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The Company You Keep
Friendship Decisions From a Functional Perspective

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INTRODUCTION

Many researchers in social psychology and judgment and decision making focus on identifying mental mistakes and troubleshooting people's decisions. The focus on biases and errors leads researchers to underestimate the intelligence of evolved computational systems. Here we examine this issue in the context of human friendship decisions. Social psychologists have long claimed that people's friendship choices are surprisingly unintelligent, based on strategically irrelevant factors such as proximity, familiarity, similarity, or very simple reinforcement learning. However, this view is becoming increasingly untenable as research on many nonhuman species uncovers sophisticated computational control systems that intelligently regulate behavior in cooperative relationships. We argue, in sharp contrast, that human friendship is caused by complex computational machinery that performs a strategic alliance-building function.

Intricately Complex Computational Systems That Make Us Smart

Natural computational systems are strikingly intelligent. The minds of bumblebees, fiddler crabs, blue jays, and humans are highly complex computational control systems that far outperform even the most advanced artificial intelligence systems made by human engineers. Human scientists can barely fathom what it takes to build a fully functional autonomous robot that can successfully navigate landscapes, capture prey, avoid predators, fight rivals, court mates, and perform other feats routinely accomplished by animal minds.

Nevertheless, scholars have long disparaged the human mind as stupid, biased, and irrational. Francis Bacon (1620) famously decried the "idols of the mind" and complained that "the human understanding is like a false mirror" that "distorts and discolors the nature of things." For instance, Bacon observed that "the human understanding when it has once adopted an opinion … draws all things else to support and agree with it," what psychologists now call "confirmation bias" (Nickerson, 1998). Bacon also noticed that "human understanding is moved by those things most which strike and enter the mind simultaneously and suddenly, and so fill the imagination," what psychologists now call "availability bias" (Tversky & Kahneman, 1973) or related "anchoring" effects (Hastie & Dawes, 2010, pp. 71–72). Bacon's insights had applications in the development of the scientific method, which aimed to produce knowledge by circumventing human cognitive weaknesses. Similarly, many modern researchers in social psychology and judgment and decision making seek to identify cognitive errors (for example, Ariely, 2008) and with important applications, such as reducing prejudice (Aronson & Patnoe, 1997) or facilitating negotiations (Bazerman, Curhan, Moore, & Valley, 2000).

So, is the human mind smart or stupid? Psychologists have learned a lot about animal minds since Bacon's *Novum Organum*. The cognitive revolution and advances in computer science have led to the computational theory of mind: Minds are information-processing programs that are run on the hardware of the brain (Pinker, 1997). As such, minds can be described in terms of the underlying machine code—their neural implementation—or, more practically, at higher levels of abstraction in terms of the pseudocode that describes the operations performed by the system. As this theory developed, artificial intelligence researchers started trying to match the performance of animal minds on tasks such as vision and locomotion, and only then did they begin to realize the intricate functional complexity of natural computational systems (Minsky, 1985; Pinker, 1997).

Modern computer systems such as "smart" phones or autonomous robots are packed with elaborate computer programs, each consisting of labyrinthine control structures represented by up to millions of lines of code. Yet these artificial intelligence systems cannot perform many of the simplest tasks that animal minds routinely accomplish. How many programs and how many lines of code would be required to successfully operate the body of a housefly, much less a human? These observations suggest that human operating systems and their specialized applications are orders of magnitude more sophisticated and complex than what has so far been produced by the coordinated efforts of thousands of professional computer engineers. In short, the human mind is smart, dazzlingly so.

People make mistakes, of course, and there is a place for Baconian criticism and its applications in troubleshooting human decisions. After all, like any good program, animal minds have error-checking subroutines, and Bacon's insights and their lasting appeal probably stem from human error-checking abilities. Baconian scholars do not stand outside of the minds they critique, and thus their error-checking successes must be properly credited to the competencies of their "irrational" minds.

However, to take "irrationality" as the basic character of the human mind is misguided. The fundamental question for psychology is "How can intelligence emerge from nonintelligence?" (Minsky, 1985, p. 17). Unlike inanimate rocks, planets, and stars, animals are physical systems that navigate landscapes, communicate with others, and replicate their complex structures in offspring. No amount of "irrationality" or "bias" can explain the difference between an intelligent living grasshopper and an unintelligent dead grasshopper (though both are composed of the same unintelligent parts). Instead, this difference can be explained by the *functions* performed by (intact) grasshopper minds.

The focus on cognitive shortcomings causes researchers to lose sight of the big picture: *explaining* decision-making systems, not just *troubleshooting* them. This mistake can be called the "bias bias" or the "troubleshooting bias" (see also Krueger & Funder, 2004). The bias bias causes researchers to greatly underestimate the complexity and performance of human cognitive systems including our focus here, human friendship systems.

Why Do Animals Seem So Smart and People Seem So Stupid?

In the deer mouse *P. maniculatus*, females mate with multiple males and their sperm compete for fertilization inside the female's reproductive tract. To increase their swimming speed, sperm form cooperative groups of 2 to 40 individuals. The sperm "choose" their partners carefully: They sense others' genetic relatedness and select partners based on this variable, thereby gaining an evolutionary advantage (Fisher & Hoekstra, 2010). How smart!

Social psychologists like to say that humans are not very choosy about their friends. They claim that despite the feeling that friends are special, in reality we make friends with whoever just happens to be around. A leading social psychology textbook claims that "the single best predictor of whether two people will get together is physical proximity" (Brehm, Kassin, & Fein, 2002). If social psychologists are correct, then brainless mouse sperm show more intelligence than humans, choosing partners based on a relevant property rather than simple proximity.

Some of our primate relatives are particularly strategic in their social relationships. Indeed, researchers often describe primate social behavior as "Machiavellian" (Byrne & Whiten, 1988; Whiten & Byrne, 1997), drawing a comparison with the famous political strategist Niccolò Machiavelli. For example, monkeys choose friends carefully, preferring high-ranking individuals; they compete for the best partners but are sometimes willing to settle for less desirable friends; and they jealously prevent the formation of rival relationships (Harcourt, 1992; Schino, 2001; Seyfarth, 1977). These abilities are vitally important because, as Seyfarth and Cheney (2002) noted, primates "live in large groups where an individual's survival and reproductive success depends on its ability to manipulate others within a complex web of kinship and dominance relations" (p. 4141). Strategic behavior is not limited to primates. Research on dolphins, for instance, shows that "patterns of alliance affiliation among males may be more complex than are currently known for any non-human, with individuals participating in 2–3 levels of shifting alliances" (Connor, 2007, p. 587).

In contrast, many researchers describe humans as strategically inept in relationships. Friend choices are claimed to be shaped by factors as arbitrary as whether individuals live next door or two doors down (Festinger, Schachter, & Back, 1950). Other researchers have claimed that mere familiarity (Zajonc, 1968) and similarity (McPherson, Smith-Lovin, & Cook, 2001) shape human friendships. Exchange theorists (Homans, 1958) argue that friendships are based on Skinnerian reinforcement generated by the prior stream of benefits emitted by the friend. These theories paint an unflattering picture of our species' strategic sophistication. The gap between the literatures on animals and people creates a puzzle: Why do animals seem so smart and people seem so stupid?

The discrepancy might be resolved, in part, by looking closer at the questions pursued in animal and human investigations. Human research has focused on the question: What determines whether someone *becomes a friend versus remains a stranger*? Animal research has asked: What determines whether an individual becomes a *friend versus an adversary*? These are obviously very different questions. For instance, hyenas recognize all clan members individually (up to 90) and friendships are invariably formed within the clan (Holekamp, Sakai, & Lundrigan, 2007). Hyenas do not form friendships with strangers, so there is no answer to the "friend versus stranger" question. Instead, hyena cognitive systems sort through known individuals to identify promising friend prospects, and the details of these systems provide answers to the "friend versus adversary" question. The same is true of nonhuman primates, many premodern human societies, and, presumably, our hominid ancestors. Friendships with strangers might not have occurred sufficiently frequently in the ancestral world to select for specialized adaptations (Seabright, 2004). In contrast, within-group friendship formation was a recurrent adaptive problem that could plausibly have shaped cognitive mechanisms for sorting the social world into friends and foes.

Shifting focus to what determines friend versus adversary, many of the discrepant human findings dissipate. For instance, although proximity does create friends (versus strangers), it is even more likely to create enemies (Ebbesen, Kjos, & Konecni, 1976). Similarly, more than liking, familiarity breeds contempt (Norton, Frost, & Ariely, 2007). Thus, humans might not be less discriminating than monkeys or hyenas once the proper comparisons are made. If human friendship is strategic, its sophistication will not be found in how strangers become friends but in how people sort known individuals into best friends, lesser friends, and enemies.

THE STRATEGIC FUNCTION OF HUMAN FRIENDSHIP

Friendship is a human universal. People everywhere invest in nonkin, nonsexual relationships, despite costs to self, family, mates, and groups. The significance of friendship is underscored in cultures that enact friendship unions in formal ceremonies, such as "blood covenants" found widely across continents and historical periods (Černy, 1955; Evans-Pritchard, 1933; Trumbull, 1893). The social importance of friendship rites is comparable to marriage ceremonies, and they are sometimes more binding than marriage (Kiefer, 1968; Roscoe, 1923). The universality of friendship provides a clue that this behavior is caused by specialized species-typical cognitive mechanisms, and hence, that the function of these mechanisms can be productively investigated.

Potential functions of friendship are sometimes put on display in friendship rituals found in different cultures. For example, the Azande of north central Africa held friendship ceremonies in which each of the two friends consumed the other's blood and then made a ritual address enumerating friendship obligations (Evans-Pritchard, 1933). The address included clauses requiring the friend to provide aid in conflicts (even if this undermined the local authorities), protect the partner's children, share material resources, avoid adultery against the partner, and provide their daughters for marriage. The friendship rites of the Azande and other cultures can be used as one source for hypotheses about the function of friendship. Indeed, many of the functions identified in these rituals reflect common biological functions for social relationships that are also found in nonhuman species, including agonistic support, alloparenting, and food sharing.

Is Friendship Exchange?

Although there are a number of competing theories of friendship (e.g., propinquity theory), for brevity, here we focus on reciprocal altruism (Trivers, 1971), the biological framework most frequently invoked to explain friendship. On this account, human friends function as exchange partners, from whom gains in trade can be profitably extracted, provided that cheaters can be detected and avoided. Consistent with this idea, friendship rites are sometimes used to cement trade relations (Herlehy, 1984). However, while reciprocity likely explains much of human sociality (Axelrod, 1984), the application to close long-term friendships has several problems (Silk, 2003).

First, people adamantly deny that friendships are exchange relationships, regarding this very idea as taboo (Fiske & Tetlock, 1997). Instead, friendship is viewed as a communal relationship in which benefits given and received are not carefully monitored (Clark, 1984; Clark & Mills, 1979). Whether or not this folk intuition is correct, reciprocal altruism does not explain why human minds draw the exchange–communal distinction.

Second, reciprocal altruism does not explain the fact that friends help each other in catastrophes when the expected benefits from future repayment are outweighed by the costs of helping (Tooby & Cosmides, 1996). A sudden catastrophe can render an individual unable to reciprocate, and therefore, if reciprocity is the correct explanation, debilitated individuals should be abandoned by their friends. In fact, people often help friends through sickness and injury—even when repayment is unlikely—serving an insurance function that might be explicable in terms of commitment mechanisms (Tooby & Cosmides, 1996).

Third, social exchange does not explain the dark side of friendship: relational aggression such as extortion, jealousy, and exclusivity (for review, see Archer & Coyne, 2005). The earliest friendships are exclusive: preschoolers reject outsiders trying to join their play group about half of the time (reviewed in Shantz, 1987, p. 293). Many children hold friendships hostage to extort favors, for example, "I'm not your friend unless you …" (Crick & Grotpeter, 1995); they jealously prevent friends from forming close relationships with others (Parker, Low, Walker, & Gamm, 2005); they spread malicious rumors to damage others' friendships

(Owens, Shute, & Slee, 2000a, 2000b); and all of these behaviors persist despite considerable efforts to stop them (for example: www.opheliaproject.org). Relational aggression continues into adulthood (for example, in the workplace, Kaukiainen et al., 2001, and in international relations, Snyder, 1997). These phenomena are left unexplained by reciprocal altruism, which is mute on interactions beyond exchange dyads, such as sabotage of rival friendships.

THE ALLIANCE HYPOTHESIS FOR HUMAN FRIENDSHIP

Another idea is that friendships function as alliances (DeScioli, 2008; DeScioli & Kurzban, 2009). In order to evaluate this idea, we discuss how alliances work, cognitive programs for managing alliances, and evidence relevant to the alliance hypothesis.

How Alliances Work

Organisms, humans included, frequently have conflicts of interest. Sometimes these conflicts are zero-sum games in which benefits to one party are costs to the other. More often, however, disputes are non-zero-sum and mixed motive games in which agents have conflicting interests over the outcomes, but they also share a common interest in reducing the costs of fighting (for example, Hawk-Dove, Chicken, or War of Attrition games; Maynard Smith, 1982; Schelling, 1960). These conflicts have led to the evolution of both adaptations for damaging opponents and adaptations for reducing fighting costs such as signaling mechanisms (for example, caterpillars; Scott et al., 2010). Via these adaptations, different balances of opposed and shared interest lead to variation in overt hostility ranging from the bloody brawls between male elephant seals (Haley, 1994) to more subtle disagreements between mother and fetus (Haig, 1993).

A long history of conflict has armed organisms with a vast arsenal of weaponry including chemical toxins, stinging barbs, razor-sharp claws, venomous fangs, and massive antlers. The arsenal also includes intelligent computational control systems that guide the deployment of weaponry in hostile encounters. Furthermore, some organisms are able to mobilize other organisms' weaponry in disputes by interfacing with those organisms' control systems, that is, they are able to recruit allies. The capacity to recruit allies adds layers of complexity to conflicts because the outcomes depend not only on individuals' fighting abilities but also the abilities of intervening allies (Harcourt, 1992).

Alliance relationships are fundamentally different from exchange relationships. In exchange relationships, the gains an individual enjoys occur by virtue of mutually profitable transactions with others. While mutual gains in wealth can generate any number of externalities to third parties, externalities are not a necessary feature of mutually profitable exchanges.

More concretely, two people on a desert island can engage in exchange, making both participants better off while making no one worse off (i.e., creating "Pareto improvements"; Frank, 2001). Alliances are fundamentally different. When two agents form an alliance, this necessarily harms third parties: Two people on a desert island cannot form an alliance because there are no others to ally against.

The simplest form of an alliance problem is described by the Simple Majority Game (von Neumann & Morgenstern, 1944). In this game, there are three players. Each player has only one decision to make, choosing one of the other two players. If two players choose each other, an "alliance" is formed, and they get a positive payoff of one-half; the third player gets –1. (If a "cycle" occurs, with each choosing a different person, they all get zero.) In other words, any two players can team up and take 1 point from the third player and then divide the spoils, each getting ½ point.

Notice that Pareto improvements are not possible in this game. More complex alliance problems can be described by adding more players, more strategies, non-zero-sum payoffs, uncertainty, asymmetries, and so forth, but a basic constant property of these games is that helping one individual, by allying with them, necessarily makes others worse off.

In games with this type of structure, from the perspective of third parties, the relationship between two players, unlike exchange, imposes costs on the excluded individual(s). Liska (1962), in his classic treatment of alliances, captured this idea in his claim that "alliances are against, and only derivatively for, someone or something" (p. 12). Alliances are threatening to others in a way that bilateral exchange relationships are not.

This feature of alliances is apparent in international relations. One famous and clear case is the Molotov–Ribbentrop Pact in August 1939. This agreement of nonaggression between Germany and the Soviet Union was perceived as a major threat by Allied nations, much greater than the earlier commercial agreements between the two nations. The pact made the subsequent invasion of Poland much less risky for Germany because Germany no longer needed to worry about the Eastern Front. Similarly, in 1917 the United States felt threatened when Germany proposed an alliance with Mexico in the famous Zimmermann Telegram, and shortly after the telegram was made public, the United States declared war against Germany. Politically, alliances are genuinely threatening to third parties.

A key problem in alliance contexts is avoiding being on the losing side of conflicts. Frequently, the side that wins is the one with the larger number of individuals, particularly because of the tactical advantages associated with numerical superiority (Adams & Mesterton-Gibbons, 2003). To avoid being in the minority, disputants need to recruit allies to try to gain numerical superiority. Third parties, on the other hand, need to choose sides carefully by considering which side will attract more allies and ultimately prevail.

These considerations lead to a key strategy for choosing sides: *bandwagoning* (Snyder, 1997). To pursue a bandwagon strategy, individuals assess who is most likely to win the incipient conflict and support that disputant. This strategy helps individuals avoid being on the losing side of disputes. In international relations, bandwagoning can be seen in late entrants to conflicts that are nearly decided, with previously neutral nations opportunistically entering on the side that is winning. Bandwagoning tends to produce positive feedback loops, with the side that is winning gaining additional allies, making victory even more likely.

A second way to choose sides in disputes is to support the individual who is more likely to side with oneself in future conflicts—*alliance building*. Siding with these loyal individuals furthers one's long-term interests by supporting those who are likely to be one's own future supporters. When individuals use this strategy, close allies become valuable and, as a consequence, a feedback loop is generated. If you know that I will aid you in your future conflicts, then I am a very valuable ally, and you benefit by keeping me safe and free from harm. I, in turn, now value you even more, given that you are motivated to maintain my health and safety. This dynamic can be described as an "integrative spiral" (Snyder, 1984) or as alliance building.

Individuals frequently have relationships with both sides in a conflict, particularly because human social networks are locally dense (Feld, 1981). In this case, individuals will have to be able to prioritize one ally over another. That is, they need to be able to determine for all possible pairwise conflicts which side they will favor. One way to do this is to maintain a ranking of allies that prioritizes one's alliances.

If individuals maintain a friend ranking, then the set of all group members' rankings of all other group members defines a "loyalty landscape." The loyalty landscape largely determines individuals' fighting power because it specifies the distribution of support for all possible conflicts. Therefore, like in dyadic conflict (Parker, 1974), individuals stand to gain by assessing, probing, displaying, concealing, and manipulating information about the loyalty landscape.

Mechanisms for Building Alliances

Decision-making systems for managing alliances should implement good strategies. Alliances pose special problems such as choosing sides in disputes, avoiding being on the losing side, and protecting one's reliable supporters. To effectively solve these problems, individuals need cognitive systems that monitor, seek, and encode the relevant information, usefully process the information, and produce behavioral output that is strategically intelligent and advantageous.

To pursue a bandwagon strategy, individuals need systems to predict which side in a conflict will win. A variety of cues could be used. Individuals could assess size, strength, agility, and other physical attributes. They could also track histories of conflict outcomes, monitor others' fighting records, and make transitive inferences based on previous fight outcomes. They might also need to parse and represent local status hierarchies. In hyenas, for instance, individuals maintain representations of the relative status of the different members of the social group. They use this information to choose sides in conflicts, always siding with the higher status individual (Engh, Siebert, Greenberg, & Holekamp, 2005). Similar evidence shows a bandwagon strategy, based on status, in baboons (Cheney, 1977) and rhesus macaques (Chapais, 1983).

Pursuing an alliance-building strategy is even more computationally demanding. This strategy involves siding with the individual who is most likely to side with oneself in future conflicts. If Ego is choosing sides in a fight between Alpha and Bravo, then in order to choose based on which of the two will be more likely to support Ego in the future, Ego must know how Alpha and Bravo each rank their allies. Then, Ego should choose the individual who ranks Ego higher. For example, if Alpha ranks Ego as their third best ally, then Alpha will often support Ego but not against Alpha's first and second rank ally. Hence, if Bravo ranks Ego first or second, then Ego should side with Bravo because Bravo's support is more reliable.

Importantly, individuals cannot afford to wait until a fight breaks out to try to gather and process this information. To make intelligent alliance tradeoffs, individuals need to assess and probe alliance information well in advance of quickly escalating disputes. And they need to process this information and produce a representation of their relative loyalties to others, that is, a ranking of friends. Friend ranking requires collapsing across friends' many qualities to rank partners along a single dimension of one's loyalty.

Further, in order to rank friends advantageously, Ego needs to know how their friends rank Ego. This requires maintaining representations of *others' representations*, a data structure that captures other individuals' loyalties to oneself and others. This information can be used to represent the "loyalty landscape," the set of all group members' rankings of all other group members.

The computational requirements for choosing sides among allies are different from those that are required for exchange partners. The value of exchange partners derives from the possibility of reaping gains in trade, and therefore requires the ability to track information that is relevant to these gains. For instance, given the key adaptive problem of preventing being cheated in exchanges (Cosmides & Tooby, 1992), information about cheating behavior should be recorded. Also relevant to these relationships is the probability of continued interaction, since the shadow of the future is important for iterated reciprocity. In contrast, managing alliances requires computations for choosing sides in disputes such as a ranking of others. Moreover, people need to monitor their own position in others' rankings, tracking friends' friends, and if necessary to take steps toward disrupting rival relationships.

Evidence From Relational Aggression

If the alliance hypothesis is correct, then humans should be capable of monitoring and manipulating alliances to their own strategic advantage. That is, they should be capable of representing and interacting with the loyalty landscapes in which they live. One straightforward way to manipulate the loyalty landscape is to damage relationships in the local social network. By severing bonds between people in their network, individuals can change the loyalty landscape and potentially improve their strategic position, that is, their ability to recruit alliance support relative to others. We will discuss three basic socially destructive maneuvers: (1) damaging or threatening damage to one's own friendships, (2) damaging friends' other friendships, and (3) damaging friendships between one's rivals. We argue that humans show all three of these strategic maneuvers and that this evidence supports the idea that friendship is caused by cognitive mechanisms specialized for handling alliance problems.

Humans use a variety of strategies aimed at damaging relationships among people in their social networks (Archer & Coyne, 2005). However, the "relational aggression" literature has largely taken a troubleshooting perspective toward this phenomenon, missing the strategic implications. Relational aggression, like physical aggression, leads to harmful outcomes for the victims of aggression, and research in this area has focused on its social harms, often regarding aggression as pathological. However, considering behavior in the context of strategy rather than pathology can be illuminating.

One of the most basic forms of relational aggression is damaging or threatening damage to one's own friendships (reviewed by Archer & Coyne, 2005). Preschool children become angry with others and respond by covering their ears and giving the silent treatment. They also extort others by saying that they will end the friendship unless the other person does what they want. This strategy continues into adulthood in both personal friendships (Bernstein, 2010, "How to break up with a friend") and workplace relationships (Kaukiainen et al., 2001). It also appears in international politics. A newspaper reported that "China called German Chancellor Angela Merkel's meeting with the Dalai Lama a serious mistake and warned Berlin that the meeting had damaged bilateral ties"—the adult equivalent of "I won't be your friend anymore."

Some people might view Chinese leaders and other adults as childish for using these tactics, but we can alternatively view children as precocious political strategists. When a preschool child threatens "I'm not your friend anymore unless …," what does this imply about their cognitive abilities for representing the social world? They need to represent themselves as having a distinct form of relationship, a friendship, with the listener. They need to represent the counterfactual that they do not have a friendship with the listener. They need to make inferences based on this counterfactual about its consequences both for the self and for the listener and compare these consequences with the current state of affairs. They need to represent that the listener can represent actual and counterfactual states of relationships, and that the listener prefers a state of friendship over an alternative state. They need to represent that listeners will actively take steps to avoid a change in state to their friendship, and specifically that the steps they will take will be those specified in the threat. They should also estimate the probability that the threat will be successful, given the costs and benefits to the listener, and the expected benefits of success compared to the costs of failure.

This task description is just a brief high-level sketch of what would be needed to effectively deploy threats to damage one's relationships. If it is true that children effortlessly perform these threats, then how can we explain these abilities? Obviously, parents do not teach children how to exploit their peers with threats. If anything, the opposite is true: Parents suppress their children's developing Machiavellian aims because these aggressive maneuvers, however intelligent, are not very nice. Instead, these abilities might reflect reliably developing cognitive machinery specialized for managing friendships.

A second important form of relational aggression is damaging friends' other friendships. People often feel jealousy about their friends' friends, a negative experience associated with behaviors aimed at disrupting the rival relationship. Children bring a broad range of tactics to bear on the problem of rival relationships, including gossip, ridicule, name calling, rumors, and breaking confidences (Archer & Coyne, 2005; Hess & Hagen, 2002; Parker et al., 2005). And these strategies continue into adulthood in personal relationships (Forrest, Eatough, &

Shevlin, 2005) and in the workplace (Kaukiainen et al., 2001). The alliance model can explain jealousy because one's friends' alternative friendships represent potential threats. When others are placed above oneself in friends' friendship queues, one has endured the cost of losing support in potential conflicts with this interloping individual.

Friendship jealousy implies sophisticated cognitive abilities. Most obviously, it would not be possible for people to experience friendship jealousy if they were unable to track third-party relationships, that is, their friends' friendships. In the nonhuman animal literature, this cognitive ability is regarded as highly sophisticated and has been observed in only a small number of species (Connor, 2007; Engh et al., 2005; Harcourt, 1992). This only scratches the surface of the cognitive abilities required to engage in the long-term multistage campaigns that people wage to protect their close friendships from interlopers.

A third form of relational aggression is damaging friendships among one's rivals. In this case, neither of the individuals is a close friend with Ego, but Ego can improve their strategic position by weakening alliances between potential rivals. This tactic is frequently used in international relations, such as in Germany's propaganda efforts to drive wedges between England and France, or between America and the European allies in the Second World War. In nonhuman primates, studies have found that high status individuals frequently prevent lower status individuals from grooming each other in order to impede rival alliances (Harcourt, 1992). Research on schoolchildren shows that they engage in malevolent gossip and spread false rumors aimed at damaging others' friendships (Owens et al., 2000a, 2000b). Interestingly, when participants were asked why they engaged in damaging and false gossip, they could offer little insight beyond that it "created excitement." This vacuous self-report (Why is malicious gossip experienced as exciting?) suggests that any underlying strategies are consciously inaccessible.

A number of organizations have made efforts to reduce relational aggression (for example: www.opheliaproject.org). Recent high-profile cases of school violence and suicide have been attributed to the effects of social bullying, exclusion, harassment, gossip, and other forms of social aggression. However, this strategic behavior is resistant to instruction aimed at suppressing it. People are natural political strategists and they will use the tactics available to them to gain advantages. Relational aggression surely can (and should) be reduced, but it might be difficult to directly suppress. An alternative approach is to focus on the relevant social environments and the costs and benefits at stake in disputes. It might be possible to reduce the frequency and stakes of disputes, and hence to reduce the advantages associated with political maneuvering, thus indirectly curbing relational aggression.

In sum, the alliance model readily explains why close friendships have substantial amounts of conflict (Bushman & Holt-Lunstad, 2009). A study of teenage girls, for example, found that "fights over friends were part of the day-to-day life of the girls," and the school principal reported that these fights were "based upon changing allegiances between the kids, the stealing of friends" (Owens et al., 2000b, p. 37). In everyday life, people frequently denigrate relational aggression as childish, petty, or pathological. These disparaging judgments serve our interests because each of us stands to gain by reproaching and suppressing the

Machiavellian strivings of others (while hypocritically engaging in the same tactics ourselves; Kurzban, 2010). If, however, we hold aside the usual social politics and view relational aggression from an engineering perspective, then it appears as a marvel of functional design in which cognitive mechanisms strategically manipulate a complex landscape of alliances. The day that an artificial intelligence system can keep up with schoolchildren's gossip is far off indeed.

Testing the Alliance Model: Predictors of Friend Rank

The alliance model of friendship identifies the relative position that one occupies in others' queue of friends as the key variable that determines the value of each friend as an ally to oneself. In the limit, being someone else's best friend, at the top of the queue, is the most valuable form of friendship.

This idea can be contrasted with the properties that people look for in friends on alternative models. For example, on homophily or assortment models, one is attracted to those who share similar properties. Exchange models, of course, point to the value of others in terms of their willingness to exchange, their capacity to exchange, and their trustworthiness. Other models hint that friends might be chosen on the basis of popularity (Levine & Kurzban, 2006) or culturally valued abilities (Henrich & Gil-White, 2001). Models based on familiarity or proximity make similarly straightforward predictions about what variables will correlate with closeness.

These different models make different predictions. The alliance model would be undermined if people named as close friends individuals who (they perceive to) rank many other people above them in their friendship queues. Similarly, the alliance model predicts that people will fill their precious best friend slot with someone who values Ego above all (or most) others. Last, if people choose their best friends based on properties (e.g., attractiveness, intelligence, and so forth) rather than where one ranks in the friendship queue, then the alliance model is undermined. Symmetrically, homophily, popularity, and exchange models predict that best friends will be chosen on the basis of these features. For instance, if friendship is for exchange, then the underlying mechanisms should be designed to prefer those individuals who are promising exchange partners; relative rank should not matter.

We conducted investigations to test these predictions of the respective models (DeScioli & Kurzban, 2009). We used three samples: a sample of undergraduates, a sample of people in a park in Philadelphia, and an Internet sample from Amazon's "crowdsourcing" Web site, Mechanical Turk. In each sample, we asked subjects to consider their top ten friends, from best friend to tenth closest friend, and answer some questions about the properties of each of these friends, including variables central to each of the models mentioned earlier.

This procedure puts these models at risk because each model makes clear predictions about what measurements ought to relate to friendship rank. For the present purpose, our main interest is the key alliance measure: We asked people where they thought they were ranked in each of their top ten friends' queues of closest friends. For each of their friends, participants indicated how their friend would rank them among other friends, that is, their perceived rank. If this rank does not predict one's own ranking of closeness, then doubt would be cast on the alliance model. For each friend, participants also rated similarity, benefits derived from the relationship, secret sharing, caring, intelligence, attractiveness, popularity, friendship duration, frequency of contact, sex, and age.

Among all of the variables that we measured, perceived rank was the best predictor of how subjects ranked their own friends. Across the three samples, the average raw correlation of perceived rank with the participant's ranking was .71, .50, and .68, respectively. These were the highest correlations for any of the 12 variables we measured. We used logistic regression to look at the effects of each variable controlling for the other 11 variables. We observed consistent effects for perceived rank, benefits, similarity, and secret sharing. In all three samples, however, perceived rank emerged as the strongest predictor of participants' rankings of friends. This evidence shows that, consistent with an alliance-building function, participants' perceptions of how others rank them were systematically related to their representations of relative closeness to their friends.

CONCLUSION

Friendship is a crucial part of human sociality, but its biological function remains poorly understood (Silk, 2003). Progress has been impeded by two problems that plague the social sciences. First, friendship is treated as functionless, rather than as the product of evolved functional mechanisms. Second, friendship decisions have been viewed as unsophisticated, based on simple rules such as attraction to proximate individuals, which stands in stark contrast to the complexity of other species' mechanisms for social life.

Instead, we suggest that the human mind has an extraordinarily intelligent cognitive machine that operates as a political strategist guiding our friendship decisions—a computational system that is far more strategically sophisticated than the most advanced professionals in political strategy. Just as the human mind is better at solving problems in computer vision than professional computer engineers, so too is the mind better at solving problems in political strategy than professional political strategists.

If friend cognition is as intelligent as we suggest, then understanding friendship will be difficult. There might be some aspects of friendship that cannot be understood until our theoretical knowledge of strategy becomes further developed. For biomechanics, Steven Vogel (1998) pointed out that "The biomechanic usually recognizes nature's use of some neat device only when the engineer has already provided us with a model" (p. 18). Similarly, we might need better theories of alliance strategy in order to understand friendship decisions.

Friendship systems solve an adaptive problem. We think that the problem has to do with strategic dynamics, specifically how to muster support when conflicts arise and how to avoid being on the losing side in fights. We think the current evidence cuts against the theory that friendship is for economic exchange. Whatever the function of friendship systems, they should be approached without the limiting lens of the "bias bias," the tendency to characterize human cognitive systems as error prone rather than computationally sophisticated. They are the product of the same evolutionary process that generated incredible feats of engineering ranging from a hummingbird's ability to hover to a lizard's ability to walk on water to our immune system's ability to neutralize pathogens.

It is a mistake to assume that the systems designed to navigate the social world will be a great deal less sophisticated. We look forward to future research that takes human friend-making decision systems to be at least as complex as other evolved systems.

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