Testing sequential patterns in human mate choice using speed-dating

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Abstract

Choosing appropriate mates from the sequential stream of possible partners we encounter over time is a crucial and challenging adaptive problem. But getting data on mate search is also challenging. Speed-dating provides an accelerated microcosm of such data which we can use to test models of sequential mate search. Here we use such data to assess search heuristics including fixed threshold models and mechanisms that adjust aspiration levels for mates in response to previous experiences of success or failure on the mating market. We find that initial thresholds related to own attractiveness combined with experience-based threshold adjustment can account for most of the offers made during speed-dating.

Keywords: mate choice; sequential mate search; aspiration level; satisficing; speed-dating

Introduction—The Problem of Mate Search

Humans and other animals search for the resources they need, from food to information to habitats to mates. Rational search strategies have been investigated for a wide variety of these search problems. Example strategies include cost-benefit analysis for making a complex choice, or comparing items directly to maximize success. However, when searching for a mate or romantic partner, there are too many factors and unknowns to compose a finite list of benefits and disadvantages of each candidate, and the equivalent to comparison-shopping takes extensive time and is dependent on the ability to return to previously-seen options, which may often be impossible (Todd & Miller, 1999). Picking a mate from the sequentially-encountered stream of possibilities is an important decision that evolution has likely built adaptive strategies to address. What strategies might humans in particular use, and how can we find evidence for them? In this paper, we use data from a sped-up form of real mate search, speed-dating, to test a variety of models of mutual sequential mate search. We begin by describing the problem of mate search in more detail, before turning to some of the proposed models that have been tested previously via simulation, and then showing how data from speed-dating can provide empirical tests as well.

Various strategies have been proposed for specific types of search problems similar to the setting of mate selection. For instance, in the secretary problem (Ferguson 1989), a firm must find the best applicant for a secretarial job, seeing each applicant one at a time and not being able to return to a rejected applicant (who has probably since been hired elsewhere) or predict the quality of future applicants. This is similar to mate choice in its time-dependent nature, with previously-passed options not being available for later choice. Furthermore, as in mate search, the distribution of the quality of the applicants is not known *a priori*. In the case of the secretary problem, the optimal strategy is to look at N/*e* of the available applicants, where N is the number of alternatives and $e \approx 2.718$ is the base of the natural logarithm system. This translates to seeing the first 37% of the applicants (without selecting any of them) to form a general idea of the search space, remembering the quality (say, typing speed) of the best applicant seen thus far, and taking his/her quality rating as the threshold for further search and acceptance. After 37% of applicants have been reviewed, selecting the next better applicant who is above the just-set threshold will result in the highest likelihood of picking the single best applicant. This strategy is optimal but takes a great deal of time and energy—requiring search through three quarters of the applicants on average—and only returns the best solution about 1/3 of the time. Moreover, this strategy requires knowing N, the number of possible candidates that could be encountered, which is also not something that actual mate seekers are likely to know.

Instead of aiming for the optimal solution, individuals can use heuristics, which are decision rules that use a small amount of time, information, and computational processing, and still yield relatively good choices (Gigerenzer, Todd, & the ABC Research Group, 1999). Heuristics enable individuals to behave adaptively—if not necessarily optimally—in complex situations, such as deciding on a

house or picking a potential partner, without high costs of time and computation. In mate choice, heuristics are particularly appropriate because the outcome criteria for a good mate are usually somewhat lenient and not readily optimized: Individuals are not looking for the perfect partner, but rather a partner with whom they can be in a successful relationship. Todd and Miller (1999) showed that instead of looking at 37% of the available candidates, assessing around 10% —or even a small fixed number like a dozen—before setting an aspiration level for further search would suffice to make a good choice. While this significantly decreases the length of the time needed to set a suitable threshold, the 10% solution makes an important simplifying assumption, namely that the potential partner will accept if an offer is made. In much of human mate search, however, either side can typically refuse, ending the potential for a relationship. That is, at the same time individuals are searching, they are being searched for in return—mate search is mutual.

Simulation Models of Mutual Mate Search

When individuals making simple decisions are put together into an environment where others are making similar decisions, this can create a complex and dynamic system that is challenging to predict and understand (Todd, 2007). Computer simulations of mutual sequential mate choice give us a handle on such complexity, allowing us to test how different decision strategies would work if individuals in a population followed particular rules when searching for a partner. A number of such simulation models of marriage and dating have been proposed, with one of the earliest and best known being Kalick and Hamilton's (1986) Matching Hypothesis model. This model was used to explore mechanisms behind the observed fact of high (e.g., r=.5-.6) correlations of the attractiveness of women and men paired in romantic couples. Kalick and Hamilton proposed a model in which agents are more likely to make offers to more attractive mates, and then, because both sexes are pursuing each other in the same way, the most attractive individuals accept each other first. The end result is high intracouple attractiveness correlations—simply due to the mutual two-sided nature of searching for a partner.

Another agent-based model takes a different approach to mate search, where the driving factor is social pressure. The "Wedding Ring" model proposed by Billari, Prskawetz, Aparicio Diaz, & Fent (2007) has agents marrying when social pressure causes a sufficient relaxation of expectations, resulting in a higher probability of marriage. Social pressure is driven by a weighted function that considers the number of married people already in an individual agent's social network, as well as the age of the agent. With increasing social pressure, the acceptable range of potential partners is expanded, increasing the chances of an agent finding a suitable partner. This model shows how the cultural and social elements of mate choice can exert an important influence on the desire and decision to marry.

A model capable of capturing the observed demographic distribution of ages at which people first get married, as well as divorce rates with age, is the Marriage and Divorce model, or MADAM (Hills & Todd, 2008). Individual agents search for mates with similar characteristics to themselves. As time progresses, individuals who have not yet found a mate relax their aspirations for similarity. Once an agent is married, their expectations are fixed. If they subsequently encounter another individual who is above this fixed threshold and who also accepts them, they will divorce their current partner to remarry. This model provides a framework to account for differences in marriage and divorce rates between different time periods.

Here we focus on further exploring the models proposed by Todd and Miller (1999; Todd, 2007) for mutual sequential search in mate choice. Individual agents in a simulated population go through an "adolescence" phase in which they form their aspiration level by interacting with potential partners, and then they proceed to real mate search in which they use their aspiration level to decide whom to make an "offer" to. Whenever two individuals both simultaneously make offers to each other, they are deemed "mated" and removed from the searching population. (Fawcett & Bleay, 2009, have also shown the adaptiveness of changing aspiration levels with experience, using a different modeling approach.)

In the simplest search model, called *Take the Next Best*, individuals merely remember the highest-quality mate they have seen during the adolescence period and use that quality as their aspiration level. Then, in the true mate search phase, they choose the first individual who has a higher mate value than their aspiration level. This strategy, however, neglects mutual search, and consequently makes unrealistic predictions: If all individuals of a population employ this method, they will all develop high expectations; but then, since both individuals must accept each other for a pairing to occur, only those with a high mate value will successfully pair up.

More realistically, individuals could use the adolescence period to get an idea of their own mate value and then use their own relative position on the mating market as their aspiration level to guide whom they make offers to. Using one's own mate value as an aspiration level proves much more successful: Most individuals pair up, and the intracouple correlation of mate value is high, making for stable pairing. Still, this model does not explain how one comes to know his/her own mate value. Individuals cannot determine it by self-observation, nor does one know what criteria the other sex might use when estimating mate value.

One explanation is that individuals use the adolescence period to constantly update their self-perceived estimation of their mate value (or aspiration level) by responding to feedback received from members of the opposite sex. In this case, during adolescence individuals make and receive trial offers that cannot end up in actual partnerships, but instead serve to explore the search space (see Furman, 2002). With positive feedback (receiving an offer), one would increase

one's self-appraisal and hence aspiration level, while with negative feedback (no offer), one would lower both. Todd and Miller (1999) showed that this *adjust up/down model* which alters one's self-perception based on feedback from everyone encountered results in pairings of only about 40% of the population, mostly those individuals with lower mate values. Their explanation is that this method results in individuals with mate values above the mean ending up with aspiration levels that are too high and individuals below the mean often ending up with aspiration levels that are too low.

Finally, with the *adjust relative model*, instead of simply adjusting aspiration levels in response to each opposite-sexed individual, individuals consider the mate value of the person they are interacting with. If that person's mate value is above the current aspiration level and they still make a proposal, the individual receiving the offer should raise his/her aspiration level in response. If the other person is below one's current aspiration level, a proposal is to be expected and thus one's aspiration level need not be adjusted. However, if the other person makes no offer, one should respond by lowering his/her aspiration level. This model leads to the most realistic patterns of mate choices, and hence is what we would most expect to see empirically.

Using Speed-dating for Mate Search Data

To test models of human mate search, we need to have data about how people search through a succession of potential partners. Ordinarily, this would take years to gather, observing a set of people proceeding through the ups and downs of dating, relationships, marriage, and divorce. But recently, sped-up versions of this sequential search have been developed, which allow us to view the process in an evening instead of in a decade. Speed-dating, one such modern mate-search institution, is designed to allow singles to meet a large number of potential romantic partners by successively participating in "minidates" that typically last 3 to 8 minutes. After each interaction, participants indicate whether they would like to see the other person again (making an "offer"). If both individuals are mutually interested, after the session their contact information is exchanged so they can arrange future meetings. Speed-dating is an ideal way to study mate choice decisions by maintaining ecological validity in a controlled environment (Finkel, Eastwick, & Matthews, 2007).

The minidates, while short, still allow for serious mate choice. Research in the minimal information paradigm has shown that people can accurately judge others in a very brief period of time. This accuracy is not just for observable traits but for personality traits and intelligence as well (Ambady, Bernieri & Richeson 2000; Borkenau, Mauer, Riemann, Spinath & Angleitner 2004). Although speed-dating events only focus on the initial interactions of individuals pursuing a romantic partner, this initial stage is important because outcomes within the speed-dating session determine which pairings have any chance of becoming short- or long-term romantic relationships. For these and other reasons, speed-dating has been used in a growing number of studies to test features sought in mates (e.g., Kurzban & Weeden, 2005; Todd, Penke, Lenton, & Fasolo, 2007; Eastwick & Finkel, 2008) and abilities of observers to judge romantic interest between speed-dating couples (Place, Todd, Penke, & Asendorpf, 2009), among other aspects of human mate choice.

The data used in our computer simulations come from the Berlin Speed Dating Study (BSDS), a set of carefully controlled experimental speed-dating sessions run at Humboldt University in Berlin ((Penke, Back, Klapilova, & Asendorpf, in preparation; Place et al., 2009). In a typical BSDS speed-dating session, roughly a dozen men and a dozen women met in pairs and talked briefly for 3 minutes. All BSDS participants were actual singles from the general population who were recruited using advertising and publicity in media outlets; in exchange for free speed-dating, they agreed to have their interactions videotaped and to provide additional data on themselves. Seventeen sessions of speed-dating were run as part of the study, for a total of 382 participants; for all the models described below, we only used data from the seven sessions of people in their 20's (78 men and 80 women).

The minidates took place in separate booths, and lasted for 3 minutes, at the end of which each individual could record their offer (or not) as well as whether or not they thought the other person was interested in them. Results from a follow-up study one year after the BSDS sessions indicate that several sexual and romantic relationships developed from matches in the sessions, showing that real mate choices were made (Penke, et al., in preparation).

Third-party attractiveness ratings of the individuals in their 20's in the BSDS dataset were also collected. Six raters (3 men, 3 women, ages 19 to 22, Cronbach's α=.54 for male raters of female photos and α=.52 for female raters of male photos) judged photos of opposite-sex individuals using a 1-9 Likert scale, where 1 was "very unattractive" and 9 was "very attractive." The mean judged attractiveness of the women was 3.98 (range of rater averages 1.00-6.67) and of men was 2.83 (range 1.67-5.33). The mean offer rate of men was 41% (n=78), and 31% among women (n=80). Mutual interest between individuals occurred 11% of the time.

Modeling Speed-dater Searches

To find what proposed mate search models might account for the patterns of sequential offers observed in our speed-dating sessions, we begin by looking at the average offer rates across the speed-dating sessions. Different possible models predict different patterns at this global level in terms of offer rates going up, down, or staying constant. One possibility is that people come to the event with a pre-fixed preference level based on past experiences in the dating world at large. These individuals would make offers to people only above that already established level, so that their offer rates would be constant throughout the session, assuming they meet people of different quality levels in random order. The experience-based aspiration-setting rules described above predict instead that individuals first explore

the range of possibilities before starting to make actual offers, which would mean an increase in offer rate that occurs near the beginning of the speed-dating session. Individuals may also relax their expectations and lower their threshold over time, particularly as the end of the session nears so as to not go home alone, resulting in a late increase in offer rate. Finally, individuals may fatigue as the evening progresses, in which case we would expect to see a decrease in offers toward the end of a session. Do rates of offers by men or women change over a session in any of these ways?

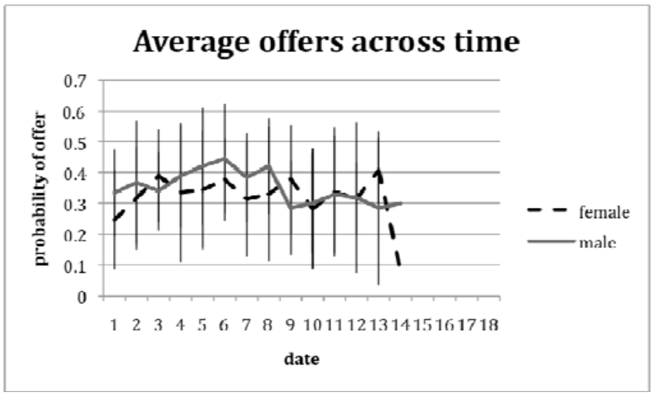

Figure 1: Mean offer rates made by women (black dashed line) and men (grey solid line) during each minidate in a session, averaged across sessions; standard deviations shown by vertical bars. Women and men saw between 9 and 14 members of the opposite sex.

Figure 1 shows the patterns of offer rates by men and women for each successive minidate, averaged across all seven sessions. The fact that the offer rates of both men and women are roughly flat across the entire speed-dating session could indicate that participants are determining their offers using a threshold which does not change with experience, corresponding to a *fixed threshold* or *fixed aspiration* model (Todd, 2006). But it could also mask individual differences in the use of changing thresholds. Hence the next step is to test a variety of mechanisms at the level of the individual, to see which search strategies fit participant decisions best. Table 1 shows the model fits.

Fixed aspirations

Operating under the assumption that individuals attending a speed-dating session have had some experience in the mating market already, it seems likely that they would have a previously-set aspiration level that they could use to decide to whom to make offers. But would they use this fixed aspiration level throughout the session, rather than change it as a result of experience *within* the session? In our first model simulation, we test how well a fixed aspiration level between 0 and 7 works to predict the offers that each individual made as they saw a succession of speed-daters with different mate values (here taken to be his/her third-party attractiveness rating, which is assumed to be highly correlated with operational mate value in this setting—see Eastwick & Finkel, 2008; Kurzban & Weeden, 2005; Todd et al., 2007). The model made an offer whenever the mate value encountered was above its fixed threshold.

To calculate the fit of this and subsequent models, we took into account the base rates of offers being made and weighted the correct predictions of offers and of rejections independently so that their total contribution to the fit score would be the same. That is, because women made offers only 30% of the time (offer rate = 0.3), correct offer predictions were each weighted 0.7 (=1.0-0.3) while correct rejection predictions were correspondingly weighted 0.3 (and likewise for assessing models of men's offers, using their 43% offer rate). If the model made an inaccurate prediction, no points were given. These weighted values were averaged over all dates for each woman (and separately for each man) and then divided by the maximum fit possible (if all of that women's offers had been correctly predicted). This resulted in a final model fit between 0 and 1, with a random model that makes offers at the group base rate yielding a fit of .5.

For females the mean best-fitting fixed aspiration level was 3.52 (sd=2.02) (when taking the highest value for the aspiration level that fits best for each woman—if the lowest value is taken, m=2.67, sd=1.58), with a fit of .81. For men, the mean best-fitting threshold was 3.7 (sd=2.12; or m=2.52, sd=1.32 for the lowest value), with fit .80. This model thus predicts offers well, but it does not address how individuals establish their pre-fixed aspiration level in the first place.

We test two answers to this question by seeing how well using the BSDS individual's attractiveness as his or her fixed aspiration level will do in predicting the offers made. It seems reasonable that individuals would establish a threshold similar to their own attractiveness value, as suggested by the high intracouple correlations of attractiveness observed in many studies (Kalick & Hamilton, 1986). First, we used each individual's *self-rated* attractiveness as their threshold for making offers. This model provided a fit of .59 for women and .60 for men. However, the correlation between self-rated attractiveness and the best-fit threshold for each individual was quite high, r=.81 for women and r=.69 for men. This is surprising for men, given that previous research found no relationship between their self-rated attractiveness and where they aimed their offers to women in a speed-dating session (Todd et al., 2007); for women, this indication that they take their own position in the mating market into account when making their offers, fits our expectations. Also, social relations analyses of the BSDS data showed that attractiveness similarity was only a factor affecting choices in women, not in men (Penke et al., in preparation). Second, using the *third-party* ratings of attractiveness as the threshold, the results were not markedly different; the model fits were .59 and .58 for women and men respectively, and correlations between third-party attractiveness ratings and best-fist threshold were r=.62 and r=.81.

Take the Next Best

Our second type of model used an "adolescent" training phase similar to that employed by Todd & Miller (1999) in their Take the Next Best model, to see if there was any learning or adjustment to the small-scale decisions made by participants as they became familiar with the speed-dating environment. In the first variation of this model, agents representing the participants began with an offer threshold equal to the mean attractiveness levels of all the opposite-sex individuals in their speed-dating session. During the adolescence phase, agents made offers to every opposite-sex individual they encountered whose attractiveness was above their initial threshold. After making an offer to an agent, they would then use that agent's mate value as their new threshold, thus implementing experience-based threshold adjustment or learning. When this phase ended, the threshold was fixed and offers were made only to subsequently encountered individuals above this threshold. Since individuals in speed-dating are able to make offers to multiple others, this search process is slightly different from that originally modeled by Todd & Miller (1999), in that here the offers made during the adolescence phase are real, and multiple offers can be made after that phase when the threshold has been fixed. The best-fitting adolescence phase length for females was around 3 dates (n=46, m=2.76), yielding an offer fit of .68 (sd=.14)—see Table 1. For some of the females (n=34) the best fit was achieved by never entering the adolescence period, simplifying this model into the fixed threshold model and, resulting in offers only to those males who were more attractive than the mean. The same held for many males (n=34), and for those that did leave the adolescence period the best fit came from leaving after 2 to 3 dates (n=44, m=2.5), fit .66 (sd=.13).

Take the Next Best was also tested with an initial threshold set at each individual's self-rated attractiveness value. The resulting model for female agents had a fit of .61, averaging around 3 dates for those individuals who were best fit with the utilization of an adolescence period (n=17, m=2.88). For men the fit was .64 averaging 2-3 dates (n=19, m=2.47). When the third-party attractiveness ratings were used as the initial threshold, female agents stayed in the adolescence phase for about 3 dates (n=37, m=3.18), resulting in a model fit of .67; there was no effect on model fit (.64) or length of adolescence for men (n=31, m=3.09).

Adjust up/down

In another simulation, corresponding to Todd and Miller's (1999) adjust up/down model, agents would increase or decrease their threshold in response to the perceived interest of the other agent. If a speed-dater believed that the person they were meeting would make them an offer, the corresponding agent increased its threshold by a fixed increment size between 0 and 1 (tested in 0.1 steps). If not, the threshold was decremented. In this simulation, agents were initiated with a threshold set at the mean attractiveness of the opposite-sex individuals. We found that an increment size of 0.0 worked for a significant portion of the population (37 females, 43 males), meaning that they did not change their aspiration level with experience. For the other individuals, the average best-fitting increment value for females was .41, with a fit to the collected data of .68; for men, the best-fitting increment was .26 yielding a fit of .65. (Given that the mean attractiveness values of the opposite-sex agents could themselves differ by as little as .3, these threshold increments could still result in significant changes in rates of offers made over a given session.)

When the initial threshold value was self-rated attractiveness, 40 females and 40 males were best fit with an unchanging threshold, while the other females were best fit with mean increment size of .57, and the other males with mean increment size of .33 (see Table 1 for fits). The use of third-party attractiveness as the initial threshold resulted in 45 females and 40 males being best fit by an unchanging threshold; the other females were best fit with an increment size of .46 and males with an increment of .43.

Adjust relative

A variation of Todd and Miller's adjust relative model (1999) was run in which agents only adjusted their threshold up when receiving positive feedback from someone above threshold and adjusting their threshold down when receiving negative feedback from someone below threshold. This model worked best with an initial threshold set at the individual's own self-rated attractiveness (see Table 1), though it was not much better than the previous model.

Table 1: The fit of various mate search models applied to empirical BSDS data, given different initial thresholds.

Model	Initial threshold	Females	Males
Set threshold	best-fit threshold	.81	.80
	self-rated attractiveness	.59	.60
	third-party ratings	.59	.58
Take the next best	session mean	.68	.66
	self-rated attractiveness	.61	.64
	third-party ratings	.67	.64
Adjust up/down	session mean	.68	.65
	self-rated attractiveness	.71	.68
	third-party ratings	.64	.63
Adjust relative	session mean	.66	.62
	self-rated attractiveness	.72	.71
	third-party ratings	.67	.65

Implications and further directions

The results from our model simulations suggest that individuals come into speed-dating sessions with an already set aspiration level. The high correlation between self-rated attractiveness and best-fitting fixed threshold indicates that self-rated attractiveness plays a large role in setting aspiration levels. Evidence has shown that women consider their self-rated attractiveness much more than men when making offers to men (Todd, et al., 2007). We also see this

pattern in our simulations, with the models with initial thresholds set to self-rated attractiveness fitting women's offers. And, surprisingly, self-rated attractiveness also provides the best model fit for men.

But our results also indicate that people are responsive to the feedback they get during the speed-dating session—that is, they adjust their aspiration levels in response to experience. This is suggested by the superior fit of the aspiration-adjusting models compared to the other models (though the former have one more free parameter), with all models starting with self-rated attractiveness as the initial threshold. We do not have enough evidence to say conclusively which of these learning models best accounts for participants' data, however, as the fits are too similar.

There could also be limits on how well participants can apply threshold-adjusting heuristics in a speed-dating situation. The short interaction time paired with multiple interactions in quick succession may diminish or distort the role of feedback on setting aspiration levels. Furthermore, feedback may be difficult to ascertain correctly, since nobody has to indicate their rejections (or acceptances) openly. But even if speed-dating does not reveal strong evidence for threshold adjusting mechanisms, individuals may still use some forms of them in regular mate searches that are based not on initial interest but longer lasting, more involved interactions. In that case, the overall experience of speed-dating might cause a change in aspiration level that could be seen only by following individuals through multiple speed-dating sessions or in their outside dates.

To understand more fully the complexity of the mate choice problem, we will continue to expand the range of heuristic models under consideration, and the sets of data we can bring to bear to test among the models. We will begin by analyzing the search behavior of speed-daters in their 30's and 40's and comparing that with the results for younger people covered here. By looking at different age groups, we hope to gain further insight into the way in which aspiration levels for mates are initiated and changed throughout an individual's lifetime.

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