards, greater fidelity and greater investment in children than they would when the sex ratio was neutral or female biased. However, Pedersen's predictions have not been tested quantitatively.

The US population of 1910 is an ideal arena in which to test such predictions. Several decades of male-biased migration left the relatively newly settled western states with highly male-biased sex ratios, while the longer settled eastern seaboard had an equal balance of men and women (Hobbs & Stoops 2002). We thus make two basic predictions: (i) men of high SES will be more successful in attracting a marriage partner than men of low SES and (ii) this effect will be moderated by the sex ratio of the state where the individual resides. As the state sex ratio becomes more male biased, men should have higher relative SES in order to marry.

2. MATERIAL AND METHODS

The Integrated Public Use Microdata Series (IPUMS) sample of 1910 contains data on demographics and household composition for the US population. It is a 1 in 250 random sample of the total population, and is widely used by economists, historians and sociologists (see Ruggles *et al.* (1997) for more details). We calculated the operational sex ratio (OSR) for each state. Following Lummaa *et al.* (1998), we define this as the ratio of males to females between 15 and 50 years old (mean age$=$30.21 years, s.d.$=$10.15). Though some of these individuals will be married, the number of married men and women in each state must be equal owing to legal monogamy, and thus our OSR measure reflects the relative availability of unmarried men and women (OSR$>$1 indicates an oversupply of men). The overall OSR is slightly male biased (mean of states$=$1.02, s.d.$=$0.03; mean of all individuals$=$1.01, s.d.$=$0.02). OSR by the state ranges from slightly female biased (Maine, 0.98; Connecticut, 0.99) to strongly male biased (Montana, 1.11; Arizona, 1.10; Nevada, 1.09).

The number of men in the analysis was 21 973. SES was measured according to the Duncan SEI score of 1950. This is a measure based on occupational prestige (higher scores equal higher status; see Haug 1977; Ruggles *et al.* 1997). Jobless men were assigned a score of 0 (10% of the sample), which is a reasonable inference about their relative SES in this pre-social security population. SES scores thus range from 0 to 96 (mean$=$22.38, s.d.$=$21.34). The main conclusions presented below were not altered if jobless men were excluded rather than assigned a value of 0. Our dependent variable is the number of times a man married (mean$=$0.52, s.d.$=$0.57). As men rarely married more than once (3.5% of men married twice or more), this variable basically measures the probability of marriage.

We examined the independent effects of the sex ratio, SES and age on the number of times married, using general linear mixed modelling (GLMM). The GLMM typically assumes a continuous dependent variable, but in the present case the dependent variable can also be taken as a count variable. Therefore, we also analysed the data using negative binomial regression (NBR; Gardner *et al.* 1995), which gave similar effects as those presented below (results not shown). However, the GLMM is more flexible than NBR in modelling multilevel predictors, random effects and covariance structures, so the GLMM results are presented here. Parameters in the models are estimated by restricted maximum log likelihood. For both the models, there was an absolute parameter, log likelihood and Hessian convergence (Verbeke & Molenberghs 2000; SPSS 2005).

First, we constructed a model with a random intercept and then compared these with the models with random slopes (for age and SES) and a random intercept based on the state level. The covariance structure of parameters was estimated in several ways (simple, compound symmetric, autoregressive, Toeplitz and unstructured), and based on information criteria (AIC, BIC) we selected the best fit for the final models (Kuha 2004; see Litell

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Table 1. Standardized parameter estimates from the general linear mixed models.

interaction model	β	s.e.	d.f.	t	p
intercept	−0.07	0.02	17.07	−3.55	0.002
sex ratio	−0.09	0.01	21.88	−6.16	<0.0001
age	0.61	0.01	233.94	60.33	<0.0001
SES	0.05	0.008	21.03	5.9	<0.0001
sex ratio ×age	−0.04	0.008	108.4	−4.84	<0.0001
age×SES	−0.01	0.005	405.71	−2.73	0.007
sex ratio ×SES	0.03	0.007	47.01	4.01	<0.0001

et al. 2000). For the final models, we present parameter estimates, with *F*-tests and correspondent *t*-tests for each parameter. The *F*-tests are used to examine whether a variable significantly contributes to the model, whereas the *t*-tests allow the examination of individual parameter estimates.

We present just one model incorporating both the baseline and interaction effects. Two predictions are tested: the first prediction is that a man's SES will influence his probability of marriage, while controlling for age and sex ratio of the state and the second prediction is that there will be a two-way interaction effect for SES×sex ratio on marriage success. As the sex ratio increases, the strength of the effect of SES on the number of times married will be strengthened. We also control for the other interaction effects on the number of times married, namely age×SES and age×sex ratios.

3. RESULTS

The model with the best fit is the one with random slopes for age and SES and a random intercept at the state level (based on BIC and AIC). It has an unstructured covariance structure (AIC: 52194, BIC: 52250). The model with the second best fit has random slopes for age and SES at the state level but no random intercept (AIC: 52540, BIC: 52572) and showed nearly identical estimates.

The *F*-tests show that all main effects and three two-way interaction effects contribute to the model (all *F*-tests $p<0.0001$, except for the *F*-test for the intercept ($F_{1,17.07}=12.63$; $p=0.002$) and the *F*-test and for the age×SES interaction ($F_{1,405.71}=44.45$; $p=0.007$)). The standardized parameter estimates for all the effects are presented in table 1. Our first prediction is confirmed. High SES men are more likely to be married than low SES men (figure 1). Figure 1 plots the model predictions rather than the raw data, as the model allows correcting for age (and random effects).

Our second prediction is also confirmed. The significant interaction between the sex ratio and the SES means that as the state becomes more male biased, the effect of individual SES on the number of times married becomes stronger. To visualize this interaction, figure 2 shows the SES of a predicted married man relative to the SES of a predicted unmarried man for each state against the sex ratio of that state. Predicted married status rather than actual status is used, as this controls for age and random effects at the state level. Figure 2 shows that where the sex ratios are balanced, the model predicts married men to have just slightly higher SES than unmarried men. As the sex ratio increases, married men are predicted to need two or three times the SES

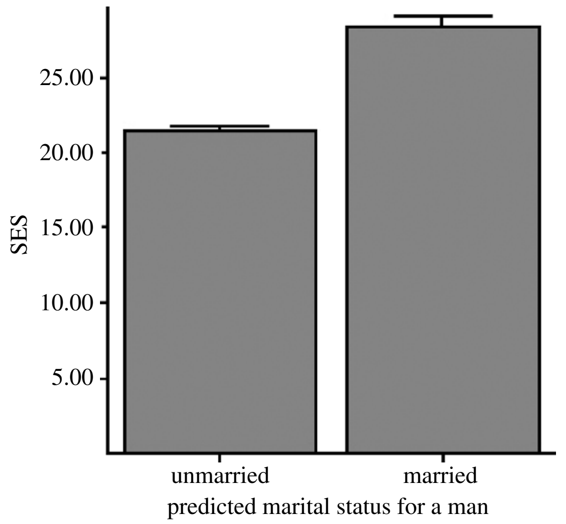

Figure 1. SES for a (predicted) married man. Bars represent 95% CI for the mean.

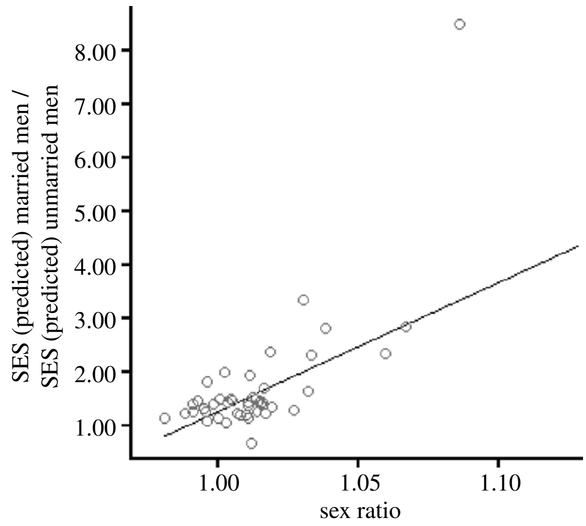

Figure 2. Ratio of SES for (predicted) married men to SES for (predicted) unmarried men plotted against sex ratio at state level. (States where OSR>1.08 are not represented as the model predicts no one would marry there. These are states with a relatively small population.)

of unmarried men from the same state. The outlier point in figure 2 represents Hawaii, which is strongly male biased with a small population and also shows large variance in the SES. Exclusion of Hawaii does not alter the significance of the SES×sex ratio interaction.

In order to illustrate the order of magnitude of the interaction effect, we calculated the model predictions for a 30-year-old man of low SES (1 s.d. below the mean) and high SES (1 s.d. above the mean) in a balanced (OSR=1) versus male-biased state (OSR=1.1). In a balanced state, the model predicts that 56% of low SES men would be married once, whereas 60% of high SES men would. In a male-biased state, however, only 24% of low SES men would be married once, but 46% of high SES men would. Thus, with a sex ratio shift from 1 to 1.1, low SES men become 2.31 times less likely to marry, whereas high SES men are 1.31 times less likely.

4. DISCUSSION

Men of low SES were less likely to marry than men with high SES. In addition, our prediction from the theory of biological markets was met. As the sex ratio became more male biased, the effect of SES on the probability of marriage became stronger, such that the relative SES required to marry became greater. This means that the effects of a male-biased sex ratio fell disproportionately on low SES men, whose probability of marriage was drastically reduced.

In line with the diverse studies of both hypothetical preferences (e.g. Buss & Barnes 1986; Buss 1989) and actual marital outcomes (e.g. Borgerhoff Mulder 1990; Hopcroft 2006), this study thus confirms that women prefer men of high SES, and that this preference is influential, as the shifts induced by sex ratio variation demonstrate. Our study confirms Pedersen's (1991) suggestion that changes in OSR will have important consequences for the marriage market. Pedersen's predictions are much broader than the effect described here. He suggests that people will change many aspects of their behaviour as a knock-on effect of the competition induced by sex ratio fluctuations. For men, these include greater fidelity, commitment to careers and increased investment in children. Thus, much about the varying ethos of male and female behaviour across populations and across time could in principle be explained with reference to the sex ratio. These questions are ripe for future investigation, but our study has clearly established the more limited fact that sex ratio fluctuations in modern humans can put one sex in the driving seat and allow them to drive a hard bargain.

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