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Competitive Mate Choice: How Need for Speed Beats Quests for Quality and Harmony

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Abstract

The choice of a mate is made complicated by the need to search for partners at the same time others are searching. What decision strategies will outcompete others in a population of searchers? We extend previous approaches using computer simulations to study mate search strategies by allowing direct competition between multiple strategies, evaluating success on multiple criteria. In a mixed social environment of searchers of different types, simple strategies can exploit more demanding strategies in unexpected ways. We find that simple strategies that only aim for speed can beat more selective strategies that aim to maximize the quality or harmony of mated pairs.

Keywords: Mate choice, sequential search, simple heuristics, strategy competition, agent-based modeling, social simulation.

Introduction

Imagine being a single individual searching for a mate. Because choosing a mate is one of the most important decisions of your life, you want your choice to be as good as possible on certain criteria. Apart from living 'happily ever after', three *a priori* plausible criteria concern the speed with which you make your choice, the quality of your chosen partner, and the harmony of your match with that partner — all of which have been discussed as important aspects of human mate search (e.g., Kalick & Hamilton, 1986).

But beware: Your competitors are searching the same pool of candidates at the same time. As you are in a race against rivals, any strategy that you use could be outperformed or exploited. For instance, the myopic strategy to accept the first willing candidate that is at least 21 years old may yield satisfactory results under some conditions, but would fail to find a mate if everyone else in the population accepted anyone at age 20. Similarly, having high quality and harmony demands may be respectable goals, but could prolong your search and increase the risk of staying single forever.

Because mate search is a competition in a social environment, it is impossible to judge the quality of a strategy by itself — its success or failure always depends on its rivals. For instance, the strategy "Find someone better than yourself" may work for an individual, but would utterly fail for an entire population, as nobody would ever mate if everyone used it. Thus, to evaluate different mate search strategies we must consider aggregate effects that only emerge on the population level.

In this paper we explore how well different mate search strategies work in the context of competing strategies, judging them on the criteria of speed, partner quality, and match harmony. This extends previous work that considered the performance of single strategies in isolation on one dimension at a time (e.g., Todd & Miller, 1999) or compared strategies with unrealistic time horizons (e.g., McNamara & Collins, 1990) or unrealistic knowledge about the distribution of available mates (e.g., Johnstone, 1997). By letting multiple strategies compete against each other within one population and evaluating their success on three criteria, we show that simple strategies that maximize speed are more successful than more complex strategies under most combinations of the criteria. This happens because simple strategies almost always find a mate and simultaneously exploit the qualities provided by more demanding strategies.

Previous Mate Search Models

Human mate search shares many features with other search tasks studied by biologists, statisticians, and economists, but presents a number of challenges (Dudey & Todd, 2001). It is typically sequential, with prospective partners being encountered and evaluated over a stretch of time rather than all at once. It is uncertain, with little knowledge of the qualities of partners one may encounter in the future, and possibly little chance of returning to people met in the past. It is costly, in terms of both time and resources that may need to be spent to interest a potential partner. And this last type of cost reflects another constraint: Human mate search—at least in modern Western societies—is also typically mutual. In contrast to choosing a car, a relationship requires both choosing and being chosen by one's partner. All of these constraints have important implications for the success of strategies in mate search scenarios. For instance, rather than identifying the very best partner on some criterion (e.g., attractiveness), a searcher may have to consider her own attributes and the degree of match between a potential mate and herself.

Todd and Miller (1999) simulated populations of various simple mate search heuristics, including fixed and learnable aspiration satisficing rules that made offers to anyone above a particular threshold, and compared their success with optimal solutions from the serial search literature. They found that simple rules that adjusted thresholds based on initial experience—upwards after receiving unexpected interest from a potential partner, and downwards after receiving unexpected rejection—learned a searchers relative place in the mating market quite quickly. Guided by this knowledge, the simulated searchers could then make appropriate offers to potential partners, and succeeded in finding mates after little search. These simple rules performed well in terms of three criteria: (a) the percentage of mated individuals, (b) the mean mate value of mated pairs, and (c) the mean within-pair difference in mate values. In an earlier simulation, Kalick and Hamilton (1986) investigated the effect of quality-based preferences versus similarity-based ones (our harmony measure), and found both could create well-matched couples, with the latter faster than the former.

However, these approaches of considering mate search strategies in isolation tell us little about how they would fare in the natural situation where different individuals could follow different rules for finding a mate (also important for exploring rule evolution). Furthermore, assessing the performance of rules separately on multiple dimensions creates problems when strategies involve trade-offs between different criteria. For instance, maximizing the percentage of mated individuals (a) can easily be achieved when completely ignoring criteria (b) and (c). Similarly, any demands regarding a partner's quality (b) and the similarity within a pair (c) will inevitably decrease the likelihood of finding a suitable partner (a). Hence, any sensible judgment of a strategy's potential requires integrating different dimensions or simultaneously comparing performance on multiple criteria.

We next present our methods for overcoming these restrictions, through multi-strategy competitive simulations and strategies on the spectrum of all possible combinations of a set of performance criteria. To show the interplay of strategies and emergent phenomena on the aggregate level we focus on a small range of relatively simple search strategies and measure how each fares against the others.

Method

Overview We modified the basic simulation setup of Todd and Miller (1999) as follows. Our Matlab™simulation contains a population of N=100 male and 100 female agents who are characterized by a unique, objective, and perceptible mate value (from $V_{min} = 1$ to $V_{max} = 100$ within each gender), meet each other in iterative encounters that are governed by a dating protocol, and pursue a specific mate search strategy.

Criteria The success of a mated pair is evaluated on three criteria based on a time value t_{match} indicating when a matched pair was formed, a quality value (operationalized as the average mate value of both partners), and a harmony value (operationalized as the similarity in mate values of both partners). All three measures are normalized to a value range from 0 to 1 (see Table 1 for definitions).

As the primary objective of any mate search strategy is to find a mate, any individual who fails to mate by the end of the simulation is assigned the lowest possible value of 0 on all criteria. The performance of a strategy is evaluated as the average performance of all individuals with that strategy.

Table 1: Definitions of evaluation criteria.

Criterion:	Definition:
Speed score s:	$\frac{t_{max}-t_{match}}{(t_{max}-1)}$
Quality score q:	$\frac{(V_{own}-1)+(V_{partner}-1)}{2\cdot(V_{max}-1)}$
Harmony score h:	$\frac{1-f(\lvert V_{own}-V_{partner}\rvert)}{V_{max}-1}$

Note. All measures are normalized to a [0;1] value range. As the mean harmony value for a randomly paired population would be .33 a parabolic function $f(x)$ is used to transform values to the [0;1] range with a mean of .50.

Strategies A goal of this paper is to assess the interplay of multiple strategies and their effects on multiple criteria. Consequently, we model three qualitatively different mate choice strategies, each of which targets one of our evaluation criteria:

1. *Speed* strategy: Our simplest strategy merely considers search time and aims to minimize it. The fastest way of finding a mate is to be entirely indiscriminate about its qualities and make an offer on every date. This naïve and extremely myopic strategy can be modeled by setting the probability of making an offer to $p(\text{offer}) = 1$.
2. *Quality* strategy: A slightly more complex strategy takes into account a potential partner's mate value ($V_{partner}$) and sets itself a minimum aspiration level Q. For instance, an individual with $V = 50$ makes an offer to any individual that meets or exceeds this criterion ($V_{partner} \geq Q$) but refuses to mate with anyone less attractive. Using such an aspiration level strategy conforms to Simon's (1956) notion of *satisficing*, which uses a threshold that allows a boundedly rational organism to stop search as soon as an acceptable alternative is encountered.
3. *Harmony* strategy: Our most complex strategy focuses on the similarity of a potential match. To do so, it needs to know its own mate value (V_{own}) and compare it to a potential partner's value ($V_{partner}$). Rather than forcing our agent to first learn its own mate value (see Todd & Miller, 1999, for simple learning algorithms) we assume that it has some vague notion of it and implement this vagueness by perturbing its perceived mate value V'_{own} with a slight error signal $V'_{own} = V_{own} \pm \varepsilon$, $\varepsilon \leq 10$, reflecting the intuition that the attractiveness of others is perceptible with slightly higher precision than our own. To achieve harmony, the strategy sets a lower-bound aspiration level H for the maximally allowed difference between V'_{own} and $V_{partner}$ and only makes an offer to a partner when $|V_{partner} - V'_{own}| \leq H$. For instance, an individual with a perceived mate value of $V'_{own} = 50$ and $H = 10$ would only make an offer to partners with $40 \leq V_{partner} \leq 60$.

The demands of each of these strategies are regulated by one parameter, $p(\text{offer})$, Q, and H, respectively. Choosing extreme values for each parameter will lead to entirely indiscriminate choices. For instance, settings of $p(\text{offer}) = 1$, $V > 0$, and $H > 100$ all entail universal acceptance, and settings of $p(\text{offer}) = 0$, $V > 100$, and $H < 0$ all entail universal rejection of all available candidates. But whereas this equivalence of strategies holds in their extremes, they yield very different patterns of behavior in intermediate ranges.

Although each strategy is implemented with one parameter, they vary in the complexity of their assumed information processing capacities. As the *speed* strategy does not use any information about its partner or itself it is the simplest strategy. The *quality* strategy is not quite as myopic and considers the attractiveness of a potential mate before making a choice. By contrast, the *harmony* strategy must compare its own with its partner's value and is the most complex of our strategies.

If 'need for speed' was the *only* objective of an organism, it could never outperform a *speed* strategy with its parameter set to $p(\text{offer}) = 1$. As a modeling strategy, we will compare this extreme setting with parameterized versions of the other two strategies.

Procedure Before the start of the simulation, strategies are randomly assigned to individuals, i.e., each of n different strategies is represented by a proportion of approximately $1/n$ individuals of either gender. Individuals' strategies and mate values are independent of each other.

The simulation then proceeds in up to $t_{max} = 200$ iterative rounds. In each round t, every male individual has a date with a random female individual, sampled without replacement. On every date, both individuals evaluate each other on the basis of their mate values and the details of their strategies. If both partners decide to make an offer they are mated by mutual consent and the newly-formed pair is scored and removed from the population. This process continues until no unmated individuals remain (in round t_{end}) or the maximum number of rounds (t_{max}) has elapsed.

To obtain stable results we average over 1,000 simulations for each parameter configuration of interest.

Results

We will first present the results of a specific strategy configuration (i.e., with one particular set of parameters) before generalizing to other parameter ranges.

Maximum speed vs. low quality vs. low harmony Our initial competition is between the naïve maximum speed strategy ($p(\text{offer}) = 1$) and relatively lenient versions of the two other strategies. A quality strategy with $Q = 20$ makes an offer to anyone with a mate value in the top 80% of the population; a harmony strategy with $H = 15$ makes an offer to anyone within a range of 30% of one's own mate value.

Table 2 shows the basic results of this competition on a variety of dependent measures. The first two lines essentially contain manipulation checks: As individuals get randomly assigned one of three strategies their mean population share of 33.3% provides an indicator that our average results are relatively stable. Similarly, a mean percentage of mated individuals of 95.0% warrants our intuition that all three initial strategies have relatively low demands. Whereas this was to be expected for the entirely indiscriminate *speed* strategy (with a share of 99.2% of individuals finding a mate), our "lenient" parameter settings of the *quality* and *harmony* strategies are also confirmed by their overwhelming majority of successfully finding a mate (92.1% and 93.6%, respectively).

Table 2: Average simulation results for each of the three strategies, with parameters $p(\text{offer}) = 1$, $Q = 20$, $H = 15$.

Criterion:	Speed $p(\text{offer})$=1:	Quality Q=20:	Harmony H=15:	Mean:
Population share:	33.4%	33.2%	33.5%	33.3%
Percent mated:	99.2%	92.1%	93.6%	95.0%
Speed score s:	.989	.915	.918	.941
Quality score q:	.479	.516	.463	.486
Harmony score h:	.600	.585	.810	.665

The average results of our three main performance criteria are contained in the bottom three rows of Table 2. The fact that individuals of all three strategies achieved average speed scores s exceeding .900 means that they typically found a partner in less than 10% of the available time (of $t_{max} = 200$ rounds), again confirming that all strategies had very low aspirations. Not surprisingly, the indiscriminate *speed* strategy achieved the highest s (of .989). With respect to quality, all average scores are substantially lower, but we have to bear in mind that the expected value of a random pairing of an entire population would be .500, as only one pair (with both partners having a mate value of 100) can achieve the maximum score of 1.0. Whereas the absolute values carry little meaning, the fact that the quality strategy achieved the highest mean quality score q (of .516) shows that—despite its moderate demands—it achieves its goal to maximize quality to a greater extent than the two rival strategies that were aiming for speed and harmony. Similarly, the harmony strategy yields the highest mean harmony score h (of .810).

The fact that each strategy wins on the criterion that it was designed to maximize is a reassuring manipulation check. But as we initially characterized the mate search scenario as a 'competition' between multiple strategies a legitimate question is: Which strategy wins overall? The correct, though somewhat unsatisfying answer is: It depends on the evaluation criterion that is being used. A standard solution to this dilemma would be to define a fitness function that somehow integrates all criteria that are deemed to be relevant, e.g., by computing a weighted average of a strategy's speed, quality, and harmony scores: $f_{fitness}(s,q,h) = w_s \cdot s + w_q \cdot q + w_h \cdot h$, with $w_s + w_q + w_h = 1$ and $0 \leq w_s, w_q, w_h \leq 1$. In the absence

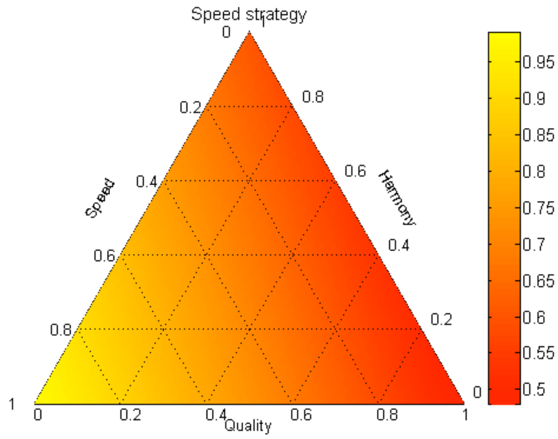

Figure 1: Ternary plot evaluating the *speed* strategy on every possible combination of three criteria.

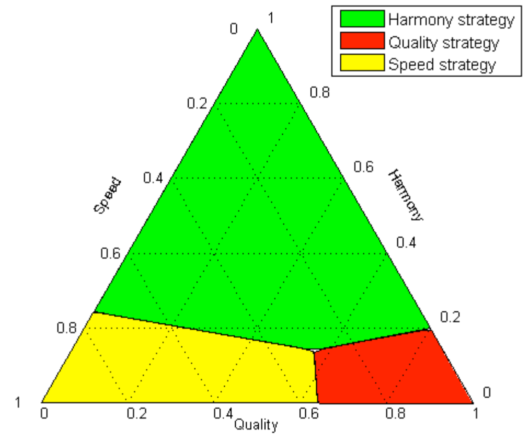

Figure 2: Best strategy plot showing the strategy with the *best* performance for every possible combination of three criteria.

of strong reasons for a specific choice of weights, we suggest a methodological alternative that has the benefit of allowing simultaneous evaluation of a strategy on all possible combinations of the criteria.

Figure 1 illustrates a so-called *ternary plot* that evaluates the *speed* strategy on all possible combinations of the three criterion dimensions (labeled as *Quality*, *Harmony*, and *Speed*). Any point on the horizontal baseline (labeled *Quality*) corresponds to a harmony weight $w_h = 0$ (note the scale on the right) and the top corner of the triangle corresponds to $w_h = 1$. For any point x on the triangular plane a horizontal projection to the *Harmony* scale running in parallel to the baseline indicates its w_h value. Weights for the quality and speed dimensions can be found in an analog fashion. The color-coded values form a 3D-landscape over the triangular plane that shows results for all possible combinations of three dimensions, each ranging from a minimum weight of 0 to a maximum weight of 1. Figure 1 shows that the *speed* strategy indeed performs best when speed is valued highly (in the bottom left corner), and worst when quality is weighted highly (bottom right corner).

Analog plots can be drawn for the two other strategies in the population, each plot summarizing the performance of all (mated and unmated) individuals that share a strategy. We now can answer the question "Which strategy wins?" by asking: Which of the three plots shows the maximum value for each point on the triangular plane? A *best strategy plot* (see Figure 2) shows which strategy wins this competition for every possible parameter combination, i.e. effectively classifies the winning strategy for each point on the triangle and thus enables us to answer the question: "Which strategy wins?" for every possible combination of criteria. Perhaps not surprisingly, each strategy performs best when its respective criterion is highly weighted. Overall, the *harmony* strategy wins most often (covering 67.6% of the triangular area), followed by the *speed* strategy (22.9%), whereas the *quality* strategy rarely wins (9.5%) in this particular competition.

Maximum speed vs. increasing demands on quality and harmony The comparison between multiple ternary plots and its representation as a best strategy plot provides us with an objective and transparent way to assess the relative success of every strategy on flexible combinations of multiple criteria. Within this framework, we can address the question: What happens when the demands for quality and harmony increase within a population of searchers?

Intuitively, one may hypothesize that the reason for the poor performance of the *quality* strategy—relative to both its rivals in the population—may be due to its very moderate demands. But although raising one's aspirations with respect to the quality of a match will undoubtedly increase the quality score of anyone who finds a mate by using this strategy, it simultaneously will affect the performance of other strategies. Thus, it is far from clear how shifts in individuals' strategies will affect performance on an aggregate level.

To test the effects of increasing aspirations on quality and harmony we conducted 12 separate simulations in which strategies with four different quality parameters ($Q = 20, 40, 60, 80$) and three different harmony parameters ($H = 5, 10, 15$) competed against the same *speed* strategy ($p(\text{offer}) = 1$). Figure 3 shows the resulting best strategy plots. Overall, the *harmony* strategy still dominates in the majority of cases. In contrast to our previous intuition, increasing demands of the *quality* strategy (from left to right in Figure 3) does not in-, but decrease its performance relative to its competitors. Similarly, increasing aspirations of the *harmony* strategy (from bottom to top in Figure 3) harms its performance on the population level. Curiously, the naïve *speed* strategy eventually outperforms its competitors on almost all possible combinations of criteria as they get sufficiently demanding.

The top-right triangle of Figure 3 summarizes the result of a competition between strategies with parameters $p(\text{offer}) = 1$, $Q = 80$, and $H = 5$. Whereas the *harmony* strategy still wins when harmony is weighted highly and speed is weighted

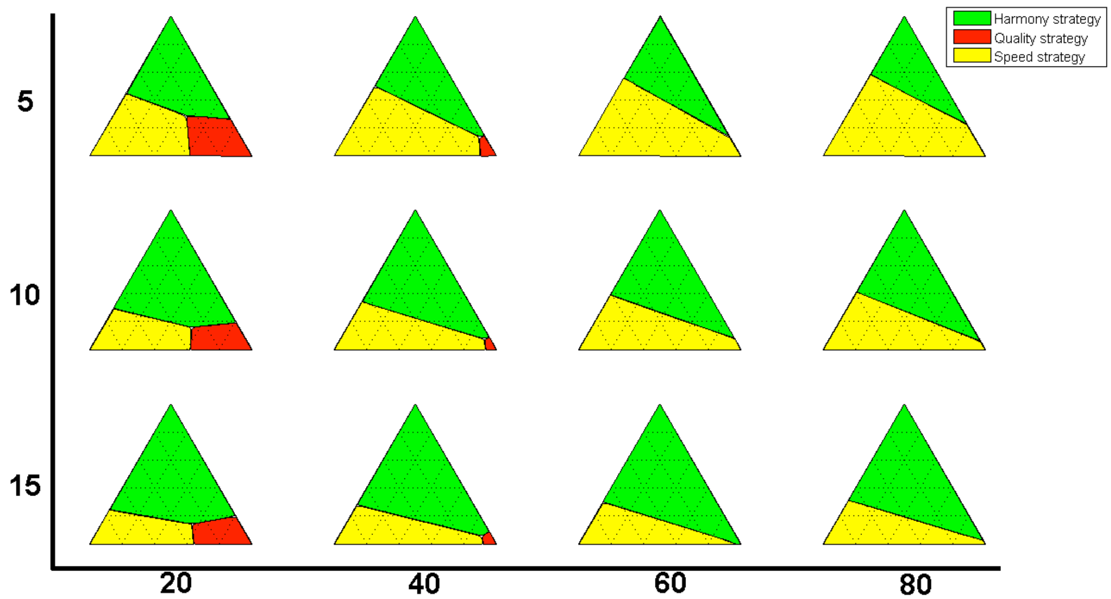

Figure 3: Best strategy plots showing the winning strategy for any combination of 3 criteria for 12 simulations. The x-axis varies 4 quality parameters ($Q = 20, 40, 60, 80$, from left to right); the y-axis varies 3 harmony parameters ($H = 5, 10, 15$, from top to bottom). The *speed* strategy was left constant at $p(\text{offer}) = 1$. Thus, the bottom-left plot repeats the previously discussed baseline condition (Figure 2), whereas plots towards the right show the effects of increasing demands of the *quality* strategy and plots towards the top show the effects of increasing demands of the *harmony* strategy.

poorly (i.e., in the top corner of the triangle), the *speed* strategy wins for all other combinations of criteria, including the situation in which all criteria are weighted equally (at the center of the triangle). Overall, the speed strategy covers 65.5% of the triangular area, the *harmony* strategy wins in 34.5% of possible weightings, and the *quality* strategy is beaten by its competitors in every possible case.

To explain this finding, Table 3 shows the quantitative results for this final simulation, but separately lists the average scores for the entire population (3a) vs. only the mated individuals (3b). As 99% of the individuals with the *speed* strategy manage to find a mate, the values in both parts of the table hardly differ. As before (see Table 2), the strategy scores highest on the speed criterion s. By contrast, only 32% of individuals with the demanding *quality* strategy manage to find a mate. Although the successful ones achieve a high average quality score q of .820 (and good scores on both other criteria) the large share of unmated individuals lowers the scores of the strategy as a whole. The results for the *harmony* strategy show a similar pattern, but the differences are not as dramatic as 86% of individuals still find a mate.

Table 3: Average simulation results for individuals for each of three strategies, with parameters $p(\text{offer}) = 1$, $Q = 80$, $H = 5$.

Criterion:	Speed p(offer)=1:	Quality Q=80:	Harmony H=5:	Mean:
Population share:	33.4%	33.4%	33.3%	33.3%
Percent mated:	99.1%	32.0%	85.7%	72.3%
(a) All individuals:				
Speed score s:	.973	.305	.737	.672
Quality score q:	.475	.262	.432	.390
Harmony score h:	.610	.236	.781	.542
(b) Mated individuals:				
Speed score s:	.982	.953	.860	.932
Quality score q:	.479	.820	.504	.601
Harmony score h:	.616	.736	.912	.755

Note that the share of 32% mated individuals with a *quality* strategy with an aspiration level of $Q = 80$ is still higher than what would be possible in a uniform environment, as only 20% of the population could find a suitable partner if *everyone* wanted to find one in the top 20%. This suggests a more subtle reason for the fact that the simple speed strategy eventually outperforms the more demanding ones: Not only will it almost always find a partner, as it gets mated as soon as it encounters an individual with the same strategy, in which case its scores will approximate the expected values for a random pairing. In addition, individuals with this strategy can also mate with any competitor who pursues a more demanding strategy. If such a competitor makes an offer, the *speed* strategy will accept—as it always does—but benefit from the fact that the other partner has assured a high quality or harmony for the pairing. In our final simulation, 11.7% of the individuals willing to accept any offer eventually mate with a partner pursuing the most demanding *quality* strategy and 18.3% mate with a partner pursuing the most demanding *harmony* strategy. Thus, the surprising success of the *speed* strategy is partly due to its status as a free-rider on the aspirations of its rivals. Instead of calling it 'naïve' we may also applaud it for exploiting its social environment in a simple and smart way.

Discussion

Through a series of competitive mate search simulations, we found that strategies with high demands do not necessarily yield higher outcomes in terms of multiple performance criteria. Instead, we have shown that a very simple strategy that is maximally flexible can exploit those high-demand strategies. This suggests that in some settings, it may be smarter for searchers to put lower bounds on their aspirations (as in Simon's (1956) notion of *satisficing*) than to increase their demands (*maximize* desired criteria).

The benefactor of the clash of demands in this search setting was the seemingly naïve speed strategy, which is arguably one of the simplest possible mate choice heuristics. It appears to win out over its more complex competitor strategies because it can exploit the efforts of the others, relying on its selected partner (following another strategy) to ensure a high level of quality or harmony.

To test the generality of our findings, we conducted simulations with a *relative quality* strategy that defines its demands on a partner's value in relation to its perceived own value V'_{own}, choosing potential partners with some distance to itself. We also explored a *harmony*-seeking strategy with fully accurate knowledge of V'_{own} (i.e., $\varepsilon = 0$) and populations with normally distributed mate values (with a mean of $V_{own} = 50$ and $SD = 20$). All variations produced the same basic pattern of results, again demonstrating the robust advantage of the simple *speed* strategy.

Removing the assumption of known mate values (and requiring to learn this value instead) would only make the *quality* and *harmony* strategies do worse. Similarly, slowing down the *speed* strategy (by using $p(\text{offer}) < 1$) would allow other strategies to win more often, but would not change the basic relationship we found. Interesting directions in which we are extending this work include:

- Expanding the set of competing strategies to include threshold-learning mechanisms that perform initial exploration of the range of potential mates before making offers.
- Letting individual agents switch strategies, e.g., when no mate has been found after some time of search.
- Allowing the possibility of separation (divorce), rather than assuming permanent matches. This may dampen the role of the time factor, as mates of different mate values may become available at various times.
- Adding multiple dimensions on which mate choices are based, rather than just a single value. More complex strategies with thresholds on multiple criteria would lead to more unpredictable outcomes at the population level, further necessitating a simulation approach.

Conclusions

Competitive mate search is challenging to study: The interplay of many individual goals, strategies, and constraints affects the aggregate results at the population level, as well as how each strategy performs relative to each other on multiple criteria. Simulation models coupled with appropriate analytic techniques help us understand the interplay between strategies and various parameters. The surprising result revealed here is that simply accepting any encountered partner can beat highly selective strategies that aim for superior partner quality or similarity. As its competitors become increasingly selective a simple and entirely indiscriminate speed strategy dominates and exploits the higher demands of the other strategies, letting them do the work of ensuring some measure of quality or harmony in the partnership.

People tend to believe that poor search results on the mating market can be improved by increasing the effort invested in the search. Indeed, some popular online dating sites entice customers with the promise of finding an optimal match by using sophisticated search algorithms coupled with detailed psychological profiles. Contrary to this, our results illustrate that increasing the demands of search criteria can have negative consequences at the aggregate level. This does not mean that quality or harmony are not important aspects of a relationship. However, achieving high values on those dimensions does not necessarily require demanding high values. Although a small proportion of individuals who can afford to have high aspirations can achieve high-quality matches, even indiscriminate searchers can achieve satisfying results by exploiting their social environment.

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