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First tests of Euclidean preference integration in friendship: Euclidean friend value and power of choice on the friend market

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ABSTRACT

Close friendships are associated with greater happiness and improved health; historically, they would likely have provided beneficial fitness outcomes. Yet each friendship requires one's finite time and resources to develop and maintain. Because people can maintain only so many close relationships, including friendships, at any one time, choosing which prospective friends to pursue and invest in is likely to have been a recurrent adaptive problem. Moreover, not all friends are created equal; some might be kind but unintelligent, some intelligent but disloyal, and so on. How might people integrate their friend preferences to make friend choices? Work using a Euclidean model of mate preferences has had significant success in elucidating this integration challenge in the domain of mating. Here, we apply this model to the domain of friendship, specifically exploring same-sex best and close friendships. We test and find some support for several critical predictions derived from a Euclidean integration hypothesis: People with higher Euclidean friend value (a) have best friends who better fulfill their best friend preferences, (b) have higher friend-value ideal best friends, and (c) have higher friend-value actual best friends. We also (d) replicate existing similar findings with regard to mating and (e) additionally provide a first test of whether people's Euclidean friend value (versus mate value) is a better predictor of their friend outcomes, and vice versa, finding some, albeit mixed, support for the dissocialbility of these constructs.

1. Introduction

Friendships, often defined as long-term bonds between unrelated conspecifics (DeScioli & Kurzban, 2009; Hruschka, 2010), are linked to greater happiness and improved health, and these bonds would have likely conferred fitness benefits throughout human evolutionary history (Chopik, 2018; DeScioli & Kurzban, 2009, 2011; Dunbar, 2016; Hruschka, 2010; Lewis, Al-Shawaf, Russell, & Buss, 2015; Seyfarth & Cheney, 2012; Silk, 2003; Tooby & Cosmides, 1996; Trivers, 1971). Although friendship remains an evolutionary mystery to some extent, there seems to be little question that choosing and maintaining the right friends is—and likely has been over human evolution—associated with benefits on both personal and evolutionary timescales (DeScioli & Kurzban, 2009, 2011; Hruschka, Hackman, & Macfarlan, 2015; Perlman, Stevens, & Carcedo, 2014; Silk, 2003).

Yet, perhaps because such links between friendship and fitness are less obvious, direct, and overt than are links between mating and fitness, many relationship phenomena have been comparatively less well studied in friendships than in mating—both within and beyond the evolutionary social sciences (e.g., in social and personality psychology; see Harris & Vazire, 2016). For example, there is a wealth of evolutionary-minded work on mate preferences (e.g., Buss, 1989; Buss & Schmitt, 2019; Gangestad, Haselton, & Buss, 2006; Kenrick & Keefe, 1992; Shackelford, Schmitt, & Buss, 2005), tools of mate retention (e.g., relationship satisfaction, sexual jealousy, mate guarding; Buss, 2000, 2013; Buunk, 1981, 1982, 1991; Olderbak & Figueredo, 2009; Scelza et al., 2019), and, more recently, empirical explorations of how the mind integrates our evolved mate preferences to make actual mate choices (Conroy-Beam, 2018; Conroy-Beam & Buss, 2016a, 2016b, 2017; Conroy-Beam et al., 2019). There is comparatively less evolutionary-minded work on friend preferences (e.g., Bleske-Rechek & Buss, 2001; Eisenbruch, Grillot, & Roney, 2019; Eisenbruch & Roney, 2020; Lewis, Al-Shawaf, Conroy-Beam, Asao, & Buss, 2012; Lewis et al., 2011; Massen & Koski, 2014; Pham, Barbaro, Mogilski, & Shackelford, 2015; Shaw, DeScioli, Barakzai, & Kurzban, 2017) or tools of friend retention (e.g., Burkett, 2009; Krems, 2018; Krems, Williams, Kenrick, & Aktipis, under review; Schutzwohl, Joshi, & Abdur-Razak, n.d.; Yamaguchi, Smith, & Ohtsubo, 2015).

The present work aims to address gaps in evolutionary work on friendship, and to do so via empirically exploring the open question of

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how the mind integrates friend preferences toward making actual friend choices. Specifically, we test critical predictions about the computational design of human friendship psychology derived from a Euclidean integration hypothesis, which has proven useful for modeling how the mind integrates mate preferences in making actual mate choices (Conroy-Beam, 2018; Conroy-Beam & Buss, 2016a, 2016b, 2017).

1.1. Friendship

Friendships are a human universal and, arguably, also exist among some non-human primates (e.g., baboons, chimpanzees, rhesus and Japanese macaques) and other animals (e.g., African elephants, dolphins, hyena, horses; Brown, 1991; Hruschka, 2010; Seyfarth & Cheney, 2012; Silk, 2002).[1] There are undeniable benefits of close friendships, from getting help when in need to speedier recovery after surgery, to perhaps even greater longevity (e.g., Cacioppo et al., 2000; Chopik, 2018; Dunbar, 2016; Giles, Glonek, Luszcz, & Andrews, 2005; Holt-Lunstad, Smith, & Layton, 2010; Kanna'Iaupuni, Donato, Thompson-Colón, & Stainback, 2005; Nabi, Prestin, & So, 2013; Waxler-Morrison, Hislop, Mears, & Kan, 1991). Indeed, research focusing on Western cultures, hunter-gatherer studies, and work in non-human animals suggest that even just a few sustained friendships can enhance individual and/or offspring survival, provide status and resources, augment mating success, mitigate the negative impact of both physical and social threats, and help individuals win agonistic conflicts (e.g., Ackerman, Kenrick, & Schaller, 2007; Aktipis et al., 2018; Barakzai & Shaw, 2018; Barclay, 2013, 2016; Benenson, 2014; Campbell, 2002; David-Barrett et al., 2015; DeScioli & Kurzban, 2009, 2011; DeScioli, Kurzban, Koch, & Liben-Nowell, 2011; Dunbar, 2016; Hruschka, 2010; Lewis et al., 2011; Seyfarth & Cheney, 2012; Silk et al., 2009; Silk et al., 2010; Silk, Alberts, & Altmann, 2003; Sugiyama, 2004). Friendships also feel valuable to us; for example, people report viewing their friendships as a primary means to achieve a meaningful life (Krems, Kenrick, & Neel, 2017; Perlman & Peplau, 1981; Smith & Christakis, 2008), and Americans report valuing their friends as much as they value having money and being employed (valuing these behind only their health and families; Gallup Poll News Service, 2005).

There are also multiple and often non-competing theories regarding the ultimate benefits of friendship (e.g., DeScioli & Kurzban, 2009, 2011; Seyfarth & Cheney, 2012; Silk, 2003; Tooby & Cosmides, 1996; Trivers, 1971). Although earlier theorizing suggested that reciprocal altruism could best account for the benefits of friendship (Trivers, 1971), more recent theorizing seems to emphasize instead social support accounts. For example, Tooby and Cosmides (1996), view friendship as a means for solving the Banker's Paradox; that is, paradoxically, we are in the greatest need of investment at exactly the time when we look like the greatest credit risks and are therefore the least likely to inspire investment from strangers (e.g., when we're ill, injured, or down on our luck). Because friends have a stake in our welfare (e.g., it is unwise to let die a person who stands to help you if/when you end up in a similar predicament), having one or more close friendships may solve this problem of getting needed investment in dire times. DeScioli and Kurzban's (2009, 2011; DeScioli et al., 2011) Alliance Hypothesis suggests that friendship arises, in part, from cognitive mechanisms that function to assemble support for future conflicts. Because the disputant with the most supporters typically wins, and because humans were likely to know both disputants in small-scale ancestral groups, a psychology that favored supporting the disputant most likely to support you in prospective conflicts could ensure that you survived and thrived in future conflicts. Indeed, De Waal (2007) describes events strikingly consistent with this theorizing in his work on captive chimpanzees.

In sum, although friendships are not as obviously and/or overtly central to reproductive fitness as are mating relationships, theory and evidence suggest that having one or more close friends could conceivably have contributed to our ancestors' reproductive success.

1.1.1. The necessity of making friend choices

One might ask, then, if close friendships are so beneficial, why not have more of them? That is, why not maintain close friendships with all of the people you know? Indeed, if this were the case, then there would be no need to assess the extent to which prospective friends meets one's ideals to prioritize which friends to pursue and maintain.

Even in small-scale ancestral groups, it is likely that humans came across an array of people (e.g., Bird, Bird, Codding, & Zeanah, 2019), suggesting that individuals may have encountered a number of prospective friendship partners. One hurdle to achieving a myriad-of-close-friends ideal, however, is that friendships require time, energy, and perhaps other finite resources to attract, develop, and maintain (e.g., Dunbar, 2016; Hall, Larson, & Watts, 2011; Hallinan, 1978; Hays, 1985; Hruschka, 2010; Krems, 2018; Miritello et al., 2013; Oswald, Clark, & Kelly, 2004).

Converging lines of evidence strongly suggest that people can possess only so many close relationships, including friendships, at any one time—whether to owing to limited time in the day and/or our limited abilities to track social relationships (e.g., Dunbar, 1993, 2008; Krems, Dunbar, & Neuberg, 2016; Krems & Wilkes, 2019; Miritello et al., 2013; Roberts & Dunbar, 2011; Roberts, Dunbar, Pollet, & Kuppens, 2009; Zhou, Sornette, Hill, & Dunbar, 2005). For example, time is required to build and also to sustain individual friendships and other social relationships (Canary & Stafford, 1994; Oswald et al., 2004; Miritello et al., 2013; Nie, 2001), but time is also notably inelastic.

We should expect, then, that people carefully fill their finite friendship niches with the best possible current partners (Tooby & Cosmides, 1996). Indeed, not all prospective friends were likely to have been, or are likely to be, equally ideal, even as what constitutes an ideal partner might be dependent on factors such as life-stage, currently-active goals, and/or features of the social environment (e.g., Ackerman & Kenrick, 2009; Smith et al., 2019). For example, a person might currently desire an ideal best friend who is exceedingly loyal, intelligent, and kind but be faced with multiple prospective friends: one might be exceedingly loyal but unintelligent, whereas another might be highly intelligent but unkind, and so on.

Taken together, this work implies that human psychology should possess some means for tractably evaluating prospective friends across a possibly wide range of likely evolved friend preferences toward helping us making beneficial friend choices, or filling our finite friendship slots with the best possible friends. Rather than delve into men's and women's specific friend preferences, we focus here on how the mind might have solved the likely recurrent challenge of integrating information across dimensions regarding the extent to which prospective friends fulfill one's numerous friend preferences—ultimately to guide decisions about which friends to pursue and invest in. If prospective friends are not all created equal, and we can maintain only so many at one time, it would seem critical that the means of integration led us to pursue and invest in those friends who more closely match our friendship ideals overall and could, presumably, bolster our fitness.

Consistent with these notions that all prospective friends are not equally ideal, and that one's time, energy, and/or other resources for social relationships are finite, theories of cooperation and partner choice presume that individuals compete for access to desirable partners in a biological market (e.g., Barclay, 2016, 2013; Nesse, 2007; Noë & Hammerstein, 1994; Palombit, Cheney, & Seyfarth, 2001; but see also Apicella & Silk, 2019; Smith, Larroucau, Mabulla, & Apicella, 2018). And such markets can be further affected by the social and physical ecologies in which they exist (e.g., Adams, 2005; Gangestad & Buss, 1993; Guttentag & Secord, 1983; Maner & Ackerman, 2020; Schug, Yuki, Horikawa, & Takemura, 2009; Yamagishi & Yamagishi, 1994).

Within any one friendship market, people vary on the extent to

[1] Notably, much of this work focuses on close bonds among genetically-related conspecifics (see, e.g., Massen & Koski, 2014).

which they are deemed desirable prospective friends, and those people who have higher friend value (i.e., the most desirable prospective friends, who fall closest to prospective friends' preferences) should enjoy greater power of choice when it comes to picking their friends. That is, people with higher friend value should be more likely to successfully attract and maintain best friendships with partners who fulfill most of their friend preferences. For example these people's actual best friends should more closely resemble their ideal best friends. Furthermore, because of their power of choice on the friend market, people with higher friend value should also have both stricter ideal standards and should recruit actual best friends with higher friend value.

1.2. How do we choose our partners: the Euclidean integration hypothesis

Evaluating, comparing, and selecting a few close friends and one best friend among the array of potential partners requires a psychology able to combine information about the extent to which each prospective friend fulfills—and fails to fulfill—our friend preferences, presumably translating this information into a summary rating of each person's seeming overall friend value (Conroy-Beam, 2018). How might the mind do this?

A number of preference integration algorithms could accomplish this task (e.g., linear combination models, threshold models; Buss & Schmitt, 1993; Hitch, Hortaçsu, & Ariely, 2010; Miller & Todd, 1998; Todd, Billari, & Simão, 2005), but the model with the greatest empirical support thus far is a Euclidean integration algorithm (Conroy-Beam & Buss, 2016a, 2016b, 2017; Conroy-Beam, Goetz, & Buss, 2016). How this Euclidean algorithm works has been described at length in other work on mate choice, mate preference fulfillment, attraction to potential mates, and feelings of satisfaction in mating relationships (Conroy-Beam, 2018; Conroy-Beam & Buss, 2016b, 2017; Conroy-Beam et al., 2019; Conroy-Beam et al., 2016). Briefly, with respect to friendship, a Euclidean algorithm represents friend preferences and potential friends as points within an *n*-dimensional space, computing friend value as inversely proportional to the distance between those points. Thus, this algorithm can integrate myriad friend preferences to compute one summary estimate of a potential friend's friend value.[2] This Euclidean algorithm outperformed six possible alternatives in an agent-based model of human mate choice evolution (Conroy-Beam & Buss, 2016b). It also outperformed other models in predicting attraction to prospective mates (Conroy-Beam & Buss, 2017).

Work using this algorithm has tested—and found support for—the critical hypothesis that, should people genuinely integrate their *mating* preferences according to a Euclidean algorithm, some people in the mating market would have higher Euclidean mate value (i.e., the most desirable prospective mates, who fall closest to prospective mates' preferences), and thus enjoy greater power of choice on the mating market. That is, to the degree that preference fulfilling partners are available, people with higher Euclidean partner value should be more likely to successfully attract and maintain mating relationships with partners who fulfill most of those high partner value people's preferences, particularly those preferences that are deemed most important. For example, such high mate value people's actual friends should more closely resemble those people's ideal friends. Furthermore, because of their power of choice on the mating market, people with higher Euclidean friend value should also be empowered to set higher expectations for a potential friend–that is, they should have ideal partners higher in friend value. Finally, as a consequence of these two differences–higher friend value people setting higher standards and attracting more preference fulfilling friends–there should also exist assortative friending for mate value: higher friend value people should attract actual friends who themselves possess higher Euclidean friend value.

These three relationships are not necessarily expected to be equal in magnitude: here, fulfilling one's friend preferences is the most challenging of these three tasks, as one can only select the most preference-fulfilling of friends that may be currently available, whereas ideal standards can be set to any value, and assortative friending relies only on successfully rank ordering–but not necessarily close matching–of partner friend values. For this reason, the relationship between friend value and friend preference fulfillment may be weaker than the same relationship for ideal and actual friend value; nonetheless, on average, a Euclidean integration hypothesis predicts that all three correlations will tend to be non-zero and positive.

In the mating domain, these three primary, empirically-testable predictions derived from a Euclidean integration hypothesis were confirmed both in agent-based modeling and via human responses: People with higher Euclidean mate value (a) were better able to fulfill their mate preferences (i.e., on a range of mate preferences, their actual mates were less discrepant with their ideal mates), (b) had higher mate-value ideal partners, and (c) had higher-mate value actual partners (Conroy-Beam, 2018; Conroy-Beam et al., 2019).

1.2.1. The Euclidean Integration Hypothesis and present predictions for friendship

We test these same three predictions in the distinct domain of human friendships, with a focus on men's and women's same-sex best (and close) friendships. Specifically, we predict that people with higher Euclidean friend value:

Hypothesis 1. …are better able to fulfill their friend preferences (i.e., on a range of friend preferences, their actual friends will be less discrepant with their ideal friends).

Hypothesis 2. …will set higher standards for friends and will therefore have higher friend-value ideal friends.

Hypothesis 3. …will have higher friend-value actual friends.

Moreover, we also assess participants' own Euclidean mate value, ideal mates, and actual mates (when applicable). Doing so allows us not only to replicate prior findings with respect to the integration of partner preferences in the functionally-distinct social domain of mating (e.g., Conroy-Beam, 2018), but also to test whether one's friend or mate value is a better predictor of one's ability to secure the friends or mates that they desire. Prior literature has hypothesized a construct of "association value": the likely total fitness benefits of associating with a particular individual (Tooby & Cosmides, 1996). This total association value is thought to reflect, at least in part, contributions from distinct domains of "social value" (Sugiyama, 2005), for instance the value a person would provide if attracted as a potential mate versus as a potential friend. Whereas some characteristics that make one an ideal prospective mate might also render one an ideal prospective best friend (e.g., kindness) and vice versa, some characteristics that might render one an ideal prospective mate (e.g., being highly sexually desirable) might render one a *non-ideal* prospective best friend and vice versa. Whereas association value, mate value, and, to a lesser extent, friend value have each been the focus of much theorizing, empirical explorations of these constructs are rare—again, particularly for friend value. Indeed, given the overlapping nature of our partner preferences (e.g., Eisenbruch & Roney, 2017), a reasonable question is whether mate value and friend value actually represent distinct constructs. Thus:

Hypothesis 4. Prior findings with regard to Euclidean mate value will replicate (Conroy-Beam, 2018).

And, even as we expect that one's Euclidean friend and mate values would be highly positively correlated with one another, we explore whether:

[2] Note, however, that this algorithm does not make assumptions about the content of friend preferences, which we expect to vary on both individual and cross-cultural levels. We return to this issue in the Discussion.

Hypothesis 5a. …people's Euclidean friend value (versus mate value) will be a better predictor of those people's friend outcomes, and.

Hypothesis 5b. …people's Euclidean mate value (versus friend value) will be a better predictor of those people's mate outcomes.

We focus here specifically on same-sex best friends for several reasons. Most research suggests at least some degree of sex-segregation in friendships across animals, human cultures, and human ontogeny (e.g., Campbell, 2002; Belle, 1989; Benenson, 2014; David-Barrett et al., 2015; Kon & Losenkov, 1978; Langergraber, Mitani, & Vigilant, 2007; Munroe & Romney, 2006; but see also Lew-Levy, Boyette, Crittenden, Hewlett, & Lamb, 2019. The focus on same-sex best friendships, beyond being normative, also allows us to better explore Hypotheses 5a and b, to the extent that same-sex friendships do not overlap in functionality with typically opposite-sex mating relationships for the majority of adults (i.e., one's same-sex friends are less likely to be targeted as prospective mates than are opposite-sex friends; e.g., Lewis et al., 2011). Finally, by definition, best friendships should be as exclusive as are monogamous mating relationships—one can have only one best friend at a time—making them an ideal first analog for mating when exploring the utility of a Euclidean algorithm. In practice, however, this definitional notion may not hold for best friends (e.g., people might feel as if they have multiple best friends), even as it may for mates (e.g., Sprecher & Regan, 2002).

1.2.2. Data availability

The data and code associated with this research are available at https://osf.io/aex9b/?view_only=c201579b3f834137a965c31ed709a0f8.

1.2.3. Study overview

Studies 1 through 3 all follow the same procedure and data processing as described below. Findings for close friends are reported in the Supplementary Materials and largely echo those for best friends.

2. Study 1

2.1. Methods

2.1.1. Participants

We recruited 209 undergraduate participants (125 female, 1 no sex information; M_{age} = 18.84, SD_{age} = 1.68) from a large Southwestern university who completed the study in return for course credit. Sample size determination estimates were based on previous work (e.g., Conroy-Beam, 2018).

2.1.2. Procedure and measures

Following established work exploring Euclidean integration hypotheses (e.g., Conroy-Beam, 2018), participants were asked to complete a preference questionnaire composed of 23 bipolar adjective scales, rating themselves, their ideal and actual same-sex best friends, and romantic partners. Participants additionally reported on close friends; however, for the reasons stated above, and for simplicity, we focus on best friends in here and report detailed analyses for close friendships in the Supplementary Material. Findings are generally similar for close friends as for best friends.

After completing an unrelated first task, participants were instructed to take a minute to reset themselves before beginning the second task. Participants were first asked: "What is the first name and last initial of your SAME-SEX best friend? (If you have a best friend from home, but don't see this person on a daily basis, please tell us about your best friend from school instead.) Please DO NOT use the name of a family member or of a romantic partner here. Please write it below—using the first name and last initial (e.g., John S.)." They were also asked a similar question regarding a same-sex close friend. Their answers were then piped into questions asking about the specific best friend, by first name and first initial of surname, to ground the study in participants' real-world relationships.

Next, participants were asked to rate themselves on 23 traits/characteristics using 8-point bipolar scales (e.g., Conroy-Beam, 2018). The ends of the scales were opposing; for example, one end would read "Very physically unattractive" and the other "Very physically attractive". Traits were assembled from evolutionary and/or social psychological research on cooperation, as well as friendship and friend preferences (e.g., Aktipis et al., 2018; Benenson, 2014; Cottrell, Neuberg, & Li, 2007; David-Barrett et al., 2015; DeScioli & Kurzban, 2009, 2011; Dunbar, 2016; Lewis et al., 2011). All trait/characteristic items appeared in random order. Note that, in actuality, there is considerable overlap in traits in friends and romantic partners (e.g., kindness; Buss, 1989; Perlman et al., 2014; Lewis et al., 2011). See Appendix A for items.

Following self-ratings, participants completed these same ratings for their ideal and actual same-sex best and close friends as well as their ideal and actual current or most recent romantic partner. (Participants who had never been in a romantic relationship were instructed to skip those ratings. Eighteen participants skipped those questions. Ninety-five participants were dating in some capacity, 91 were currently single but interested in dating, and 23 were currently single and not interested in dating.) For example, participants would be told: "For the following questions, we are interested in where your best friend, [name of best friend] falls on each of these traits. Please rate the extent to which [name of best friend] possesses each of these characteristics." All trait/characteristic items appeared in random order.

Finally, participants filled out common demographic information (e.g., sex, age) and other individual difference measures (e.g., undergraduate major) that were unlinked to our hypotheses and that we did not analyze.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. All research was IRB-approved.

2.2. Data processing

We used participant preferences (for ideal best friends and mates), self, best friend, and mating ratings to calculate several Euclidean association value variables. Preference fulfillment was calculated as the Euclidean distance between preferences and association partner traits. These distances were re-scaled such that a value of 10.0 meant a perfect match between ideals and partner traits and a value of 0.0 meant the maximum possible distance through the preference space. We calculated the mate value of each participant, their mate, and their ideal mate in a two-step process. We first calculated the average mate preferences of all male participants and of all female participants. Next, we calculated the mate value of a given female (real or ideal) as the Euclidean distance between her traits and the vector of average male preferences and the mate value of males (real or ideal) as the Euclidean distance between his traits and the vector of average female preferences. These distances were transformed to the same 0.0–10.0 scale as preference fulfillment. Friend value was calculated using the same procedure for participants, their best friends, and their ideal best friends with respect to average friend preferences, with male friends compared to male preferences and female friends to female preferences.

For close friends, data were similarly processed and analyzed. Results largely echo those reported in detail below for best friends and are described in full in the Supplementary Materials available online.

2.3. Results and discussion

2.3.1. Replicating mate value and power of choice

We first sought to assess whether we could replicate prior findings concerning Euclidean mate value and power of choice on the mating market. To do this, we conducted three regressions, predicting mate

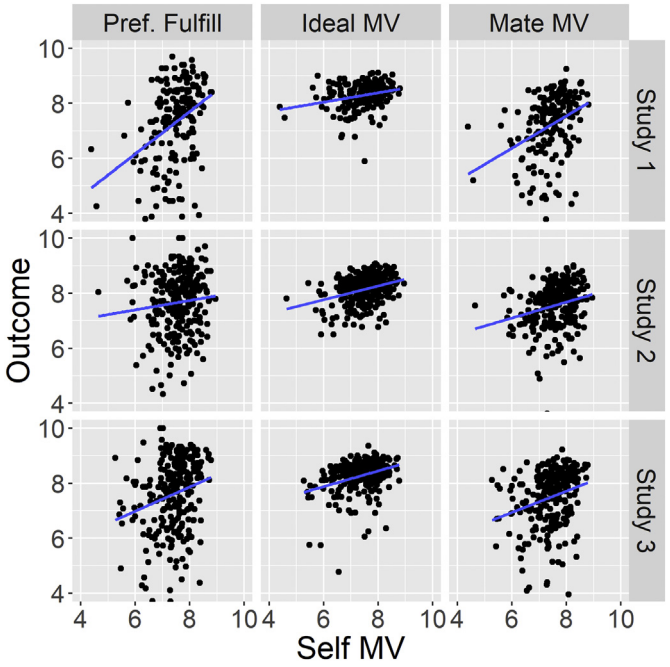

Fig. 1. Relationships between mate value and mating outcomes across Studies 1, 2, and 3. In general, across studies participant mate value tended to positively predict mate preference fulfillment, ideal partner mate value, and actual partner mate value.

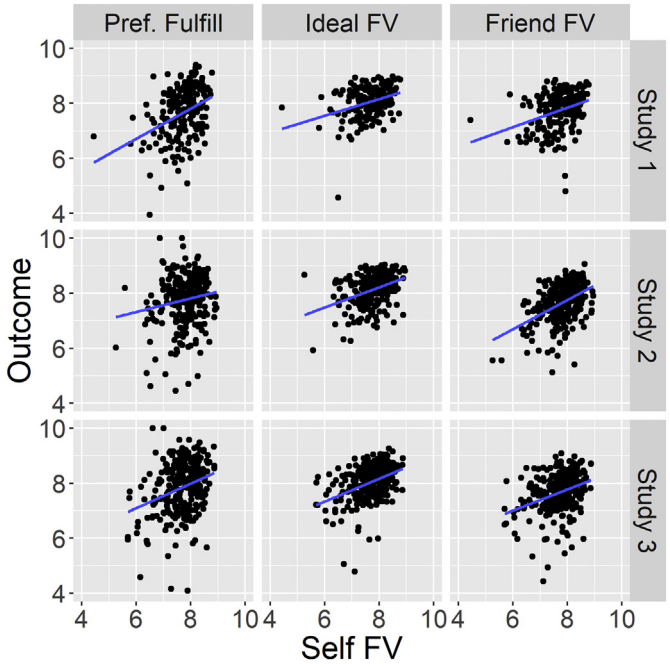

Fig. 2. Relationships between best friend value and friendship outcomes across Studies 1, 2, and 3. As for mating, in general across studies best friend value tended to positively predict friend preference fulfillment, ideal friend value, and actual best friend friend value.

preference fulfillment, ideal romantic partner mate value, and actual romantic partner mate value from participant mate value. As Fig. 1 shows, we did replicate prior findings indicating that people higher in Euclidean mate value experience greater power of choice on the mating market in that these high mate value participants tended to better fulfill their mate preferences ($b = 0.77, \beta = 0.37, p < .001$), set higher mate value ideals ($b = 0.17, \beta = 0.25, p < .001$), and tend to be paired with higher mate value partners ($b = 0.59, \beta = 0.36, p < .001$).

2.3.2. Novel exploration: friend value and power of choice

We next sought to assess whether these relationships extended to friendship—that is, do people higher in friend value experience greater power of choice on the friendship market such that they (1) attract best friends who better fulfill these higher friend value people's friend preferences, (2) set higher ideal standards in a best friend, and (3) pair with higher friend value best friends. All three of these relationships held for best friendships in this sample (Fig. 2). People higher in friend value tended to better fulfill their friend preferences (i.e., have more preference-fulfilling best friends), $b = 0.55, \beta = 0.37, p < .001$. These participants also set higher ideal standards for a friend, $b = 0.30$, $\beta = 0.35$, $p < .001$. Finally, consistent with higher friend value participants setting higher standards and better fulfilling their preferences, participants friended assortatively for friend value: higher friend value participants had higher friend value best friends, $b = 0.37, \beta = 0.33$, $p < .001$.

2.3.3. Distinguishing mate value and friend value

Given the overlapping nature of these patterns of correlation, a reasonable question is whether mate value and friend value actually represent distinct constructs. We assessed the dissociability of these constructs in two ways. First, we assessed whether mates and best friends differently corresponded to mate and friend preferences; that is, are mates truly better mates than are best friends are best friends truly better best friends than are mates? To compare these, we calculated the degree to which best friends matched mate preferences and compared this to the degree to which mates matched mate preferences in a paired *t*-test. In this sample, mates did in fact provide a better fit to mate preferences ($M = 7.23$) than did best friends ($M = 6.96$), $t(175) = -3.24$, $p = .001$, $d = 0.29$. Similarly, best friends were a stronger fit to friend preferences ($M = 7.72$) than were mates ($M = 6.87$), $t(175) = -10.87$, $p < .001$, $d = 0.93$.

Second, we used path modeling to compare the predictive power of mate value and friend value in predicting mating and friending outcomes (Fig. 3). We fit three separate path models to the data: (1) a model in which mate value predicted mating outcomes (mate preference fulfillment, ideal mate value, and romantic partner mate value) and friend value predicting friending outcomes (friend preference fulfillment, ideal friend value, and best friend friend value), (2) a model in which all six outcome variables were predicted by friend value alone, and (3) a model in which all six outcome variables were predicted by mate value alone. Consistent with the above regressions, all paths in all models were positive and significant. We compared these three models using the AIC; if mate value and friend value are dissociable constructs, the first model should provide the best fit to the data. However, if they are not separate constructs, models 2 and 3 should fit the data better than the more complex model 1. Despite its greater complexity, model 1 ($AIC = 2049.317$) provided a better fit to the data than either model 2 ($AIC = 2060.718$) or model 3 ($AIC = 2061.179$). This suggests that mate value and friend value are in fact distinct constructs that separately predict mating and friending outcomes.

3. Study 2

3.1. Methods

3.1.1. Participants

As the second task in a two-part study, we recruited 304 undergraduate participants (125 female; $M_{age} = 19.70$, $SD_{age} = 2.05$) from a large Southwestern university who completed the study in return for course credit. Sample size determination estimates were based on previous work (e.g., Conroy-Beam, 2018).

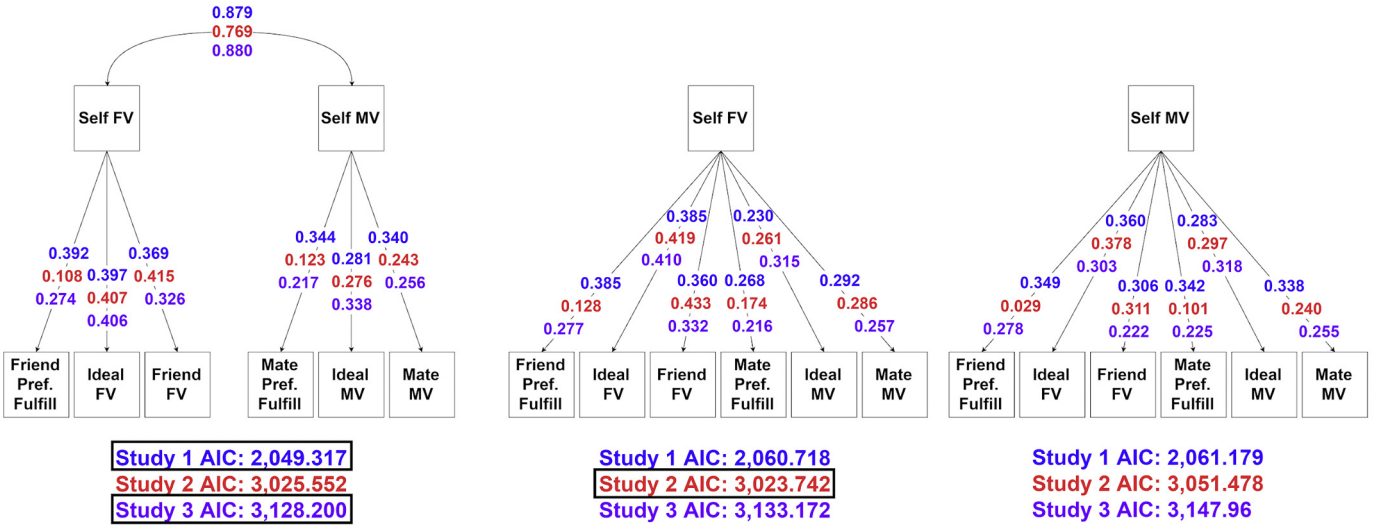

Fig. 3. Path models testing the distinguishability of friend value and mate value. In Studies 1 and 3, the best model treats best friend value and mate value as separate predictors of friendship and mating outcomes. In Study 3, the best model predicts all relationship outcomes from best friend value. Path coefficients are standardized.

3.1.2. Procedure and measures

The procedures and measures were the same as for Study 1.

3.1.3. Data Processing

Data processing proceeded identically as for Study 1.

3.2. Results and discussion

3.2.1. Replicating mate value and power of choice

Again, we first sought to assess whether we could replicate prior findings connecting mate value and power of choice on the mating market. The results were broadly similar as for Study 1 (Fig. 1). The relationship between participant mate value and mate preference fulfillment was positive but relatively weak and only marginally significant within this sample, $b = 0.17$, $\beta = 0.10$, $p = .099$. However, just as for Study 1, higher mate value participants did again set higher ideal mate value standards, $b = 0.25$, $\beta = 0.28$, $p < .001$, and tend to be paired to higher mate value partners, $b = 0.29$, $\beta = 0.24$, $p < .001$.

3.2.2. Novel exploration: friend value and power of choice

Just as for Study 1, we found evidence consistent with people higher in friend value experiencing greater power of choice on the friendship market (Fig. 2). These participants tended to have best friends who better fulfilled theseparticipants' friend preferences, $b = 0.25$, $\beta = 0.15$, $p = .013$, set higher ideal standards for a friend, $b = 0.37$, $\beta = 0.38$, $p < .001$, and have higher friend value best friends, $b = 0.53$, $\beta = 0.45$, $p < .001$.

3.2.3. Distinguishing mate value and friend value

As in Study 1, we again compared the degree to which best friends and mates matched participants mate and friend preferences, respectively. Again, mates provided a better match to mate preferences ($M = 7.66$) than did best friends ($M = 7.05$), $t(265) = -8.62$, $p < .001$, $d = 0.61$. Best friends also were better fits to friend preferences ($M = 7.76$) than were mates ($M = 7.06$), $t(265) = -11.12$, $p < .001$, $d = 0.71$. Furthermore, we again used the path modeling approach from Study 1 to compare the relative predictive power of best friend value and mate value. In this sample, the best fitting model was the one in which best friend value predicted all six outcomes (friend and mate preference fulfillment, ideal friend and mate value, and actual partner friend and mate value; $AIC = 3023.742$). The second best model was the model in which best friend value predicted friend outcomes and mate value predicted mating outcomes ($AIC = 3025.552$) followed by the model in which mate value predicted all outcomes ($AIC = 3051.478$; Fig. 3).

4. Study 3

4.1. Methods

4.1.1. Participants

We recruited 304 undergraduate participants (213 female; $M_{age} = 19.22$, $SD_{age} = 2.32$) from a Midwestern university who completed the study in return for course credit. Sample size determination estimates were based on previous work (e.g., Conroy-Beam, 2018).

4.1.2. Procedure and measures

The procedures and measures were the same as for Studies 1 and 2.

4.1.3. Data processing

Data processing proceeded identically as for Studies 1 and 2.

4.2. Results and discussion

4.2.1. Replicating mate value and power of choice

As in Studies 1 and 2, participants higher in mate value showed evidence of experiencing greater power of choice on the mating market (Fig. 1). These participants better fulfilled their mate preferences, $b = 0.44$, $\beta = 0.22$, $p < .001$, set higher mate value ideals, $b = 0.29$, $\beta = 0.33$, $p < .001$, and tended to be paired to higher mate value partners, $b = 0.39$, $\beta = 0.25$, $p < .001$.

4.2.2. Novel exploration: friend value and power of choice

Friend value predicted friending outcomes similarly to mate value within this sample (Fig. 2). Participants higher in friend value had best friends who better fulfilled these participants' friend preferences, $b = 0.45$, $\beta = 0.29$, $p < .001$; these participants set higher ideal friend standards, $b = 0.42$, $\beta = 0.42$, $p < .001$; and these participants had best friends higher in friend value, $b = 0.38$, $\beta = 0.34$, $p < .001$.

4.2.3. Distinguishing mate value and friend value

Again, mates tended to provide better matches to mate preferences ($M = 7.60$) than did best friends ($M = 6.84$), $t(252) = -8.71$, $p < .001$, $d = 0.67$. Furthermore, best friends tended to provide better matches to friend preferences ($M = 7.85$) than did mates ($M = 6.79$), t

(253) = −13.67, p < .001, d = 1.07.

Finally, we used the same path modeling approach to compare the dissociability of mate value and friend value in predicting partnership outcomes. Similar to Study 1, but unlike in Study 2, the best fitting model in this sample was the model which treated mate value and friend value as separate predictors, *AIC* = 3128.200 (Fig. 3). This model was better than the model that predicted all outcomes from best friend value alone (*AIC* = 3133.172) and the model that predicted all outcomes from mate value alone (*AIC* = 3147.96).

5. Discussion

Given that friends can affect our health, happiness, and perhaps even longevity, wisely selecting our closest friends—deciding in whom to invest our finite time as well as social and other resources—would seem to be a recurrent problem tributary to reproductive success. The present findings represent a first exploration of how people might integrate their friend preferences toward making same-sex best (and close) friend choices—and specifically whether evidence is consistent with predictions derived from a Euclidean integration hypothesis. Across three studies, we find support for several such predictions: People with higher Euclidean friend value (1) are better able to fulfill their best friend preferences (Hypothesis 1), (2) have higher friend-value ideal best friends (Hypothesis 2), and (3) have higher friend-value actual best friends (Hypothesis 3).

Previous work tested—and found support for—these critical predictions in the social domain of mating (Conroy-Beam, 2018). Here, we (4) replicated those findings, providing further support (Hypothesis 4). Additionally, we (5) provide some, albeit mixed, support for the prediction that people's Euclidean friend value (versus mate value) is a better predictor of their friend outcomes, and (Hypothesis 5a) and people's Euclidean mate value (versus friend value) is a better predictor of their mate outcomes (Hypothesis 5b). This latter finding adds to the conversation about association value (e.g., Sugiyama, 2005; Tooby & Cosmides, 1996).

Overall, the present data are consistent with similar, existing work on mating: Results suggest that a Euclidean algorithm is a good model for how multiple friend preferences are integrated to make friend choices, and thus suggest that this algorithm has important implications for understanding the dynamics of human friend selection—as it does for human mate selection (e.g., Conroy-Beam, 2018; Conroy-Beam & Buss, 2016b). Indeed, humans possess preferences for a variety of partners in addition to friend and mates, such as allies, leaders, and followers (Benenson, Markovits, Emery Thompson, & Wrangham, 2009; Grabo, Spisak, & van Vugt, 2017; Pietraszewski, 2016, 2019; Von Rueden & Van Vugt, 2015). Although people might have some strikingly different preferences across these different social partners, the Euclidean algorithm may be applied to each of these social domains. For example, researchers may wish to explore the same predictions tested here with regard to friends and mates with respect to allies, leaders, followers, and/or other social partners.

These findings also fit nicely with existing biological markets research (e.g., Noë & Hammerstein, 1994, 1995) and other extant research using economic models to understand mating and other partnering processes (e.g., Baumeister & Vohs, 2004; Hatfield, Walster, & Berscheid, 1978; Homans, 1958; Thibault & Kelley, 1959). For example, Social Exchange Theory would predict that one outcome of trying to secure the best possible partner would be assortative partnering. We would similarly expect, if people with higher friend value set higher standards for their own friends (Hypothesis 2) and can also better fulfill their friend preferences (Hypothesis 1), that people friend assortatively for Euclidean friend value. Indeed, existing data support this prediction with respect to Euclidean mate value (e.g., Conroy-Beam, 2018).

Additionally, the present work also speaks to foundational work on friendships and begin to address gaps in our understanding of relationship processes—and specifically those processes that have been well studied in the romantic relationships but much less well studied in friendships (e.g. Harris & Vazire, 2016). For example, some early friendship research found differences between people's descriptions of ideal and actual friends (La Gaipa, 1977; Weiss & Lowenthal, 1975), which led some to suggest that conclusions about actual friendships could not be based on responses to hypothetical friendships, and vice versa (e.g., Rose & Serafica, 1986). Contrary to those conclusions, we find ideal and actual best friends might seem less distinct from one another, and this especially seems to be the case for people with high friend value. This has practical implications for future work, including, for example, the computational modeling of friendship processes (e.g., Ford, 2016; Sutcliffe, Wang, & Dunbar, 2015).

5.1. Future directions and limitations

To help conduct fruitful future work on friendship, existing research on mating might provide a valuable playbook. That is, areas and/or processes that have been fruitfully studied within the domain of mating would seem especially ripe for study in the domain of friendship. Both relationship satisfaction and jealousy are considered coordinating programs that propel adaptive action, both are linked to relationship maintenance (Al-Shawaf, Conroy-Beam, Asao, & Buss, 2016; Sznycer, Cosmides, & Tooby, 2017; Tooby & Cosmides, 2008), and both have been comparatively better-studied in romantic relationships than in friendships.We focus on these to illustrate directions for future research. For example, consider that some recent mating research that suggests mate value discrepancies are a better predictor of relationship satisfaction than is mate preference fulfillment, such that people who have higher mate value than their partners were more satisfied with their relationships when their partners were less desirable than possible alternative partners (Conroy-Beam et al., 2016). Similar work might thus ask whether friend value discrepancies or friend preference fulfillment—and/or the length of the friendship, the proximity of the friends, and so on—best predict satisfaction with our friendships.

Relatedly, one might ask what other cognitive and behavioral outcomes might be linked to high Euclidean friend value (one's own and/or that of one's friend). For example, whereas friendship satisfaction might prompt us to work toward maintaining a partner's continued interest in the relationship, friendship jealousy is hypothesized to prompt us to prevent a partner's defection from the relationship and to a third party, and evidence suggests that friendship jealousy is most strongly evoked when a third party threatens one's place in valued, dyadic friendship (Burkett, 2009; Krems, 2018; Krems et al., under review). Because people with higher Euclidean friend value are perhaps both better able to replace their friends and also less replaceable, Euclidean friend value may play a notable role in feelings of friendship jealousy and in related friend-guarding behavior.

Additionally, we focused on the within-market aspect of friend choices here. To the extent that markets themselves occupy spaces with varying social and physical ecological features, one might explore whether and how such features affect those markets and perhaps also individuals' values in their respective markets. For example, consider regional differences in relational mobility; people in North America may have an easier time leaving friendships, a greater number of prospective friends to choose from, and thus might also make more friend choices over the lifespan than people in East Asia (Falk, Heine, Yuki, & Takemura, 2009; Schug et al., 2009; Schug, Yuki, & Maddux, 2010). Not only might relational mobility affect the importance of making beneficial friend choices—in areas of lower relational mobility, each choice is potentially longer-lasting and higher-stakes—but it might further affect the strength of the relationship between friend value and ability to fulfill ideal friend preferences. Indeed, whereas our Euclidean integration hypothesis expects actual friends to be similar in friend value, extant research has shown that friends in regions with lower relational mobility have lower similarity (Schug et al., 2009). Thus, just as varying sex ratios have been shown to affect individuals' mate values

within a market (Maner & Ackerman, 2020) as well as nation-level features (e.g., divorce rates, debt; Guttentag & Secord, 1983; Griskevicius et al., 2012), so too might varying ecological features impact friend value dynamics on individual and potentially national levels. The intersection of these ecological variables and a Euclidean integration algorithm seems a potentially promising area for future research.

Somewhat similarly, we have focused on the hypothesized elements of friend selection that involve active choice. Given that people select friends from those in close proximity (Nahemow & Lawton, 1975), selection of one's social niche (or ecological space) can also guide friend choice in a more passive way. Such niche selection could even account for some degree of the apparent effects of friend preferences. For example, people might select niches expected to contain promising friends. The data presented here cannot rule out such an explanation, but future studies should endeavor to separate the contributions of active choice and niche selection in determining friend selection.

Furthermore, whereas we have focused primarily on what preference dimensions are integrated into friend value evaluations, the Euclidean model tested here is relatively agnostic as to how, temporally, friend value evaluations emerge. Not all pieces of information relevant to friend value are knowable on first acquaintance, and so evaluating the value of potential friends in the absence of complete information is an important problem that friend selection psychology must solve. One possible way to solve this problem is to continually update friend evaluations as new information becomes available, similar to Miller and Todd (1998)'s proposed sequential aspiration algorithm. Alternatively, people are adept at making accurate inferences about a variety of dimensions based only on relatively brief exposures (e.g., Ambady, Hallahan, & Conner, 1999; Ambady & Rosenthal, 1992; Borkenau, Mauer, Riemann, Spinath, & Angleitner, 2004; Funder, 2012; Willis & Todorov, 2006). Human friend evaluation psychology could rely on these rapid inferences until higher quality information could be evaluable. Finally, people likely form prior beliefs regarding the distributions of friendship-relevant traits in their local environments; these priors could serve as placeholders in friend value estimations on those dimensions not yet sufficiently observed. Future work could explore how friend value estimates unfold over time to gain insight into how people evaluate potential partners in the absence of complete information.

This work is not without limitations. Present findings are based on data from college students in the United States, who are often White and educated, and live in a rich, industrialized, democratic society (Henrich, Heine, & Norenzayan, 2010). However, recent evidence suggests that this same Euclidean algorithm works well to integrate the mate preferences not only of Western college students, but also of people from around the world (i.e., 45 countries; Conroy-Beam et al., 2019). Moreover, even as we would expect to see some differences in the *content* of friend preferences across nations or cultures, we would nonetheless expect that the Euclidean algorithm would be equally useful for integrating these preferences across nations or cultures. In terms of leveraging cross-national or cross-cultural differences, the Euclidean integration hypothesis itself makes no strong assumption that there is consensus in a given culture as to what features are most desirable in prospective friends; however, this hypothesis does imply that, in nations or cultures where there is greater consensus as to which features are most desirable in prospective friends, people possessing those features should have greater power of choice.

Relatedly, we have focused exclusively on those elements of friend preferences that are consensual, or shared among members of the population. Yet preferences are also to some degree idiosyncratic. Even the preferences we have considered here have individual elements: some people, for instance, desire more intelligence in a friend than others. Furthermore, it has long been known that people tend to become friends with self-similar others (e.g. Nahemow & Lawton, 1975); friend choice will be necessarily idiosyncratic on those dimensions for which people prefer self-similar friends. Ultimately, decisions to pursue, accept, and maintain friendships are made within the minds of individuals, making individual preferences paramount to understanding choice. Even the overall friend value variables we have considered here attain power only because human preferences are non-random and idiosyncratic preferences tend to have substantial overlap. To work toward more complete models of friend choice, future studies should endeavor to model contributions to friend choice from both these individual aspects and also any consensual aspects of preferences.

The present studies were based on self-report. One concern with such self-reports is that many of our findings might be subject to self-reporting biases: for instance, people biased to perceive themselves positively might be similarly biased in perceptions of their friends and partners, generating apparent assortative mating and friending. Such bias may contribute to our assortative selection results to some degree, and the self-report data presented here cannot necessarily rule out this possibility. However, such biases are unlikely to account for our results completely, as such self-report biases cannot account for the dissociable effects of friend value and mate value. Nonetheless, to further test these same predictions, work should incorporate not only self-report, but also partner- and third-party reports.

Similarly, the present studies were also based on reports from existing friendships (and existing or most recent romantic relationships). A stronger test of the Euclidean algorithm in friendships could use preferences at one time point to predict future friend choices. Similar tests have been successful in mate choice research (e.g. Campbell, Chin, & Stanton, 2016; Gerlach, Arslan, Schultze, Reinhard, & Penke, 2019). Indeed, we expect this algorithm to have predictive utility for phenomena across the lifespan of friendships, from initial attraction to dissolution. Given the social upheaval characteristic of beginning college, incoming freshman might be an especially useful group in which to explore existing, ending, and newly beginning friendships. In doing so, future work might thus attend to the ongoing debate about the utility of ideal partner preferences for predicting relationship formation and outcomes, particularly at earlier versus later stages of relationships (e.g., Campbell & Stanton, 2014; Huang, Ledgerwood, & Eastwick, 2019).

In line with past work, we attempted to curtail the number of friend preference items (< 25). We would not argue that the friendship preference items used here are exhaustive or necessarily capture each and every salient friend preference one could imagine. Ideally, we would have employed a validated measure of friend preferences. However, we note that even as the content of those preferences might be distinct from the content used here, we would nevertheless expect that a Euclidean algorithm would be equally capable of aggregating across those preferences to produce findings similar to those presented here. Future work may build a more definitive friend preference inventory, ideally one attuned to cross-cultural similarities and differences, from which could be drawn a number of items that might better reflect friend preferences.

One other possible limitation is inherent in the Euclidean algorithm: This algorithm integrates friend preferences assuming that all are weighted equally. This is an unrealistic assumption. For example, there are well-known sex differences in friendship preferences (e.g., Benenson, 2014; David-Barrett et al., 2015; Geary, 1998), suggesting that, in reality, males might more heavily weight some preferences than females and vice versa. Following suggestions for mitigating this challenge in mating-related research, we suggest that future friendship-related research could request that participants report their ideal friends' friend value on each trait (e.g., "I would like my same-sex best friend to be a 7/7 on loyalty") as well as how important it is that the prospective friend matches that ideal on each trait (e.g., "It is 5/7 important to me that my same-sex best friend match my intelligence preference").

5.2. Conclusions

In sum, the present work speaks to how we pick our friends—an important question, given that the benefits of having even just one good friend can be potentially great, just as can be the costs of lacking friends (e.g., Dunbar, 2016). Specifically, the results support critical predictions derived from a Euclidean integration hypothesis, and represent the first work to do so in a social domain beyond mating: friendship. In doing so, this research begins to redress gaps in our knowledge and understanding of friendship. By replicating existing work on mating relationships, these data also underscore the broad utility of a Euclidean algorithm as a model for understanding how human psychology integrates multiple preferences—for distinct types of partners—toward guiding important partner choices.

Declaration of competing interest

The authors declare no competing interests.

Appendix A

Very untrustworthy: Very trustworthy.
Very unsupportive: Very supportive.
Very unkind: Very kind.
Very insecure: Very secure.
Very unsociable: Very sociable.
Very unambitious: Very ambitious.
Very unintelligent: Very intelligent.
Very pessimistic: Very optimistic.
Very closed-minded: Very open-minded.
Very needy: Very independent.
Very unfashionable dresser: Very fashionable dresser.
Very poor financial prospects: Very good financial prospects.
Very physically unattractive: Very physically attractive.
Very disloyal: Very loyal.
Very masculine: Very feminine.
Very sexually restricted (e.g., does not want and/or does not have sex with multiple partners): Very sexually unrestricted (e.g., wants to and/or does have sex with multiple partners).
Very socially isolated (e.g., talks to only his/her small group of friends):Very socially well-connected (e.g., talks to a lot of different people, is a social butterfly).
Very much prefers to listen to others talk: Very much prefers to talk.
Very much prefers to spend time with lots of different friends: Very much prefers to spend time with just you.
Very much prefers to spend time with people in groups (at least 3 + people): Very much prefers to spend time with people one-on-one.
When spending time together, very much prefers to sit together and talk about things (rather than do activities such as homework, sports, video games, shopping): When spending time together, very much prefers to do activities such as homework, sports, vi.
Very submissive: Very dominant.
Very short: Very tall.

References

Ackerman, J. M., & Kenrick, D. T. (2009). Cooperative courtship: Helping friends raise and raze relationship barriers. *Personality and Social Psychology Bulletin, 35*(10), 1285–1300.

Ackerman, J. M., Kenrick, D. T., & Schaller, M. (2007). Is friendship akin to kinship? *Evolution and Human Behavior, 28*(5), 365–374.

Adams, G. (2005). The cultural grounding of personal relationship: Enemyship in north American and west African worlds. *Journal of Personality and Social Psychology, 88*(6), 948.

Aktipis, A., Cronk, L., Alcock, J., Ayers, J. D., Baciu, C., Balliet, D., ... Sullivan, D. (2018). Understanding cooperation through fitness interdependence. *Nature Human Behaviour, 2*(7), 429.

Al-Shawaf, L., Conroy-Beam, D., Asao, K., & Buss, D. M. (2016). Human emotions: An evolutionary psychological perspective. *Emotion Review, 8*(2), 173–186.

Ambady, N., Hallahan, M., & Conner, B. (1999). Accuracy of judgments of sexual orientation from thin slices of behavior. *Journal of Personality and Social Psychology, 77*(3), 538.

Ambady, N., & Rosenthal, R. (1992). Thin slices of expressive behavior as predictors of interpersonal consequences: A meta-analysis. *Psychological Bulletin, 111*(2), 256.

Apicella, C. L., & Silk, J. B. (2019). The evolution of human cooperation. *Current Biology, 29*(11), R447–R450.

Barakzai, A., & Shaw, A. (2018). Friends without benefits: When we react negatively to helpful and generous friends. *Evolution and Human Behavior, 39*(5), 529–537.

Barclay, P. (2013). Strategies for cooperation in biological markets, especially for humans. *Evolution and Human Behavior, 34*(3), 164–175.

Barclay, P. (2016). Biological markets and the effects of partner choice on cooperation and friendship. *Current Opinion in Psychology, 7*, 33–38.

Barclay, P. (2016). Biological markets and the effects of partner choice on cooperation and friendship. *Current Opinion in Psychology, 7*, 33–38.

Baumeister, R. F., & Vohs, K. D. (2004). Sexual economics: Sex as female resource for social exchange in heterosexual interactions. *Personality and Social Psychology Review, 8*(4), 339–363.

Belle, D. (1989). Gender differences in children's social networks and supports. In D. Belle (Ed.). *Children's social networks and social supports* (pp. 173–188). New York: Wiley.

Benenson, J. F. (2014). *Warriors and worriers: The survival of the sexes.* Oxford, UK: Oxford University Press.

Benenson, J. F., Markovits, H., Emery Thompson, M., & Wrangham, R. W. (2009). Strength determines coalitional strategies in humans. *Proceedings of the Royal Society B: Biological Sciences, 276*(1667), 2589–2595.

Bird, D. W., Bird, R. B., Codding, B. F., & Zeanah, D. W. (2019). Variability in the organization and size of hunter-gatherer groups: Foragers do not live in small-scale societies. *Journal of Human Evolution, 131*, 96–108.

Bleske-Rechek, A. L., & Buss, D. M. (2001). Opposite-sex friendship: Sex differences and similarities in initiation, selection, and dissolution. *Personality and Social Psychology Bulletin, 27*(10), 1310–1323.

Borkenau, P., Mauer, N., Riemann, R., Spinath, F. M., & Angleitner, A. (2004). Thin slices of behavior as cues of personality and intelligence. *Journal of Personality and Social Psychology, 86*(4), 599.

Brown, D. E. (1991). *Human universals.* New York, NY: McGraw-Hill.

Burkett, B. N. (2009). *Friendship, jealousy, and the Banker's paradox.* Unpublished doctoral dissertationSanta Barbara, Santa Barbara, CA: University of California.

Buss, D. M. (1989). Sex differences in human mate preferences: Evolutionary hypotheses tested in 37 cultures. *Behavioral and Brain Sciences, 12*(1), 1–14.

Buss, D. M. (2000). *The dangerous passion: Why jealousy is as necessary as love and sex.* New York: Simon & Schuster.

Buss, D. M. (2013). Sexual jealousy. *Psychological Topics, 22*(2), 155–182.

Buss, D. M., & Schmitt, D. P. (1993). Sexual strategies theory: An evolutionary perspective on human mating. *Psychological Review, 100*(2), 204.

Buss, D. M., & Schmitt, D. P. (2019). Mate preferences and their behavioral manifestations. *Annual Review of Psychology, 70*, 77–110.

Buunk, B. (1981). Jealousy in sexually open marriages. *Alternative Lifestyles, 4*(3), 357–372.

Buunk, B. (1982). Anticipated sexual jealousy: Its relationship to self-esteem, dependency, and reciprocity. *Personality and Social Psychology Bulletin, 8*(2), 310–316.

Buunk, B. P. (1991). Jealousy in close relationships: An exchange theoretical perspective. In P. Salovey (Ed.). *The psychology of jealousy and envy* (pp. 148–177). New York: Guilford Press.

Cacioppo, J. T., Hawkley, L. C., Crawford, E., Ernst, J. M., Burleson, M. H., Kowalewski, R. B., et al. (2000). Loneliness and health: Potential mechanisms. *Psychosomatic Medicine, 64*, 407–417.

Campbell, A. C. (2002). *A mind of her own: The evolutionary psychology of women.* Oxford, UK: Oxford University Press.

Campbell, L., Chin, K., & Stanton, S. C. (2016). Initial evidence that individuals form new relationships with partners that more closely match their ideal preferences. *Collabra: Psychology, 2*(1), 2–7.

Campbell, L., & Stanton, S. C. (2014). The predictive validity of ideal partner preferences in relationship formation: What we know, what we don't know, and why it matters. *Social and Personality Psychology Compass, 8*(9), 485–494.

Canary, D. J., & Stafford, L. (1994). Maintaining relationships through strategic and routine interaction. *Communication and relational maintenance*. San Diego, CA: Academic Press.

Chopik, W. (2018). The unique role of friendship for health and well-being across life and around the world. *Innovation in Aging, 2*(Suppl. 1), 269.

Conroy-Beam, D. (2018). Euclidean mate value and power of choice on the mating market. *Personality and Social Psychology Bulletin, 44*(2), 252–264.

Conroy-Beam, D., & Buss, D. M. (2016a). Do mate preferences influence actual mating decisions? Evidence from computer simulations and three studies of mated couples. *Journal of Personality and Social Psychology, 111*(1), 53.

Conroy-Beam, D., & Buss, D. M. (2016b). How are mate preferences linked with actual mate selection? Tests of mate preference integration algorithms using computer simulations and actual mating couples. *PLoS One, 11*(6), e0156078.

Conroy-Beam, D., & Buss, D. M. (2017). Euclidean distances discriminatively predict short-term and long-term attraction to potential mates. *Evolution and Human Behavior, 38*(4), 442–450.

Conroy-Beam, D., Buss, D. M., Asao, K., Sorokowska, A., Sorokowski, P., ... Zupancic, M. (2019). Contrasting computation models of mate preference integration across 45 countries. *Scientific Reports, 9*(1), 1–13.

Conroy-Beam, D., Goetz, C. D., & Buss, D. M. (2016). What predicts romantic relationship satisfaction and mate retention intensity: Mate preference fulfillment or mate value

discrepancies? *Evolution and Human Behavior, 37*(6), 440–448.
Cottrell, C. A., Neuberg, S. L., & Li, N. P. (2007). What do people desire in others? A sociofunctional perspective on the importance of different valued characteristics. *Journal of Personality and Social Psychology, 92*(2), 208.
David-Barrett, T., Rotkirch, A., Carney, J., Izquierdo, I. B., Krems, J. A., Townley, D., ... Dunbar, R. I. (2015). Women favour dyadic relationships, but men prefer clubs: Cross-cultural evidence from social networking. *PLoS One, 10*(3), e0118329.
De Waal, F. B. (2007). *Chimpanzee politics: Power and sex among apes.* Baltimore: JHU Press.
DeScioli, P., & Kurzban, R. (2009). The alliance hypothesis for human friendship. *PLoS One, 4*(6), e5802.
DeScioli, P., & Kurzban, R. (2011). The company you keep: Friendship decisions from a functional perspective. In J. I. Krueger (Ed.). *Social judgment and decision making* (pp. 209–225). New York, NY: Psychology Press.
DeScioli, P., Kurzban, R., Koch, E. N., & Liben-Nowell, D. (2011). Best friends: Alliances, friend ranking, and the MySpace social network. *Perspectives on Psychological Science, 6*(1), 6–8.
Dunbar, R. I. M. (1993). Coevolution of neocortical size, group size and language in humans. *Behavioral and Brain Sciences, 16*, 681–735.
Dunbar, R. I. M. (2008). Cognitive constrains on the structure and dynamics of social networks. *Group Dynamics: Theory, Research, and Practice, 12*, 7–16.
Dunbar, R. I. M. (2016). The anatomy of friendship. *Trends in Cognitive Sciences, 22*(1), 32–51.
Eisenbruch, A. B., Grillot, R. L., & Roney, J. R. (2019). Why be generous? Tests of the partner choice and threat premium models of resource division. *Adaptive Human Behavior and Physiology,* 1–23.
Eisenbruch, A. B., & Roney, J. R. (2017). The Skillful and the stingy: Partner choice decisions and fairness intuitions suggest human adaptation for a biological market of cooperators. *Evolutionary Psychological Science, 3*(4), 364–378.
Eisenbruch, A. B., & Roney, J. R. (2020). Social taste buds: Evidence of evolved same-sex friend preferences from a policy-capturing study. *Evolutionary Psychological Science,* 1–12 accepted for publication.
Falk, C. F., Heine, S. J., Yuki, M., & Takemura, K. (2009). Why do westerners self-enhance more than east Asians? *European Journal of Personality: Published for the European Association of Personality Psychology, 23*(3), 183–203.
Ford, H. (2016). *Predicting relationship satisfaction in same and cross sex friendships.* Unpublished Doctoral Dissertation Orono, Maine: The University of Maine. Retrieved from https://digitalcommons.library.umaine.edu/etd/2475/.
Funder, D. C. (2012). Accurate personality judgment. *Current Directions in Psychological Science, 21*(3), 177–182.
Gallup Poll News Service (2005, December). Gallup Poll social series: Lifestyle. Retrieved from http://brain.gallup.com/documents/questionnaire.aspx?STUDY=P0512059&p=3.
Gangestad, S. W., & Buss, D. M. (1993). Pathogen prevalence and human mate preferences. *Ethology and Sociobiology, 14*, 89–96.
Gangestad, S. W., Haselton, M. G., & Buss, D. M. (2006). Evolutionary foundations of cultural variation: Evoked culture and mate preferences. *Psychological Inquiry, 17*(2), 75–95.
Geary, D. C. (1998). *Male, female: The evolution of human sex differences.* Washington, DC: American Psychological Association.
Gerlach, T. M., Arslan, R. C., Schultze, T., Reinhard, S. K., & Penke, L. (2019). Predictive validity and adjustment of ideal partner preferences across the transition into romantic relationships. *Journal of Personality and Social Psychology, 116*(2), 313–330.
Giles, L. C., Glonek, G. F., Luszcz, M. A., & Andrews, G. R. (2005). Effect of social networks on 10 year survival in very old Australians: The Australian longitudinal study of aging. *Journal of Epidemiology and Community Health, 59*, 574–579.
Grabo, A., Spisak, B. R., & van Vugt, M. (2017). Charisma as signal: An evolutionary perspective on charismatic leadership. *The Leadership Quarterly, 28*(4), 473–485.
Griskevicius, V., Tybur, J. M., Ackerman, J. M., Delton, A. W., Robertson, T. E., & White, A. E. (2012). The financial consequences of too many men: Sex ratio effects on saving, borrowing, and spending. *Journal of Personality and Social Psychology, 102*(1), 69.
Guttentag, M., & Secord, P. F. (1983). *Too many women? The sex ratio question.* Beverly Hills, CA: Sage.
Hall, J. A., Larson, K. A., & Watts, A. (2011). Satisfying friendship maintenance expectations: The role of friendship standards and biological sex. *Human Communication Research, 37*(4), 529–552.
Hallinan, M. T. (1978). The process of friendship formation. *Social Networks, 1*(2), 193–210.
Harris, K., & Vazire, S. (2016). On friendship development and the Big Five personality traits. *Social and Personality Psychology Compass, 10*(11), 647–667.
Hatfield, E., Walster, G. W., & Berscheid, E. (1978). *Equity: Theory and research.* Boston: Allyn and Bacon.
Hays, R. B. (1985). A longitudinal study of friendship development. *Journal of Personality and Social Psychology, 48*, 909–924.
Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences, 33*(2–3), 61–83.
Hitch, J., Hortaçsu, A., & Ariely, D. (2010). Matching and sorting in online dating. *American Economic Review, 100*, 130–163.
Holt-Lunstad, J., Smith, T. B., & Layton, J. B. (2010). Social relationships and mortality risk: A meta-analytic review. *PLoS Medicine, 7*(7), e1000316.
Homans, G. C. (1958). Social behavior as exchange. *American Journal of Sociology, 63*(6), 597–606.
Hruschka, D., Hackman, J., & Macfarlan, S. (2015). Why do humans help their friends? Proximal and ultimate hypotheses from evolutionary theory. In V. Zeigler-Hill, L. L. M. Welling, & T. K. Shackelford (Eds.). *Evolutionary perspectives on social psychology* (pp. 3–12). New York: Springer.
Hruschka, D. J. (2010). *Friendship: Development, ecology and evolution of a relationship.* Berkeley and Los Angeles, CA: University of California Press.
Huang, S. A., Ledgerwood, A., & Eastwick, P. W. (2019). How do ideal friend preferences and interaction context affect friendship formation? Evidence for a domain-general relationship initiation process. *Social Psychological and Personality Science,* 226–235 1948550619845925.
Kanna'Iaupuni, S., Donato, K., Thompson-Colón, T., & Stainback, M. (2005). Counting on Kin: Social network, social support and children health status. *Social Forces, 83*, 1137–1164.
Kenrick, D. T., & Keefe, R. C. (1992). Age preferences in mates reflect sex differences in human reproductive strategies. *Behavioral and Brain Sciences, 15*(1), 75–91.
Kon, I. S., & Losenkov, V. A. (1978). Friendship in adolescence: Values and behavior. *Journal of Marriage and the Family, 40*, 143–155.
Krems, J. A. (2018). *Friendship jealousy: An (overlooked) emotion for friendship maintenance?* Doctoral dissertationArizona State University.
Krems, J. A., Dunbar, R. I., & Neuberg, S. L. (2016). Something to talk about: Are conversation sizes constrained by mental modeling abilities? *Evolution and Human Behavior, 37*(6), 423–428.
Krems, J. A., Kenrick, D. T., & Neel, R. (2017). Individual perceptions of self-actualization: What functional motives are linked to fulfilling one's full potential? *Personality and Social Psychology Bulletin, 43*(9), 1337–1352.
Krems, J. A., & Wilkes, J. (2019). Why are conversations limited to about four people? A theoretical exploration of the conversation size constraint. *Evolution and Human Behavior,* 140–147.
Krems, J.A., Williams, K.E.G., Kenrick, D.T., & Aktipis, A. (under review). Friendship jealousy: One tool for maintaining friendships in the face of third-party threats?
La Gaipa, J. J. (1977). Testing a multidimensional approach to friendship. In S. W. Duck (Ed.). *Theory and practice in interpersonal attraction.* London & New York: Academic Press.
Langergraber, K. E., Mitani, J. C., & Vigilant, L. (2007). The limited impact of kinship on cooperation in wild chimpanzees. *Proceedings of the National Academy of Sciences, 104*(19), 7786–7790.
Lewis, D. M., Al-Shawaf, L., Conroy-Beam, D., Asao, K., & Buss, D. M. (2012). Friends with benefits II: Mating activation in opposite-sex friendships as a function of sociosexual orientation and relationship status. *Personality and Individual Differences, 53*(5), 622–628.
Lewis, D. M., Al-Shawaf, L., Russell, E. M., & Buss, D. M. (2015). Friends and happiness: An evolutionary perspective on friendship. *Friendship and Happiness* (pp. 37–57). Dordrecht: Springer.
Lewis, D. M., Conroy-Beam, D., Al-Shawaf, L., Raja, A., DeKay, T., & Buss, D. M. (2011). Friends with benefits: The evolved psychology of same-and opposite-sex friendship. *Evolutionary Psychology, 9*(4) 147470491100900407.
Lew-Levy, S., Boyette, A. H., Crittenden, A. N., Hewlett, B. S., & Lamb, M. E. (2019). Gender-typed and gender-segregated play among Tanzanian Hadza and Congolese BaYaka hunter-gatherer children and adolescents. *Child Development, 29*(4), 309–318.
Maner, J. K., & Ackerman, J. M. (2020). Ecological sex ratios and human mating. *Trends in Cognitive Sciences, 24*(2), 98–100.
Massen, J. J., & Koski, S. E. (2014). Chimps of a feather sit together: Chimpanzee friendships are based on homophily in personality. *Evolution and Human Behavior, 35*(1), 1–8.
Miller, G. F., & Todd, P. M. (1998). Mate choice turns cognitive. *Trends in Cognitive Sciences, 2*(5), 190–198.
Miritello, G., Moro, E., Lara, R., Martínez-López, R., Belchamber, J., Roberts, S. G., & Dunbar, R. I. (2013). Time as a limited resource: Communication strategy in mobile phone networks. *Social Networks, 35*(1), 89–95.
Munroe, R. L., & Romney, A. K. (2006). Gender and age differences in same-sex aggregation and social behavior: A four-culture study. *Journal of Cross-Cultural Psychology, 37*(1), 3–19.
Nabi, R. L., Prestin, A., & So, J. (2013). Facebook friends with (health) benefits? Exploring social network site use and perceptions of social support, stress, and well-being. *Cyberpsychology, Behavior and Social Networking, 16*(10), 721–727.
Nahemow, L., & Lawton, M. P. (1975). Similarity and propinquity in friendship formation. *Journal of Personality and Social Psychology, 32*(2), 205.
Nesse, R. M. (2007). Runaway social selection for displays of partner value and altruism. *Biological Theory, 2*(2), 143–155.
Nie, N. H. (2001). Sociability, interpersonal relations, and the Internet: Reconciling conflicting findings. *American Behavioral Scientist, 45*(3), 420–435.
Noë, R., & Hammerstein, P. (1994). Biological markets: Supply and demand determine the effect of partner choice in cooperation, mutualism and mating. *Behavioral Ecology and Sociobiology, 35*(1), 1–11.
Noë, R., & Hammerstein, P. (1995). Biological markets. *Trends in Ecology & Evolution, 10*(8), 336–339.
Olderbak, S., & Figueredo, A. J. (2009). Predicting romantic relationship satisfaction from life history strategy. *Personality and Individual Differences, 46*(5–6), 604–610.
Oswald, D. L., Clark, E. M., & Kelly, C. M. (2004). Friendship maintenance: An analysis of individual and dyad behaviors. *Journal of Social and Clinical Psychology, 23*(3), 413.
Palombit, R. A., Cheney, D. L., & Seyfarth, R. M. (2001). Female–female competition for male "friends" in wild chacma baboons (*Papio cynocephalus* ursinus). *Animal Behaviour, 61*(6), 1159–1171.
Perlman, D., & Peplau, L. A. (1981). Toward a social psychology of loneliness. *Personal Relationships, 3*, 31–56.
Perlman, D., Stevens, N., & Carcedo, R. J. (2014). Friendship. J. Dovidio (Vol.Eds.), P. Shaver & M. Mikulincer (Series Ed.) In J. Simpson (Ed.). *APA handbook of personality and social psychology: Vol. 2. Interpersonal relations and group processes* (pp. 463–493). Washington, DC: American Psychological Association.
Pham, M. N., Barbaro, N., Mogilski, J. K., & Shackelford, T. K. (2015). Coalitional mate

retention is correlated positively with friendship quality involving women, but negatively with male–male friendship quality. *Personality and Individual Differences, 79*, 87–90.
Pietraszewski, D. (2016). How the mind sees coalitional and group conflict: The evolutionary invariances of n-person conflict dynamics. *Evolution and Human Behavior, 37*(6), 470–480.
Pietraszewski, D. (2019). The evolution of leadership: Leadership and followership as a solution to the problem of creating and executing successful coordination and cooperation enterprises. *The Leadership Quarterly*. https://doi.org/10.1016/j.leaqua.2019.05.006 (in press).
Roberts, S. G., & Dunbar, R. I. (2011). Communication in social networks: Effects of kinship, network size, and emotional closeness. *Personal Relationships, 18*(3), 439–452.
Roberts, S. G., Dunbar, R. I., Pollet, T. V., & Kuppens, T. (2009). Exploring variation in active network size: Constraints and ego characteristics. *Social Networks, 31*(2), 138–146.
Rose, S., & Serafica, F. C. (1986). Keeping and ending casual, close and best friendships. *Journal of Social and Personal Relationships, 3*(3), 275–288.
Scelza, B. A., Prall, S. P., Blumenfield, T., Crittenden, A. N., Gurven, M., Kline, M., ... Shenk, M. K. (2019). Patterns of paternal investment predict cross-cultural variation in jealous response. *Nature Human Behaviour, 4*(1), 20–26.
Schug, J., Yuki, M., Horikawa, H., & Takemura, K. (2009). Similarity attraction and actually selecting similar others: How cross-societal differences in relational mobility affect interpersonal similarity in Japan and the USA. *Asian Journal of Social Psychology, 12*(2), 95–103.
Schug, J., Yuki, M., & Maddux, W. (2010). Relational mobility explains between-and within-culture differences in self-disclosure to close friends. *Psychological Science, 21*(10), 1471–1478.
Schutzwohl, A., Joshi, N., & Abdur-Razak, F. (in press). Competitor derogation in romantic jealousy and friendship rivalry. Evolutionary Behavioral Sciences.
Seyfarth, R. M., & Cheney, D. L. (2012). The evolutionary origins of friendship. *Annual Review of Psychology, 63*, 153–177.
Shackelford, T. K., Schmitt, D. P., & Buss, D. M. (2005). Universal dimensions of human mate preferences. *Personality and Individual Differences, 39*(2), 447–458.
Shaw, A., DeScioli, P., Barakzai, A., & Kurzban, R. (2017). Whoever is not with me is against me: The costs of neutrality among friends. *Journal of Experimental Social Psychology, 71*, 96–104.
Silk, J. (2003). Cooperation without counting: The puzzle of friendship. In P. Hammerstein (Ed.). *Genetic and cultural evolution of cooperation* (pp. 37–54). Cambridge, MA: MIT Press.
Silk, J. B. (2002). Females, food, family, and friendship. *Evolutionary Anthropology: Issues, News, and Reviews: Issues, News, and Reviews, 11*(3), 85–87.
Silk, J. B., Alberts, S. C., & Altmann, J. (2003). Social bonds of female baboons enhance infant survival. *Science, 302*(5648), 1231–1234.
Silk, J. B., Beehner, J. C., Bergman, T. J., Crockford, C., Engh, A. L., Moscovice, L. R., ... Cheney, D. L. (2009). The benefits of social capital: Close social bonds among female baboons enhance offspring survival. *Proceedings of the Royal Society of London B: Biological Sciences, 276*(1670), 3099–3104.
Silk, J. B., Beehner, J. C., Bergman, T. J., Crockford, C., Engh, A. L., Moscovice, L. R., ... Cheney, D. L. (2010). Strong and consistent social bonds enhance the longevity of female baboons. *Current Biology, 20*(15), 1359–1361.
Smith, K. M., Larroucau, T., Mabulla, I. A., & Apicella, C. L. (2018). Hunter-gatherers maintain assortativity in cooperation despite high levels of residential change and mixing. *Current Biology, 28*(19), 3152–3157.
Smith, K. P., & Christakis, N. A. (2008). Social networks and health. *Annual Review of Sociology, 34*, 405–429.
Sprecher, S., & Regan, P. C. (2002). spreLiking some things (in some people) more than others: Partner preferences in romantic relationships and friendships. *Journal of Social and Personal Relationships, 19*(4), 463–481.
Sugiyama, L. S. (2004). Illness, injury, and disability among Shiwiar forager-horticulturalists: Implications of health-risk buffering for the evolution of human life history. *American Journal of Physical Anthropology, 123*(4), 371–389.
Sugiyama, L. S. (2005). Physical attractiveness in adaptationist perspective. In D. M. Buss (Ed.). *The handbook of evolutionary psychology* (pp. 292–343). Hoboken, NJ: Wiley.
Sutcliffe, A. G., Wang, D., & Dunbar, R. I. (2015). Modelling the role of trust in social relationships. *ACM Transactions on Internet Technology (TOIT), 15*(4), 16.
Sznycer, D., Cosmides, L., & Tooby, J. (2017). Adaptationism carves emotions at their functional joints. *Psychological Inquiry, 28*(1), 56–62.
Thibault, J. W., & Kelley, H. H. (1959). *The social psychology of groups.* New York: John Wiley.
Todd, P. M., Billari, F. C., & Simão, J. (2005). Aggregate marriage patterns from individual mate-search heuristics. *Demography, 42*, 559–574.
Tooby, J., & Cosmides, L. (1996). Friendship and the banker's paradox: Other pathways to the evolution of adaptations for altruism. *Proceedings of the British Academy, 88*, 119–144.
Tooby, J., & Cosmides, L. (2008). The evolutionary psychology of the emotions and their relationship to internal regulatory variables. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.). *Handbook of emotions* (pp. 114–137). (3rd ed.). New York, NY: Guilford Press.
Trivers, R. L. (1971). The evolution of reciprocal altruism. *QUARTERLY REVIEW OF BIOLOGY, 46*, 35–57.
Von Rueden, C., & Van Vugt, M. (2015). Leadership in small-scale societies: Some implications for theory, research, and practice. *The Leadership Quarterly, 26*(6), 978–990.
Waxler-Morrison, N., Hislop, T. G., Mears, B., & Kan, L. (1991). Effects of social relationships on survival for women with breast cancer: A prospective study. *Social Science & Medicine, 33*(2), 177–183.
Weiss, L., & Lowenthal, M. F. (1975). Life-course perspectives on friendship. In M. Lowenthal, M. Thunher, & D. Chirboga (Eds.). *Four stages of life*. San Francisco, CA: Jossey-Bass.
Willis, J., & Todorov, A. (2006). First impressions: Making up your mind after a 100-ms exposure to a face. *Psychological Science, 17*(7), 592–598.
Yamagishi, T., & Yamagishi, M. (1994). Trust and commitment in the United States and Japan. *Motivation and Emotion, 18*(2), 129–166.
Yamaguchi, M., Smith, A., & Ohtsubo, Y. (2015). Commitment signals in friendship and romantic relationships. *Evolution and Human Behavior, 36*(6), 467–474.
Zhou, W. X., Sornette, D., Hill, R. A., & Dunbar, R. I. (2005). Discrete hierarchical organization of social group sizes. *Proceedings of the Royal Society of London B: Biological Sciences, 272*(1561), 439–444.