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Original Article

Euclidean distances discriminatively predict short-term and long-term attraction to potential mates

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ABSTRACT

We tested the ability of a Euclidean algorithm to predict attraction to potential mates—a relatively upstream domain in the temporal sequence of the mating process. Participants in two studies reported their ideal mate preferences using a 23-item preference instrument. Separately, they rated their attraction to profiles of potential mates that varied on those 23 dimensions. Study 1 ($N = 522$) found that Euclidean distances predicted attraction to potential mates both in terms of (1) overall mate value and (2) unique mate value. Study 2 ($N = 411$) replicated these effects and further found that Euclidean mate values discriminatively predict between short- and long-term attraction. Across both studies, a Euclidean model outperformed a variety of alternative models for predicting attraction to potential mates. These results suggest that a Euclidean algorithm is a good model for how multiple preferences are integrated in mate choice.

1. Introduction

Mate selection poses both a critical adaptive problem and a formidable computational challenge. Choosing one mate from a larger pool of potentials has large and direct effects on individual reproduction, the driving engine of evolution. But successfully selecting a mate requires comparing a set of mate preferences to an array of potential mates who vary somewhat independently across multiple dimensions in a way that reliably identifies those mates that are overall fitness-beneficial and those mates that are fitness-costly. One hypothesis suggests that human mate selection psychology solves this computational problem by integrating information on multiple mate preference dimensions according to a Euclidean algorithm that represents ideal preferences and potential mates as points within a common multidimensional space (Conroy-Beam & Buss, 2016; Conroy-Beam, Goetz, & Buss, 2016). Here we test this hypothesis by examining whether Euclidean integration of mate preferences can predict attraction to potential mates.

Mate selection would have had large and direct impacts on fitness throughout human evolutionary history. For ancestral humans, chosen mates could have represented reproduction partners, cooperation partners, and parenting partners. Which mates an ancestral individual selected would have affected their reproduction, the care their offspring received, the strength of their social alliances, and the traits their offspring inherited. For these reasons, selection would have strongly favored the evolution of mating psychologies capable of guiding ancestral individuals toward fitness beneficial mates and away from cost-inflicting mates.

Prior mate preference research supports this fundamental idea. People across cultures express desires for many qualities that would have yielded fitness benefits to human ancestors, including kindness, intelligence, dependability, emotional stability, and healthiness (Buss, 1989; Botwin, Buss, & Shackelford, 1997; DeBruine, Jones, Crawford, Welling, & Little, 2010). Moreover, men, more than women, desire partners who are physically attractive and youthful, embodying cues to reproductive potential. Women, more than men, desire partners who are slightly older than they are and who have social status and good financial prospects—cues to provisioning ability (Buss, 1989; Kenrick & Keefe, 1992; Li, Bailey, Kenrick, & Linsenmeier, 2002).

These many mate preferences are hypothesized to function to guide mate selection in fitness-beneficial directions, but their multiplicity introduces a computational challenge to mate selection. The fitness benefits a potential mate offers can vary at least somewhat independently across a large number of dimensions. A kind cooperator, for example, may or may not be intelligent or healthy. An emotionally stable individual may or may not be high in social status. Crucially, these individual dimensions could also interact in complex ways: a mate whose beauty would otherwise signal fertility could only offer few benefits if they are also cruel, selfish, or extremely ill. Each potential mate represents a constellation of qualities that must be compared against a constellation of preferences. How does a mate who is intelligent, considerate, and ill compare to one who is dull, selfish, and healthy? To make these decisions, ancestral humans would have needed some computational machinery capable of integrating information from many

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different preference dimensions into useful summary variables that track overall value as a mate.

There are a variety of algorithms human psychology could use to integrate mate preferences. One class of preference integration algorithms are satisficing algorithms that involve using few, highly informative criteria to search for mates only until a mate who fulfills some aspiration is found (e.g. Miller & Todd, 1998). Such satisficing algorithms do not search for the best mates, but rather accept the first mate who meets some acceptable threshold. These algorithms work well for decision problems such as the "secretary problem" wherein alternatives are encountered sequentially—that is, one must decide upon one alternative before evaluating another—and problems wherein the space of alternatives is too large or too costly to search exhaustively (Todd & Miller, 1999). The conditions under which satisficing algorithms perform well appear to be good descriptions of mate search in large modern populations, and could serve as a good description of the problems faced in mate choice for species such as guppies that must forage their environment for mates, risking predation in the process (Godin & Briggs, 1996).

However, it is less clear that sequential, costly mate search would have characterized the mating markets of the ancestral environments that forged human mating psychology. For most of our evolutionary history, humans lived in small social groups (Dunbar, 1992; Marlowe, 2005) that would have been easier to search relatively exhaustively. Whereas modern humans can measure their space of potential mates in the millions, ancestral humans would likely have measured this space in at most the hundreds. Humans are additionally adept at extracting information from others relatively quickly based on brief exposure (e.g. Naumann, Vazire, Rentfrow, & Gosling, 2009) and at leveraging information from third-parties (e.g. Rodeheffer, Leyva, & Hill, 2016), so ancestral humans could have extracted much information from each of their potential mates at low cost. Finally, our small-group living ancestors could have evaluated mates relatively simultaneously. One potential mate does not need to be rejected before another can be considered. Moreover, mates rejected at one time could become potentials again when circumstances change. Given these circumstances, and particularly given the large impact of mate choice on reproductive success, sequential and information-frugal satisficing algorithms may have been less efficient solutions to the problem of selecting fitness-beneficial partners than algorithms that utilize more information and allow identification of the best available mates, rather than merely sufficient mates.

One such algorithm is a linear combination algorithm where mate preferences act like slopes in a linear regression (Eastwick, Luchies, Finkel, & Hunt, 2014; Miller & Todd, 1998). A psychology that used such an algorithm could guide individuals to fitness beneficial partners because it would estimate high mate value partners as being those who possess more of preferred features. By using preferences as weights, a psychology with a linear combination algorithm would allow stronger preferences to contribute more strongly to mate value estimates overall.

Nonetheless, such linear combination algorithms have some shortcomings. For example, a regression-like combination must consider each preference dimension independently and simply aggregate information across dimensions after the fact. This linear combination algorithm cannot consider interactions between preference dimensions without the addition of potentially intractable numbers of interaction parameters. Because of this, a mate who is brilliant but extremely cruel could be considered equal in value to a mate who is moderately kind and intelligent.

In contrast to satisficing or linear combination algorithms, emerging evidence suggests that human mate selection psychology employs an alternative algorithm, a Euclidean algorithm, that is able to integrate a variety of preferences in a holistic fashion (Conroy-Beam & Buss, 2016; Conroy-Beam et al., 2016). A Euclidean algorithm represents ideal preferences and potential mates as points within a multidimensional preference space. Consider a simplified scenario in which humans have just three preferences—for kindness, dependability, and intelligence. These three preferences could be used to form a three-dimensional preference space with one preference representing each of the X, Y, and Z axes (Fig. 1). Any point within this 3D space represents a possible set of mate preferences as well as a possible set of traits. A Euclidean preference integration algorithm places ideal preferences and the traits of potential mates at their appropriate locations within this preference space and calculates mate value as proportional to the distance between these points.

This algorithm has several features that make it useful for integrating preferences in mate choice. First, just as with a linear combination algorithm, the Euclidean algorithm can integrate any number of preferences into a single decision variable reflecting the extent to which a mate embodies a given set of mate preferences. These values can be compared continuously among an array of potential mates to identify which mates best fulfill mate preferences overall. Second, the nature of the Euclidean algorithm directly reflects the computational challenge human ancestors would have faced in mate selection. Each potential mate encountered represents a unique collection of qualities—a single point at the intersection of multiple mate preference dimensions. It is this point that must be accepted or rejected as a whole: one cannot accept a potential mate's beauty without also accepting their cruelty, ill-health, and so on. The Euclidean algorithm, unlike satisficing or linear combination algorithms, represents potential mates in exactly this way: as points within an *n*-dimensional preference space that must be evaluated as a whole.

Finally, because the Euclidean algorithm evaluates potential mates simultaneously across all dimensions, it naturally incorporates interactions between preference dimensions that historically could have led to more fitness-beneficial mate choices. Due to the nature of the Euclidean distance, but not other distance metrics such as the Manhattan distance, deviation from preferences on any one dimension decrease the extent to which other dimensions can contribute to mate value. A mate's beauty or intelligence counts less in determining their mate value if they are also cruel or infectious. A Euclidean algorithm therefore captures threshold effects documented in prior mate preference research (Li et al., 2002). Under a Euclidean algorithm, a potential mate increases in mate value to the extent that they fulfill preferences across all dimensions; mates who are exemplary on some dimensions but deficient on others do not suffice.

Because of these features, the Euclidean algorithm proves to be a highly evolvable means of integrating mate preferences. In agent-based models where agents compete to identify and select the most fitness beneficial mates among mates who vary on multiple dimensions,

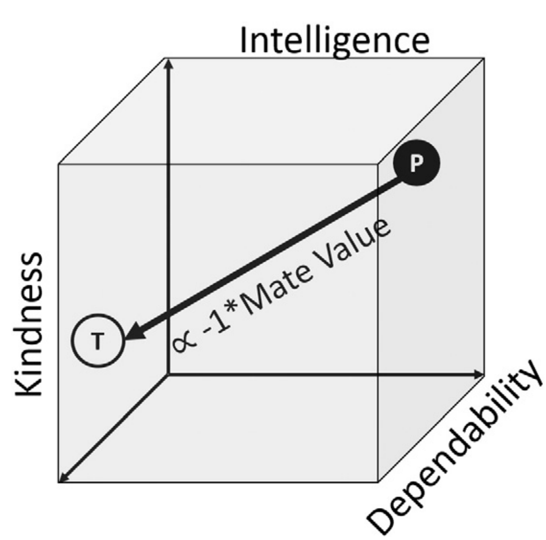

Fig. 1. Graphical depiction of preference integration according to a Euclidean algorithm. Mate value is calculated as proportional to the distance between ideal preferences (P) and potential mate traits (T) through the multidimensional preference space.