Why Do Humans Form Long-Term Mateships? An Evolutionary Game-Theoretic Model

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Abstract

Human long-term mating is an evolutionary mystery. Here, we suggest that evolutionary game theory provides three essential components of a good theory of long-term mating. Modeling long-term relationships as public goods games parsimoniously explains the adaptive problems long-term mating solved, identifies the novel adaptive problems long-term mating posed, and provides testable predictions about the evolved psychological solutions to these adaptive problems. We apply this framework to three adaptive problems long-term mating may have solved and generate novel predictions about psychological mechanisms evolved in response. Next, we apply the public goods framework to understand the adaptive problems produced by long-term mating. From these adaptive problems, we derive novel predictions about the psychology responsible for (1) selection and attraction of romantic partners, (2) evaluation of long-term

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relationships, and (3) strategic behavior within relationships. We propose that public goods modeling synthesizes adaptive problems at all stages of long-term mating—from their initiation through their maintenance and through their dissolution. This model provides an important tool for understanding the evolution and complex psychology of long-term committed mating.

1. INTRODUCTION

Pair-bonding species such as humans represent just 3% of all mammals (Kleiman, 1977). We are the only great apes that engage in long-term pair-bonding. Chimpanzees and bonobos, our closest relatives, mate promiscuously and do not form long-term bonds (Dixson, 1998). The fitness costs of long-term mating account for its rarity. Committing to one or a few mates risks the large opportunity cost of forgoing other beneficial mating opportunities (Hurtado & Hill, 1992). Long-term mating males face paternity uncertainty because of internal female fertilization and gestation, which creates the adaptive problem of investing resources in the children of same-sex rivals (Buss, 2000). Women who commit to one man often fail to secure the best possible genes for their children, in part because men with good-genes indicators are often reluctant to commit to one woman and because women's own mate value limits the quality of the long-term mate they are able to attract. Males and females both risk significant costs at the hands of jealous or controlling long-term partners in the form of physical violence, emotional abuse, or manipulation, adding yet another cost to long-term committed mating (Buss & Duntley, 2011). Despite its costs and infrequency in nature, long-term mating is a major mode of mating in all human cultures (Jankowiak & Fischer, 1992). Human long-term mating psychology is therefore an important part of human life as well as our species' unique evolutionary trajectory.

The evolution of our long-term mating psychology must have been driven by selection pressures that were at least somewhat specific to humans. Once a long-term mating psychology began to evolve, it would have generated an additional suite of novel adaptive problems, resulting in further selection for new psychological solutions. A complete understanding of human long-term mating psychology ideally includes an understanding of (1) the selection pressures that favored long-term mating psychology in humans initially, (2) the additional selection pressures that long-term mating, once formed, exposed our ancestors to, and (3) the psychological machinery these selection pressures produced. We propose a conceptual

framework that integrates these essential components by modeling mating relationships as public goods games. This framework provides precise predictions about the long-term mating adaptations humans evolved to solve adaptive problems. Public goods modeling also connects research on long-term mating psychology to the origins of long-term mating itself. This novel connection provides a more complete understanding of the problems encountered within long-term relationships and the possible psychological solutions. By identifying and uniting the adaptive problems long-term mating solved and posed, public goods analysis yields a thorough and productive picture of human long-term mating psychology.

2. PART I: ADAPTIVE PROBLEMS AND EVOLUTIONARY GAME-THEORETIC MODELS

Adaptive problems are recurrent challenges from the physical, biotic, social, or internal environment—such as extremes of temperature, parasites, hostile conspecifics, or caloric needs—whose solution increases reproduction (Cosmides & Tooby, 1995). Knowledge of the adaptive problems a species has faced is essential because natural selection, by definition, favors traits that solve adaptive problems. Researchers can identify previously unrealized adaptive problems a species faces in social relationships with evolutionary game-theoretic modeling. Here, we review the relation between adaptive problems and their evolved solutions, as well as the ways in which evolutionary game-theoretic models identify adaptive problems solved and faced in long-term mating.

2.1. Adaptive problems and adaptations

Natural selection is the only known causal process capable of creating psychological and physiological systems that are complex, efficient, and reliable in solving adaptive problems (Tooby & Cosmides, 1990; Williams, 1966). Traits that solve adaptive problems increase the reproduction of their own genetic bases and thus actively contribute to their representation in future generations. This positive feedback process is more likely to favor traits that efficiently solve adaptive problems than are chance or random processes. The set of possible human traits is infinitely large—much larger than the delimited set of traits that could, in principle, solve adaptive problems. Unguided chance evolution, due to processes such as random mutations and genetic drift, picks randomly from this array and consequently almost never produces complexly functional traits; it tends instead to produce

nonfunctional or even fitness-detrimental alternatives. Complex design for solving adaptive problems is therefore the hallmark of evolution by selection (Williams, 1966).

Researchers can exploit the fact that selection favors adaptive problem solving traits to generate predictions about the nature of human psychology. If a psychological mechanism is an adaptation, it must have demonstrable features that would have made it an improbably good solution to an adaptive challenge humans recurrently faced throughout their evolutionary history (Pinker, 2003). The more design features a mechanism has, the more likely that mechanism was the product of natural selection rather than serendipity. Hypothesizing that a psychological mechanism solves some candidate adaptive problem therefore provides predictions about features that psychological mechanism must have: those that coordinate improbably well with the design specs of the problem like a key in a lock. Confirming these predictions also allows conclusions about a psychological mechanism's ultimate origins.

Consider the adaptive problem of thermoregulation. A psychological or physiological mechanism *could* have any of a vast array of design features: a bright color pattern; a computational system for tracking social exchanges; an aerofoil shape for producing lift. From the array of possible features, only a tiny subset is capable in principle of solving adaptive problems in thermoregulation: for instance, producing and exposing watery secretions to body surfaces in order to shed heat through evaporative cooling. If a researcher hypothesizes the existence of thermoregulatory adaptations (e.g., sweat glands in humans; panting in dogs), that researcher immediately knows to look for mechanisms that embody this small subset of efficient thermoregulation design features. Thus, correctly identifying an adaptive problem dramatically reduces hypotheses about candidate evolved solutions, physiological or psychological.

Jealousy in long-term relationships provides a useful psychological example. Buss, Larsen, Westen, and Semmelroth (1992) recognized that the sexes confronted distinct adaptive problems in the face of infidelity. When it comes to offspring, women are certain of their maternity but men face the threat of genetic cuckoldry and investing substantial resources in the offspring of rivals. Women, on the other hand, incur large reproductive costs relative to men in the form of internal fertilization, gestation, and breast feeding. For women more than men, a partner's infidelity thus risks the diversion of essential investment away from the woman and toward another woman and her children. Buss et al. (1992) thus proposed that men and women would have

sex-differentiated jealousy adaptations. This hypothesis predicts that male jealousy adaptations are more oriented toward detecting and preventing *sexual* infidelities whereas female jealousy adaptations are designed to prevent *emotional* infidelities. The hypothesis of sex-differentiated jealousy adaptations is derived by considering the sex-differentiated adaptive problems jealousy evolved to solve for women and men in long-term mateships.

Decades of research strongly support this hypothesis. More women than men find imagined emotional infidelities more upsetting than imagined sexual infidelities; more men than women are upset by sexual infidelities (Buss et al., 1992). This finding has been replicated across cultures from Brazil (de Souza, Verderane, Taira, & Otta, 2006); to Germany, the Netherlands, Korea, and Japan (Buunk, Angleitner, Oubaid, & Buss, 1996); to the sexually egalitarian Norway (Kennair, Nordeide, Andreassen, Strønen, & Pallesen, 2011). Sex-differentiated jealousy is detectable both in self-reports of jealousy as well as physiological indicators of upset (Pietrzak, Laird, Stevens, & Thompson, 2002) and brain imaging (Takahashi et al., 2006). Kuhle (2011) found naturalistic sex-differentiated responses from partners on the television show "Cheaters," which depicts real-life infidelities. For reviews of this research and the downstream consequences of jealousy, which include specialized memory biases, mate guarding biases, as well as aggression and homicide, see Buss (2000, 2013).

2.2. An evolutionary game-theoretic model of long-term relationships

Understanding the adaptive problems solved and generated by long-term mating is vital to understanding the design of human long-term mating psychology. A comprehensive theory of human long-term mating ideally includes a means to identify which original adaptive problems long-term mating solved as well as the array of novel adaptive problems humans faced as a consequence of long-term mating. Evolutionary game-theoretic models provide such a tool.

Game-theoretic models are mathematical models of strategic decision making. Models take the form of "games." Each game allows a certain number of players who have specific information and behavioral decisions available to them; the outcomes of these decisions to each player depend on the decisions of other players. The "prisoner's dilemma" is a well-studied example. The prisoner's dilemma is named after the familiar scenario of police officers separately interrogating co-conspirators in a crime. Two players have a choice of cooperating with or defecting on their partners. Neither

player may know the other's choice, but players know that cooperating pays small benefits to each whereas a player who defects on their cooperating partner gets a large benefit while their partner pays a large cost. These payouts mean that the optimal decision for either player is to defect even when both players defecting results in costs to each. Game-theoretic models aid the study of behavior and decision making because even simple games can mimic important properties of real-life situations.

Evolutionary game theory models the decisions of organisms over evolutionary time. Payoffs in evolutionary games occur in the currency of fitness. Natural selection favors adaptations that, in these games, use environmental information to guide organisms toward high fitness payoff decisions. Therefore, by providing researchers with a payout matrix of fitness costs and benefits, evolutionary game-theoretic models aid in discovering adaptive problems and adaptations. Evolutionary game-theoretic modeling has been essential to the study of cooperation and conflict in social relationships, including the psychology of cheater detection in dyadic alliance formation (Cosmides, 1989), solutions to the problem of free-riders in coalitional cooperation (Tooby, Cosmides, & Price, 2006), strategies for fighting versus ceding resources in antagonistic social conflicts (Delton, Krasnow, Cosmides, & Tooby, 2011; Maynard Smith & Price, 1973), and even the evolution of moral virtues (Curry, 2007).

A long-term mating relationship can be conceptualized as a special type of cooperative social relationship that simultaneously shares some features with other cooperative relationships, yet possesses many distinctive features. Just as for other enduring cooperative relationships, evolutionary game-theoretic analysis provides a cogent framework for identifying how long-term mating psychology would have solved important adaptive problems. Specifically, we propose that analyzing long-term relationships as public goods games with fitness as the invested resource expands our understanding of adaptive problems faced in long-term relationships.

2.2.1 Long-term relationships modeled as public goods games

In public goods games, players invest resources into a shared pool; resources in the pool grow and are then shared between the players. Figure 1 depicts how long-term relationships can be modeled as public goods games. Long-term relationships have shared pools where partners independently invest resources into opportunities that pay fitness dividends to both. Shared offspring are the cardinal example of a shared pool. Each partner invests resources in offspring shared by the couple. These resources are finite: each

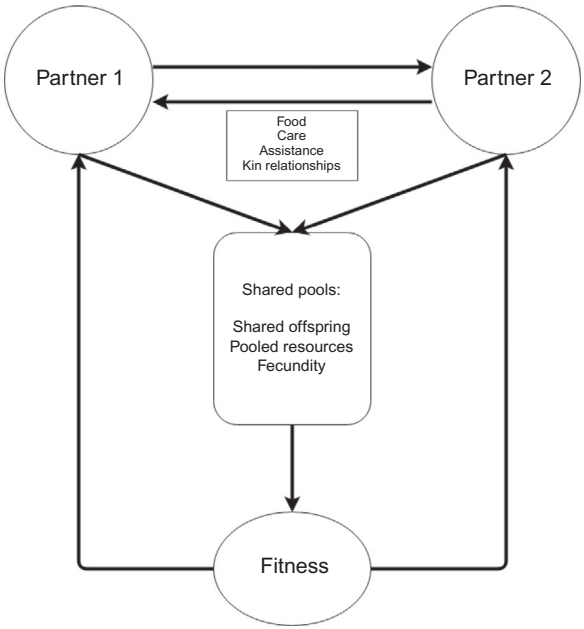

Figure 1 Long-term relationships as viewed as public goods games. In addition to exchanging benefits directly, partners invest finite resources in shared pools which return shared fitness dividends.

parent only has limited food to share with offspring, limited time to safeguard them, and limited resources to support them. Resources invested in shared pools necessarily come with opportunity costs. Those resources could have gone toward other fitness-enhancing opportunities such as investing in one's caloric intake for growth or maintenance, investing in kin, or investing in alternative mates. Long-term maters are therefore investing some of their fitness when they invest in shared pools like offspring.

Just as in public goods games, fitness investments in long-term relationship pools typically grow and pay fitness dividends shared between long-term partners. For instance, investing in offspring allows them to grow healthfully, to reach reproductive maturity, to enhance their mate value, to attract mates, and ultimately to reproduce. Because shared offspring are equally genetically related to both parents, any fitness gains from investment in mutually produced offspring are shared between long-term partners. Long-term committed partners therefore reap the fitness benefits of both their own investments *and* those of their partners.

Beyond shared offspring, partners invest in shared pools such as merged financial resources or shared social networks. Pooling resources buffers both partners against harsh times. Gaining social relationships offers new outlets for beneficial cooperation. These and other joint fitness opportunities act as joint pools for long-term relationships by paying long-term partners shared fitness benefits in exchange for initial fitness costs. The public good dynamics of long-term relationships generated the adaptive problems that shaped long-term mating psychology. Through growth and sharing of investment, the public goods nature of long-term mating allowed participants to receive more resources from relationships than they invested—"gains in trade" in the language of economics. These resource gains allowed long-term mating to solve adaptive problems throughout human evolution.

In Section 3, we review these adaptive problems, focusing on how a public goods games framework generates predictions about the psychology evolved to solve them. Public goods dynamics would also have created many novel adaptive problems. Solving these newly created adaptive problems required the evolution of further specialized long-term mating psychology. We review these adaptive problems in the final section (see Table 1 for a summary of adaptive problems solved and posed by long-term mating).

Table 1 Adaptive problems related to long-term (LT) mating

Adaptive problems LT mating evolved to solve	New adaptive problems created by LT mating
Acquiring parental investment in shared offspring of sufficient magnitude by: – Reducing conflicts of interest – Supporting mutual facilitation of investment – Supporting complementarity of investment	Selecting beneficial mates
Acquiring parental investment in shared offspring efficiently	Attracting beneficial mates
Acquiring parental investment in shared offspring of the necessary type	Avoiding costly mates
Enhancing female fecundity	Monitoring current relationships – Tracking partner–self mate value discrepancies – Tracking partner–potential partner mate value discrepancies
	Identifying and avoiding romantic free-riders
	Punishing romantic free-riders
	Behaving in response to relationship evaluations

3. PART II: LONG-TERM MATING AS THE SOLUTION TO MULTIPLE ADAPTIVE PROBLEMS

The evolutionary incentive for human pair-bonding has proven elusive to researchers in biology, anthropology, and psychology (Geary, 2000; Henrich, Boyd, & Richerson, 2012; Kaplan, Hill, Hurtado, & Lancaster, 2001; Key & Aiello, 2000). Many theories offer plausible origins for human long-term mating but not precise predictions about long-term mating psychology. Embedding these theories in a public goods model identifies how long-term mating could have solved adaptive problems in the mating domain. A public goods model thus lends extant theories new predictive power and gives researchers a means to empirically explore and compare theories of the origin of human long-term mating.

3.1. Long-term mating and the magnitude of parental investment

One crucial adaptive problem solved by long-term mating centers on investing in offspring (Quinlan & Quinlan, 2007). Compared to other great apes, human infants demand extensive care from their parents (Kaplan, Hill, Lancaster, & Hurtado, 2000). Children across societies consume more calories than they produce until at least the age of 15, relatively late compared to chimps' emergence as net producers as early as 5 years of age. Furthermore, parental investment extends long after offspring begin their reproductive careers through assistance such as grandparental investment (Hrdy, 1999). Finally, humans often raise several offspring concurrently, compounding the investment needed at any time. These extreme demands seem impossible to meet alone. Indeed, in some traditional cultures, a child whose father dies puts such a strain on the resources of a group that sometimes a decision is made to kill a child whose only source of support is the mother (Hill & Hurtado, 1996). Theorists have suggested that parental assistance from bonded long-term mates was the key solution to the extraordinary resource demands of human children.

The importance of parental assistance is clear given the heavy demands of human parental investment. However, investment in children also can come from close kin, older offspring, or other cooperation partners (Sear & Coall, 2011). For the demands of parental investment to have spurred the evolution of long-term mating rather than other cooperative relationships, long-term mates must have been able to provide special benefits in rearing offspring.

Public goods analysis of long-term mating identifies three key factors that allow mates to be particularly good sources of parental investment: reduced conflicts of interest, mutual facilitation of investment, and complementarity of investments.

3.1.1 Reduced conflicts of interest

All individuals have multiple fitness vehicles, including offspring or other genetically related kin, into which they can potentially invest their finite resources. These vehicles are sometimes shared. However, the fitness consequences of investing in these vehicles differ across people. A mother gains more from investment in her .50 genetically related son than she does from investment in her .25 genetically related niece or nephew. This fact creates conflicts of interest: a mother will prefer investing in her own son but her siblings will attempt to pull her investment toward her nieces and nephews. Conflicts of reproductive interests exist between all individuals, but some factors reduce their severity. The shared pools of long-term mateships comprise one unusual and special case in which conflicts of interest are dramatically reduced.

Because parents have an equal genetic stake in shared offspring (assuming 100% paternity certainty), investment in offspring is a public goods game and offspring become a shared resource pool. When offspring are a shared pool, a person benefits directly by investing in their partner's offspring because those offspring are also their own. The large benefits mates receive from investing in offspring lower the conflict of interest between partners and increase their potential investment. On the other hand, unmated cooperation partners are more easily tempted to invest in alternative fitness opportunities: parents are often best off spreading investment across siblings; siblings enhance their own fitness by investing in their offspring; friends attend to their own kin and offspring. We hypothesize that natural selection favored adaptations that specially motivate seeking parental investment from long-term mates because long-term mates are more motivated to invest substantially in offspring than other potential cooperation partners.

Because long-term partners served as important sources of parental investment, public goods modeling of long-term mating suggests that long-term mating psychology includes adaptations that not only *seek* high-investing partners, but also separate adaptations that *monitor* parental investments of long-term partners. In selecting long-term partners, long-term mating adaptations must motivate acquiring information about the parenting abilities of potential mates and produce attraction in proportion to

these assessed parenting abilities. Once long-term mateships formed, efficient solution of problems of parental investment required adaptations that monitored and compared investment needed with investment supplied. If actual investment and required investment differ, these adaptations must motivate emotions and behaviors that can address the discrepancies. Examples include adaptations producing anger and punitive behaviors toward a partner's underinvestment, which would demotivate under-investment by increasing its fitness costs to partners. Joy and rewarding behaviors toward a partner's investment that meets or exceeds expectations could motivate continuance by delivering greater fitness benefits to these generous partners. If one's partner cannot or will not meet requisite needs, compensatory parental investment of one's own may be a necessary last resort.

3.1.2 Mutual facilitation of investment

Partners' shared genetic stake in offspring means that anything that enhances offspring fitness also enhances the fitness of both parents, just as pool gains in public goods games are shared equally between players. Because of the "shared fate" involved in long-term coupling in offspring production, each partner becomes uniquely irreplaceable to the other (Tooby & Cosmides, 1996). The gains from the shared pool dry up if one partner becomes debilitated or dies. Barriers to investment faced by one partner are consequently fitness threats to the other partner; both partners benefit if these barriers are removed.

Several factors limited the investment individuals could provide to their offspring. Illness, for example, requires a parent to suspend investing in offspring in order to dedicate resources to restoring their own health. When one partner becomes ill, both parents can invest: one providing metabolic and immune function resources and the other providing food, care, medicine, and nurturance until health returns. Each partner reaps fitness dividends as a result of the ill partner returning to health and parental investment. Additionally, just as partners sometimes sacrifice for one another's careers, investing in a partner's status ascension or assisting them in increasing their earning potential ultimately pays fitness dividends to both partners if new benefits are channeled toward shared offspring.

Adaptations capable of identifying recurrent barriers to partner investment and motivating behaviors to remove them—such as nursing partners back to health or facilitating their status ascension—benefit both partners by allowing greater total investment in shared offspring. This mutual support from long-term partners would have opened up greater opportunities for

parental investment than are available alone, efficiently solving the problem of investing in demanding human offspring.

3.1.3 Complementarity of investment

The public goods nature of long-term relationships also creates complementarity between the investments of parents into offspring. Consider two long-term partners with a finite amount of food available to share. One route for each parent to enhance their fitness is to share this food with their offspring. If a child is likely to survive, sharing food with them can help them grow healthily, making them more productive and desirable later in life.

Sharing food with offspring, however, is wasteful if the offspring are unlikely to survive long enough to reproduce; each parent is better off sharing resources with kin, friends, or coalition members. This situation changes if either partner does choose to invest some of their food, increasing the offspring's probability of survival. With the offspring more likely to live to reproductive age, the potential payoff of investing changes for the other partner. Through public goods dynamics, investments by one partner can increase the benefits of investing to the other.

Adaptations could capitalize on this complementarity by promoting increased parental investment in the context of investing long-term mateships. These adaptations need to track partner parental investment by directing attention and memory toward instances of partner care. As partners invested more in offspring, the benefits of investing in return increase. Adaptations responsible for generating parental investment next need design features that calibrate personal investment to estimates of partner investment.

Complementarity could lead to a continual upscaling of parental investment from both partners. A parent sharing food with their child can induce further investment from their partner due to increased benefits of investing. If the partner's new investment sufficiently changes the payoffs of further food sharing, for instance by dramatically increasing offsprings' probability of survival, it motivates the other partner to invest still more. At some point, further investment will no longer benefit one partner and the upscaling of investment will cease. Both mates should end at equilibrium where further investment in shared pools pays no more fitness benefits. The key point is that, due to complementarity of investment, this equilibrium point where further investment no longer pays fitness benefits will be higher than the investment level either mate could reach were they forced to invest in offspring alone. Through the public goods nature of long-term relationships, the parental investment available to one's offspring can spiral up much in

the way Tooby and Cosmides (1996) proposed occurs for commitment in human friendships. The complementarity of investment created by public goods dynamics allows for even small initial investments to continually ratchet up, ultimately facilitating more investment from either partner than would be possible alone.

3.2. Economic partnerships and the nature of parental investment

Some parental investment resources are more easily acquired by one sex than by the other. Hunting in particular is a more efficient activity for males than it is for females (Kaplan et al., 2001). Males on average have more of the strength and stamina required for large game hunting than do females. Pregnancy and lactation also make hunting more dangerous and energetically inefficient for females. Theorists have therefore proposed that long-term mating evolved not merely to solve the problem of acquiring sufficient resources to invest in offspring but also to more efficiently provide offspring the right kinds of investment (Kaplan et al., 2001).

According to this theory, males and females who formed economic partnerships characterized by exchange of foraged goods were better off than those who attempted to meet all of their needs alone. In such partnerships, each partner focused on the type of foraging in which they were most efficient and received goods from other foraging methods through exchange. Both partners thus acquired the nutrition they and their offspring needed with time and energy to spare for investment in other fitness-enhancing opportunities. These economic partnerships also allow for *risk pooling*. In times when meat was scarce, males relied on foraged goods supplied by their long-term mates; males in turn supplied meat and fish to their mates when foraged goods came short.

In principle, economic partnerships could be formed between any members of the opposite or same sex rather than committed long-term mates. It is the public goods nature of long-term relationships, and the particular value of shared offspring as a shared pool, that makes long-term mates particularly valuable economic partners. As long as exchanged goods were invested in part in shared offspring, economic partnerships between males and females contribute to solving problems both in acquiring nutrients and in investing sufficiently and efficiently in offspring. People with adaptations that direct attention and memory toward cues of how their partners are using exchanged resources would outcompete those who formed economic partnerships indifferent to, or oblivious about, their partners' use of their

exchanged goods. When one detects that shared resources are not being directed toward offspring or other shared pools, other adaptations must act to redirect investment by, for instance, producing anger and punishment to lower the fitness benefits of misdirecting one's investments.

3.2.1 Sex differences in invested resources

Public goods analysis also suggests that men and women will focus on exchanging resources that their partners are inefficient at acquiring. Economic partnerships between long-term partners benefit each individually by freeing up time and energy otherwise spent on inefficient resource acquisition. These benefits are not merely personal, however, because partners share fate through their shared offspring. More efficient foraging by one partner allows them more time and energy to invest in offspring. Because offspring act as shared pools in public goods contexts, these additional investments provide fitness benefits to both long-term partners.

Both partners in long-term relationships are therefore best off if they not only invest in shared pools but also if they invest in a way that relieves burdens on their partners. We hypothesize natural selection favored adaptations that motivated individuals to share with their partners both (1) resources that they are highly efficient at acquiring and (2) resources that their partners are highly inefficient at acquiring. Public goods analysis predicts that males have adaptations that specifically motivate them to acquire and share those resources that females are least efficient at acquiring and females to acquire and share those resources that males are least efficient at acquiring.

3.3. Long-term mateships and female fecundity

Female fecundity is an important constraint on the fitness of both males and females. Female fecundity is more restricted than male fecundity and acts as a major limiting factor in total fertility rates. Moreover, fecundity in females, much more so than in males, is extraordinarily responsive to environmental context (Ellison, 2003). Cues that suggest lowered probabilities of successful reproduction, such as food scarcities, cause a temporarily suppression of fecundity as a means of delaying reproduction until the environment is more suitable. This flexibility comes at a cost. Suppressing fecundity prevents untimely reproduction, but by forcing delays in offspring production it also necessarily limits the number of offspring females and their partners can produce across their reproductive careers. Females with resources that allowed them to weather these environmental threats would maintain fecundity for

longer and experience higher rates of reproduction than females forced to suppress fecundity. Because male reproduction rate is limited primarily by the availability of fecund females, males would also have benefited from interventions able to enhance female fecundity. In short, long-term mating may have evolved, in part, as a cooperative partnership designed to enhance female fecundity (Key & Aiello, 2000).

Incorporating this hypothesis into a public goods model of long-term relationships yields the theoretically novel consequence that female fecundity, contrary to intuition that it remains primarily women's concern, is actually part of a relationship's shared pool. Male and female partners can separately invest some of their resources into enhancing the female partner's fecundity at some cost to themselves. Because female fecundity is highly responsive to energetic factors, men and women could have enhanced the women's fecundity through increased provisioning of food or by lowering her workload. These investments carry costs: loss of food for offspring, increased energetic burdens on those who take over female workloads, or leaving key tasks incomplete or unfinished. But to the extent that these investments improve fecundity, these investments grow and provide returns that are shared by both partners in the form of higher fertility. This framework makes several predictions about long-term mating psychology.

If long-term mating did evolve, in part, as a solution to the problem of enhancing female fecundity, the benefits of forming long-term mateships should be linked to overcoming the key recurrent impediments to female fecundity. Variability in fecundity differs across and within populations. Because women have adaptations to suppress fecundity during periods of relative caloric scarcity (Ellison, 2003), women's fecundity fluctuates more frequently in conditions where the availability of energy is highly variable. Forming long-term mateships in these environments could decrease fluctuations in fecundity, allowing more time available for reproduction and more chances for partners to capitalize on their reproductive years. Fecundity is more constant in environments where resource availability is less variable, decreasing the need for the compensatory effects of long-term mating. Adaptations sensitive to these environmental factors could promote long-term mating behavior when its benefits were greatest. This hypothesis predicts that adaptations will track cues suggesting one's environment is or has become more variable—for instance, environmental changes demanding more reliance on high-risk/high-yield hunted goods rather than stable foraged goods—and in response increase (1) motivations to mate romantically and (2) attraction to suitable long-term mates.

Public goods analysis also suggests that long-term mating adaptations include adaptations designed to track constraints on female fecundity. For instance, a key variable is net caloric intake or "energy balance" (Lager & Ellison, 1990). Fecundity is suppressed as energy balance grows increasingly negative. Solving the adaptive problem of enhancing female fecundity requires male investment motivations sensitive to cues to partner energy balance, including local energy availability. We hypothesize women also have adaptations to seek more investment from their partners when energy balance decreases. These adaptations could acquire investment by increasing *desire* for partner investment and increasing *anger* and *punishment* at partner noninvestment under conditions of low energy balance.

Enhancing women's fecundity additionally requires adaptations that alleviate the specific constraints women confront. High workload suppresses fecundity independently of energy balance (Jasieńska & Ellison, 1998). Investing additional food is inefficient when partner fecundity is suppressed due to high workload; food sharing is a more profitable investment when partner fecundity is suppressed due to energy balance. Men thus need adaptations that are able to (1) recognize the fecundity constraints women are facing, (2) recognize investments that alleviate those particular constraints, and (3) motivate investment of those resources relative to others. Women should have complementary adaptations that motivate seeking the constraint-specific investments as well as adaptations that specially shunt those invested resources toward enhancing fecundity.

Finally, because women's fecundity begins to decline by mid-30s and wanes at menopause, these fecundity-adaptations would no longer activate later in life—a specific age-graded empirical prediction afforded by this model. In modern environments, with trends toward later marriage and marriage after divorce, the deactivation of these adaptations in older couples may contribute to dramatic differences in long-term relationships between older and younger couples. Males mated to older partners may show decreased fecundity-linked investment concerns, for instance, decreased concern about partner workloads. In contrast, men's adaptations for these functions should remain activated if they are mated, or re-mated, with younger fertile women. In women, adaptations that motivate seeking compensatory investments may deactivate postmenopausally. These women, relative to their younger counterparts, should experience lesser long-term mating motivations or investment seeking desires in response to increases in workload or restrictions in energy availability.

3.4. The benefits of long-term mating

Table 2 reviews the adaptive problems discussed here and the hypothesized design features of their psychological solutions. Although the precise benefits that allowed for the *initial* evolution of pair-bonding may never be known with certainty, a public goods perspective shows how humans could have capitalized on the many potential benefits of long-term mating. We expect some combination of the adaptive problems reviewed here laid the foundation for a long-term mating psychology. Additionally, both women and men could have benefited from a long-term mating psychology because committed mates serve as highly valuable and sometimes irreplaceable cooperation partners. Long-term mating offered expanded cooperation networks through their mates' extended kin. Sharing resources with

Table 2 Long-term relationships as the solution to multiple adaptive problems

Adaptive problem domain	Hypothesized design features of psychological solutions
Acquiring sufficient parental investment	– Attend, remember, and monitor partner investment – Punish partner underinvestment – Reward appropriate or overinvestment – Identify barriers that may inhibit partner investment – Provide support to overcome barriers (e.g., nursing if ill, help ascending status hierarchies) – Calibrate investment in response to partner's investment
Acquiring different types of investment	– Punish partner misdirected investment – Motivate sharing resources an individual can acquire efficiently – Motivate sharing resources that a partner acquires inefficiently
Maintaining female fecundity	– Track environmental resource variability – Males: Track female partner energy balance, workload, and local energy availability – Males: Invest resources specific to constraints on female fecundity – Males: Invest in female fecundity depending on constraints (e.g., alleviate workload vs. increase food sharing) – Females: Seek investment when energy balance decreases – Females: Anger and punishment in response to insufficient investment in energy balance

long-term mates pools risk against times of environmental harshness when resources are scarce. Finally, offspring who share parents are more closely related than those who do not, allowing for the evolution of adaptations that promote more extensive inter-sibling cooperation due to a greater confluence of fitness interests. Increased sibling cooperation increases the well-being of offspring themselves and thereby the fitness benefits to parents of romantically bonding over the long term (Daly, Salmon, & Wilson, 1997).

Men and women also gained sex-differentiated benefits from long-term mating. Investing long-term partners offered women greater access to resources than available otherwise (Buss, 2003). Women also gained protection by bonding with formidable mates (Wilson & Mesnick, 1997). By offering long-term commitment, men received fitness benefits by gaining access to higher quality mates and by securing more or less continuous access to their mate's reproductive resources (Buss, 2003). Men gained fitness dividends in the form of increased probability of paternity; short-term mating strategies carry no comparable paternity increases. Indeed, failure to solve the paternity uncertainty problem is likely one of the key reasons that the evolution of long-term mating is so rare among mammals. Forming long-term relationships also increased a man's social status (Buss, 2012). Analysis of how these costs and benefits accrued in the context of a public goods model clarifies the adaptive problems long-term mateships have solved; these adaptive problems, in turn, give clues as to the origins and design features of human long-term mating psychology.

4. PART III: NOVEL ADAPTIVE PROBLEMS CREATED BY LONG-TERM RELATIONSHIPS

Engaging in long-term mateships solved some adaptive problems but also exposed humans to new adaptive problems. Many of these challenges required solutions for long-term mating relationships to evolve, just as reciprocal alliances require solution of the cheater-detection problem (Cosmides, 1989) and coalition formation requires solution of the free-rider problem (Tooby et al., 2006). As a result, much of human long-term mating psychology is composed of adaptations to the problems uniquely posed by forming long-term mating relationships, reducing their costs, increasing their efficiency, and extracting maximal benefits from the array such relationships afford (see Table 3 for a review). Some have already been targets of research on the psychology of long-term mating (e.g., Buss & Shackelford, 1997;

Table 3 Novel adaptive problems created by long-term relationships

Adaptive problem domain	Examples of hypothesized design features of psychological mechanisms that provide solutions
Selecting and attracting long-term mates	– Identify and pursue mates with whom public good pooling is maximally beneficial – Identify and avoid mates with whom long-term relationships would entail significant fitness cost
Monitoring and evaluating relationships	– Calculate mate value discrepancies between partner and potential mates – Seek increased contact with alternative mates to assess accuracy of comparisons between partner and potential mates – Calculate mate value discrepancies between partner and self – Calculate the probability mate value can be leveraged to enhance fitness – Detect romantic free-riders – Calculate welfare-trade-off ratios between self and partner
Responding to relationship evaluations	– Relationship satisfaction as an internal regulatory variable motivating cognitive, emotional, and behavioral responses – Linking relationship satisfaction and relationship assessments in proportion to the utility of behavior – Calibrating personal investment to the magnitude of partner investment

Gonzaga & Haselton, 2008; Sugiyama, 2005). A public goods approach to long-term mating parsimoniously unites these well-studied problems with novel problems in a single theoretical framework.

4.1. Mate selection and attraction

The first set of challenges in long-term mating concern the selection and attraction of long-term partners. Long-term mating generates problems of selecting and acquiring mates with whom public goods games were maximally beneficial and minimally costly. These adaptive problems have been the focus of an impressive body of research on mate preferences and mate attraction strategies (e.g., Buss, 1989; Buss & Schmitt, 1993; Feinberg, DeBruine, Jones, & Little, 2008; Gangestad & Scheyd, 2005;

Gangestad & Thornhill, 1997; Kenrick & Keefe, 1992; Kenrick, Sadalla, Groth, & Trost, 1990; Marlowe, 2004; Rhodes, 2006; Singh, 1993; Sugiyama, 2005). Given the extensive focus on this research area in the extant literature and the existence of more thorough reviews (e.g., Sugiyama, 2005), we review these adaptive problems only briefly.

4.1.1 Selecting beneficial mates

The first problem encountered in long-term mating is to *identify and pursue mates with whom public goods pooling is maximally beneficial*. One solution entails selecting mates who are dispositionally inclined to be excellent cooperative partners. The premium that women and men both place on potential mates who are "kind and understanding" reflects this solution (Buss, 2003).

Partners with access to many resources, or who are skilled resource accruers, can invest heavily in shared pots to one's own benefit. This is especially valuable to women, who bear larger reproductive costs of offspring production. Hence, the premium that women place on a man's resource acquisition abilities, such as on hunting skills in hunter-gatherer societies, supplies one key solution (Hill & Hurtado, 1996; Symons, 1979). *Committed* mates who are *able* and *willing* to invest their acquired resources are excellent candidate contributors to shared pools. After all, some men with excellent resource accrual abilities are unwilling or unable to invest them in a particular woman over the long term. From men's perspective, mates with high reproductive value are able to produce more offspring and thus more shared pools from which partners reap benefits.

Human standards of attractiveness map strongly onto cues recurrently associated with beneficial mateships (for a review, see Sugiyama, 2005). Financial resources, willingness to commit, and parenting potential are highly desirable to females when selecting long-term mates (Buss & Schmitt, 1993). Cues to health and fecundity are perceived as physically attractive, especially by men (Jasieńska, Ziomkiewicz, Ellison, Lipson, & Thune, 2004; Sugiyama, 2005). The most comprehensive study of the evolutionary design of human mate preferences remains Buss's (1989) cross-cultural study of preferences of over 10–1000 participants from 37 cultures around the world. Across cultures, mate preferences were sex-differentiated as predicted: men placed more value than women on youth and physical attractiveness; women more than men valued age and good financial prospects. Importantly, the sexes equally valued traits like kindness, intelligence, good health, and pleasing dispositions.

4.1.2 Avoiding costly mates

Long-term maters also needed to *identify and avoid individuals with whom long-term mateships entailed substantial fitness costs*. Costly liabilities are one source of fitness costs from potential long-term partners. These include "deal breakers" that women and men find highly undesirable in long-term mates, such as inclinations toward being mean, cruel, lazy, undependable, emotionally unstable, unintelligent, or disease-ridden (Buss, 2003). Individuals who have jealous former mates carry with them risks of injury or other forms of cost-infliction. Children from previous mateships are major liabilities. They siphon substantial investment, with benefits going to enhance the fitness of rivals.

Investing in some mates is costly because of properties of those mates themselves. For example, investment in mates who tend to be unfaithful puts one's valuable resources at risk of being diverted toward others. These investments not only fail to return benefits, but also result in the provisioning of benefits to rivals. Jealous, aggressive, or controlling mates use cost-inflicting tactics like violence, derogation, or stalking in attempt to manipulate their partner's investments in ways that are costly to their victims (Buss & Duntley, 2011; Duntley & Buss, 2012).

Solving the adaptive problem of selecting beneficial long-term partners required adaptations able to identify and demotivate attraction to mates that impose these fitness costs—a problem made difficult by the fact that potential mates sometime conceal the costs they carry (Haselton, Buss, Oubaid, & Angleitner, 2005). Mate preferences research strongly supports this hypothesis. Potential partners who are unkind toward oneself, but not necessarily toward others, are indeed found undesirable (Lukaszewski & Roney, 2010). Cues to unfaithfulness, such as a history of promiscuity, decrease perceptions of attractiveness for long-term mates (Buss & Schmitt, 1993).

4.2. Monitoring and evaluating relationships

After forming relationships, long-term maters faced challenges of evaluating and monitoring their long-term relationships—adaptive problems that have been largely ignored by relationship researchers from all theoretical perspectives. Selected partners may turn out on closer inspection to have exaggerated the benefits a long-term relationship with them, such as misleading about earning potential or existing commitments (Haselton et al., 2005). Similarly, previously unknown or even intentionally hidden costs often are not revealed until after mate selection. Circumstances can also change

after long-term relationships are formed, elevating the costs (e.g., partner starts drinking alcohol heavily) or decreasing the benefits (e.g., partner loses job). Initial estimates of partner value may turn out to be inaccurate. Long-term maters therefore have faced a problem in evaluating whether benefits expected are actually delivered or whether unexpected costs have accrued. At the same time, long-term maters need to ensure that their relationship's pools—and not other opportunities—remained the best use of their limited resources.

4.2.1 Mate preferences and relationship tracking adaptations

Humans in all cultures do apply sex-differentiated preferences in *selecting mates*, such as the priority placed on economic resources, youth, and physical attractiveness (Buss, 1989). These preferences are also useful in ongoing mateships by contributing to the assessment of the net benefits provided by one's long-term partner—their value as a public goods partner. However, mate preferences are most usefully applied in assessing a partner's value *relative to oneself or to other potential partners*. Even a partner who provides many benefits is not highly valuable if there are other available partners willing and able to provide more benefits. Similarly, a lackluster partner might be better than no partner if they are the best of available alternatives (and a partner who inflicts costs net of benefits, of course, is worse than no partner at all). Solving adaptive problems of evaluating relationship quality requires calculating two psychological assessments: (1) mate value discrepancies between partner and potential mates and (2) mate value discrepancies between partner and self (Buss, 2000).

4.2.2 Partner–potential mate value discrepancies

Adaptations responsible for calculating discrepancies in mate value between current and potential partners need to determine (1) the costs one pays and benefits one receives by sharing pools with one's partner, (2) the costs and benefits likely provided by alternative partners, (3) the costs of dissolving one's relationship, (4) the probability that one is be able to acquire alternative partners, and (5) the start-up costs of acquiring replacement partners. Such computations incorporate mate preferences not as much by asking "Does my partner match my preferences?" but rather as "How much does my partner match my preferences relative to the other partners I could likely attract?"

Evidence that one's current mate is a highly valuable relationship partner relative to alternatives indicates that a given relationship is worth

maintaining through mate retention tactics (Buss & Shackelford, 1997). This information is essential in solving challenges pertaining to the regulation of behaviors, emotions, and cognitions whose fitness benefits depended on the value of one's relationship.

Complicating this computation is the greater degree of *uncertainty* associated with calculating positions on preferred characteristics of the lesser-known alternative partners compared with better-known current mates. The asymmetric uncertainty levels between current and potential alternative mates may activate *error management biases* and *strategies designed to reduce uncertainty*, some of which are likely to be sex-differentiated (Haselton & Buss, 2000). Investigating a mate who turns out to be undesirable may be less costly than missing out on a very desirable mate. In order to avoid this error, we hypothesize that selection favored inference adaptations that assume potential alternative mates are especially desirable in order to motivate information acquisition. Seeking increased contact with alternative mates, overtly or surreptitiously, reduces uncertainty on unknown traits to render current versus alternative comparisons more accurate. Men's greater evolved desire for sexual variety (e.g., Symons, 1979) suggests men might err more than women in attributing high positive values for desired traits for which little information is known.

4.2.3 Partner–self mate value discrepancies

Value discrepancies between one's mate and oneself create a second suite of problems. Partners with higher mate value are likely to have better alternative mating opportunities. These partners are, on average, more likely to defect or engage in infidelity with these higher value partners (Buss, 2000). Mechanisms that tracked partner–self mate value discrepancies therefore aid in solving the problems of preventing defection or infidelity. Jealousy adaptations, for example, are expected to track cues of partner–self mate value discrepancy (Buss, 2000; Buss & Shackelford, 1997). On the other hand, an individual whose mate value is higher than their partner's typically has greater leverage in extracting benefits.

Partner–self mate value discrepancies should affect behavior and decision making in circumstances in which relatively greater mate value is employable to attract a better partner or when it is usable to extract additional benefits from their current partner. We predict that psychological mechanisms that assess this discrepancy also calculate the probability that a person can leverage their mate value to enhance fitness. One index of this probability is the difference between one's own partner–potential partner discrepancy

and one's partner's. A partner who is more able to attract alternative partners has more *implementable value*: they can leverage their value into more desirable alternative partners. Feelings of extra-pair attraction will be increased in proportion to a person's relative implementable value alongside attempts to extract additional benefits from current partners.

4.2.4 The problem of romantic free-riders

Public goods analysis suggests the aversion of romantic free-riders was an important adaptive problem in the evaluation of long-term relationships. Romantic free-riders are partners who attempt to reap the benefits of long-term mateships without paying their costs. In public goods contexts, because pool gains are split regardless of contribution, free-riders prosper by not contributing resources but nonetheless taking pool gains (Tooby et al., 2006). Individuals who invest in relationship pools minimally reap whatever benefits come from a relationship while also still reserving their resources to invest in other desirable opportunities.

Investing heavily in pools shared with romantic free-riders is detrimental to fitness for two reasons. First, because free-riders under-invest in relationships, fitness gains from relationships are minimized and resources invested in long-term mateships yield minimal returns. Allocating resources to other domains is more beneficial than investing in pools shared with free-riders. And because many of the fitness gains from long-term mateships are shared, investing in pools shared with free-riders delivers benefits to romantic free-riders at cost to contributing partners. Free-riders consequently enjoy higher fitness than cooperators and genes that promote free-riding will ultimately eliminate cooperation genes from the population (Tooby et al., 2006). Therefore, in order for long-term mating to have evolved, humans must have solved the problem of detecting romantic free-riding—an important challenge uniquely illuminated by the current public goods model of long-term mating, and one not generated by any previous theory of long-term mating.

4.2.5 Detecting romantic free-riders

Solving the adaptive problem of free-riders in long-term mateships requires adaptations designed to detect which mates are free-riders. Free-riders under-invest resources such as time and energy spent on shared goals, foraged goods (e.g., from gathering or hunting), financial resources spent on the partner, or care of the couples' offspring. Adaptations that direct attention

and memory toward partner contribution of these and similar resources are one means of identifying free-riding mates.

However, absolute level of a partner's investment is not necessarily the sole or a key cue to free-riding. We hypothesize that *welfare tradeoff ratios* are crucial. A welfare tradeoff ratio is the ratio of the extent to which a party values your welfare relative to the extent that they value their own (Sell, Tooby, & Cosmides, 2009). A person with another-skewed welfare tradeoff ratio is willing to sacrifice personal benefit to deliver even small benefits to their partner. Welfare tradeoff ratios are known to be important in the regulation of anger (Sell et al., 2009), but have not yet been applied to long-term mating relationships.

Welfare tradeoff ratios are independent of the magnitude of actual investment. Saintly figures are exemplars of other-skewed welfare tradeoff ratios because they deliver benefits to others through great personal sacrifice. These individuals are often remembered more fondly than wealthy philanthropists who give much to others but nonetheless give small portions of what they have. A partner who commits few resources but has another-skewed welfare tradeoff ratio is a poor-quality mate but not necessarily a free-rider. However, a partner who invests a large amount of resources but has a self-skewed welfare tradeoff ratio is a free-rider because they are unwilling to pay costs in exchange for the benefits of their relationship. The adaptive course of action differs in these two mateships. Coercing a more other-skewed welfare tradeoff ratio would provide additional resources out of the free-riding mate but not from the poor-quality mate. Separately, committing to the poor-quality mate, but not the free-rider, is beneficial if the mate's total resources are expected to increase.

The pool investments of a long-term mate must also be compared to the extent to which potential alternative mates are able and willing to invest. Long-term mateships with low-quality mates—such as mates who are ill, infertile, selfish, or dangerous—provide fewer benefits than mating with high-quality mates. These individuals should inspire low levels of investment from the potential mate pool in general relative to their high-quality peers. Low levels of investment from a given mate thus do not necessarily signify free-riding if no potential mates offer investment. Under these circumstances, continually defecting from free-riders does not provide as many benefits as accepting investment that is available. Individuals must have some estimate of the level of investment they can expect from potential mates in general and identify free-riders as individuals willing to invest less than what is attainable for them.

4.2.6 Punishing romantic free-riders

Once romantic free-riding mates are detected, solutions require taking action that make free-riding less beneficial. Punishment is one tactic known to be effective in preventing free-riding in the context of coalitions (Tooby et al., 2006). One form of punishment is coercive manipulation of romantic free-riders. Adaptations that applied costs to under-investing partners change the cost–benefit calculus of investment for free-riders. By withholding investment in relationships, forcing free-riders to expend resources, damaging free-riders' reputations, or applying other costs, punishment adaptations render free-riding too costly to be worthwhile. Selection would then favor abandoning a free-riding strategy and shifting to investing in one's long-term mateships.

A second form of punishment is defection. Adaptations that motivated individuals to abandon mates detected to be free-riders prevent exploitation by free-riders. Individuals with these adaptations invest their resources only in pools shared by cooperators, avoiding the loss of valuable resources. As these adaptations spread and potential victims decrease in number, the benefits of free-riding decline.

4.3. Infidelity, defection, and relationship maintenance

Assessments of long-term relationships could only have contributed to solving adaptive problems if these assessments motivated relationship decisions and behaviors in appropriate contexts. The public goods processes of relationships are dynamic because partners, pools, and circumstances change over time. Navigating shifting conditions requires flexible, environmentally sensitive production of relationship actions such as defection, infidelity, changes in one's own investment strategy, and attempts to induce or prevent these behaviors by one's partner. Successful long-term mating requires a means to track, synthesize, and summarize ever-changing relationship evaluations and calibrate behaviors to these summaries.

4.3.1 The functions of relationship satisfaction

Once individuals solve the adaptive problem of evaluating the value of their long-term relationships, they must put these evaluations to use. This requires adaptations capable of capturing and summarizing the many assessments of long-term relationships produced by other adaptations into "internal regulatory variables" (Tooby, Cosmides, Sell, Lieberman, & Sznycer, 2008). Internal regulatory variables are summary variables that convey adaptively relevant information to behavior-producing adaptations. Relationship

behaviors, including defection, infidelity, and maintenance, can be calibrated to relationship contexts by motivating and demotivating behaviors in proportion to the value of internal regulatory variables. We hypothesize that relationship satisfaction is one such variable.

4.3.2 Relationship satisfaction as an internal regulatory variable

Relationship-tracking mechanisms produce numerous evaluations. Evaluations include estimates of the fitness benefits of staying in relationship such as having a supportive partner during difficult times; resource benefits that come with sharing provisioning responsibilities; and benefits associated with increased parental care of offspring. Evaluations also include estimating the costs of long-term mateships. A needy, high maintenance, or cost-inflicting partner absorbs resources—they inflict a high *relationship load* (Buss, 2006), preventing resources from being distributed toward oneself, offspring, kin, or coalition members. An abusive partner inflicts costly emotional and physical damage. Benefits of leaving a relationship are increased when there are a greater number of other high-quality potential mates and the probability of acquiring a better relationship is high. Leaving a relationship is more costly if competitors stand a better chance at attracting available mates.

All of these relationship assessments have important consequences for the benefits of relationship behaviors such as remaining in a relationship or defecting, attempting to manipulate partner behavior, or being unfaithful. We hypothesize that the regulatory variable of relationship satisfaction-dissatisfaction functions to translate long-term relationship assessments into adaptive relationship cognitions and behaviors. Satisfaction adaptations must track and aggregate the outputs of relationship evaluation adaptations into summary satisfaction variables. By taking account of multiple available assessments, satisfaction variables reflect the estimated net benefits of terminating a relationship, attempting to change the relationship in beneficial ways, or maintaining a long-term relationship as is. Defection, infidelity, manipulation, and other relationship-relevant behaviors are in turn motivated in proportion to the value of satisfaction variables.

The hypothesis that satisfaction functions to calibrate relationship behaviors to the fitness costs and benefits of relationships furnishes key insights about the inputs and contexts to which satisfaction adaptations are sensitive.

4.3.3 Inputs to relationship satisfaction adaptations

We hypothesize several contexts and individual differences that predict when people will experience changes in relationship satisfaction and their

cognitive appraisal of the relationship. In general, these are circumstances in which the fitness costs and benefits associated with being in the relationship change over time or context. We highlight specific subsets of contexts and individual differences here:

1. *Individual differences and contexts that alter the weight of costs and benefits*. Characteristics such as sex, mate value, physical attractiveness, and status change how costly or beneficial various factors are to a particular individual within a relationship. For example, an individual with a low partner–potential mate value discrepancy faces better odds when on the mating market, increasing the magnitude of the potential benefits associated with leaving a relationship. Comparing individuals across these characteristics should reveal differences in relationship satisfaction because of differences in the significance of associated costs and benefits. Certain contexts, such as having children, also alter the weight of various costs and benefits. The costs associated with abandonment are typically greater for a woman with a child than one without. Thus, we expect the same abusive behavior from a mate to result in greater relationship dissatisfaction in a childless woman than a woman with children because of the magnitude of the costs of leaving are diminished.
2. *Individual differences in ability to manipulate costs and benefits of the relationship*. Some individuals may be better skilled at manipulating their partner's investment level—perhaps those who are more cognitively complex, emotionally intelligent, socially adept, or Machiavellian. These adept individuals should experience relationship satisfaction and evaluate their relationships differently than those without these abilities. For example, a woman who is less skilled at manipulating her mate's resource investment toward her experiences relationship dissatisfaction and is motivated to leave the relationship if her mate fails to invest enough in her. However, a woman who experiences similar disinvestment, but is more skilled at manipulating investment, is in a better position to stay in the current relationship and continue to extract benefits. She experiences less relationship dissatisfaction to motivate her leaving. Two women experience the same decrease in benefits from a partner experience different levels of relationship satisfaction based on their abilities to alter the situation.
3. *Contexts in which signaling relationship problems is costly*. Conscious acknowledgment of relationship dissatisfaction has many downstream consequences. People discuss their relationships and their emotional experiences with those outside of the relationship. People are also astute

observers of their friend's relationship status. Arguments, frustrations, and disappointments that are outwardly expressed can become public knowledge despite a person's desire for privacy. This purposeful or accidental broadcasting of relationship dissatisfaction can be costly. It is a cue of exploitability to potential mate poachers (Buss & Duntley, 2008; Schmitt & Buss, 2001). Moreover, people in the relationship develop reputations as poor and unstable relationship partners. Therefore, we expect people to experience less relationship dissatisfaction to avoid displaying potentially costly cues. The reputational costs of one's dirty laundry being aired may be greater than the fitness costs of enduring an unsatisfying relationship. Those who are able to hide their relationship problems should thus experience lesser relationship dissatisfaction in order to avoid sending social signals; those unlucky persons whose relationships problems are well known should experience greater dissatisfaction to both terminate their costly relationship and mitigate reputational damage.

4.3.4 Relationship satisfaction as a motivational mechanism

The use of satisfaction to motivate behaviors in long-term relationships creates a new problem: motivating those behaviors most when they are most necessary. A simple model of a satisfaction adaptation computes relationship satisfaction based on various relevant relationship assessments, stores this computed satisfaction, and motivates behaviors in proportion to the stored satisfaction level. For individuals in highly valuable relationships, such a satisfaction adaptation produces high levels of satisfaction, motivating behaviors such as additional investment or relationship maintenance behaviors. Individuals in poor relationships compute and store low satisfaction levels, motivating tactics such as defection, manipulation, or relationship repair.

This simple model has a design flaw: relationship behaviors, such as relationship maintenance or defection, are motivated *regardless of the fitness benefits of those behaviors*. More efficient satisfaction adaptations would motivate behavior in proportion to cues correlated with the fitness benefits of that behavior. Defecting from a poor relationship does not pay until one's alternative mate is also available; maintenance behaviors provide more benefits for their costs if used to deflect a mate poacher than when used spontaneously. If acting on assessments of one's relationship provided more fitness benefits in some contexts than in others, ancestral humans needed satisfaction adaptations capable of additionally motivating behavior in those specific contexts.

Instead of merely aggregating and storing satisfaction levels, a more effective relationship satisfaction adaptation would vary the link between relationship evaluations and the stored satisfaction variable. Such a mechanism takes as input both the outputs of relationship assessment adaptations as well as cues that suggest the current utility of relationship behaviors (see Figure 2 for a graphical depiction). Without cues suggesting that relationship behaviors are the best use of that individual's resources, the impact of relationship assessments on satisfaction is down-regulated. The satisfaction variable rests at a set point of satisfaction motivating relationship continuance, but not necessarily manipulation, maintenance, or infidelity. As the benefits of relationship behaviors increase, satisfaction adaptations increase the impact of assessments on satisfaction level. When the utility of behaviors of fade, the adaptation toggles satisfaction back to its set point.

4.3.5 Commitment devices and the regulation of investment

Long-term maters face an adaptive problem of determining exactly how much to invest in their long-term relationships. Several informational inputs

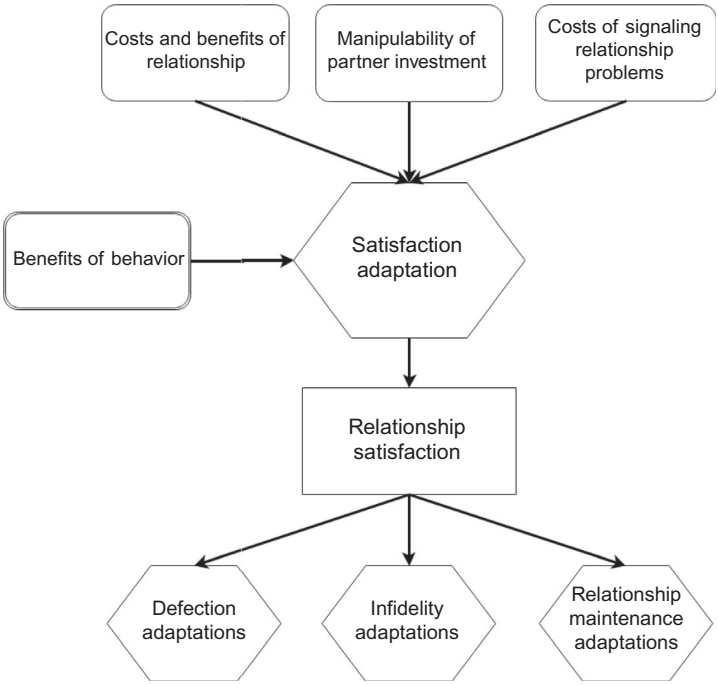

Figure 2 A hypothesized satisfaction adaptation. This adaptation translates relationship evaluations into behaviors, but only when behaviors would provide fitness benefits.

are relevant. Mate value discrepancies provide one input. Individuals with available alternative mates higher in value than their current mates benefit from increased extra-pair investment. On the other hand, if one's partner is of higher mate value, investing heavily is beneficial as a means of preventing one's valuable mate from defecting (e.g., through positive inducements, Buss, 1992; Buss & Shackelford, 1997).

Other processes act to dissociate investment levels from partner value. The commitment device hypothesis proposes adaptations that promote commitment above and beyond the value of current partners (Frank, 1988). Commitment must be sustained over time for investments to grow and return benefits. This insight meshes well with a public goods model of long-term relationships—investments in shared pools such as offspring typically take time to pay their fitness dividends. Individuals who repeatedly abandoned their mates every time a better opportunity presented itself would never reap the benefits of their pool investments. The commitment device hypothesis proposes that selection has designed commitment adaptations so that individuals apply strict standards while selecting mates but "make do" once a mate is successfully attracted, regardless of their standing on preferred traits (see Gonzaga & Haselton, 2008; Gonzaga, Haselton, Smurda, & Poore, 2008). Under the influence of commitment device adaptations, when dissolving a relationship would entail forgoing important future dividends, individuals invest highly in their mates even if they have lower mate value than alternative partners.

Cues that suggest that extra-pair investment opportunities are more worthwhile than investment in one's relationship should also decrease investment levels. Some of these extra-relational opportunities come directly from the mating domain, such as mate attraction. Resources spent on one's current relationship are resources that cannot go to acquiring new mates. Especially for men, who potentially can fertilize several women in brief periods of time, sometimes even very high benefits from investment in one mate are not enough to outweigh the benefits of successfully attracting several mates (Hurtado & Hill, 1992).

4.3.6 Public goods and positive feedback in investment

Explicitly evaluating long-term relationships with a public goods model reveals one additional crucial input: the current investment level from one's partner. For many—but not all—evolutionarily relevant resources, the value of investing in a relationship should be contingent on one's partner's investments. Time and energy was more usefully spent caring for offspring if one's

partner were also working to guarantee their survival; food was best used to enhance one's mate's fecundity if that mate was also directing energy toward his or her fecundity. Without partner investment, one's resources are better spent on other fitness opportunities—acquiring new mates, developing dyadic social alliances, building coalitions, or maintaining one's bodily systems. Given that the value of one's investment depends on the level of investment of one's partner, an important cue in determining how much to invest in a long-term relationship is how much one's partner is currently investing.

This hypothesis generates several novel predictions. First, for shared pools that allow positive feedback, the investment levels of long-term partners will be correlated across relationships or across time. A sudden increase in investment from one partner, either accidental or due to changes in their cost–benefit calculus, changes the calculus of investment for the other. If Charles suddenly invests more in the relationship pool than he had initially, further investment now returns to Emma more benefits. Adaptations in Emma responsible for promoting investment in relationships will recognize Charles's shift and motivate increases in investment from Emma in accordance with the new cost–benefit calculus. Conversely, decreases in investment from Charles decrease the benefits of any given level of investment to Emma, which will on average decrease Emma's inclination to invest.

If investment adaptations are sensitive to partner investment levels, investment will follow positive feedback cycles. Increases in investment by Emma increase the benefits to Charles of further investment. Charles's adaptations will motivate him to invest more as long as the now-increased benefits are greater than those offered by alternative opportunities. Charles's increased investment in turn changes the cost–benefit calculus for Emma, and so on. As long as personal investment is calibrated to partner investment, and as long as both pairs of a dyad share similarly designed adaptations, positive feedback cycles will commence. Small changes in investment are, over time, amplified through this process by initiating iterative cycles of changing investment. These cycles initiate dramatic scaling up or down of investment in relationships based on only minor changes in relationship condition.

Researchers can detect these positive feedback cycles in several ways. First, our public goods model suggests that changes in investment levels by one partner will predict changes in investment levels by the other. Researchers can experimentally induce changes in investment levels by individuals and observe their effects on partners or observe complementary changes in partners longitudinally. Second, investment levels in relationships

will become increasingly idiosyncratic as relationships persist. Initial investment levels will be determined lawfully by inputs available to adaptations: mate value discrepancies, available alternative mates, available resources, and so on. However, because changes in partner commitment alter the costs and benefits of commitment, small changes in one partner induces positive feedback cycles that cause investment levels to drift. As these positive feedback cycles continue, investment levels will become increasingly a function of these cycles rather than of the initial determinants of investment. As relationships persist, then, investment levels become increasingly determined by the particular dynamics of that relationship's positive feedback cycles and less by the external factors that determined their initial points. A similar process has been proposed to occur in human friendship, wherein commitment from a friend is repaid with commitment to that friend (DeScioli & Kurzban, 2009; Tooby & Cosmides, 1996). Public goods analysis of long-term mating suggests for the first time that positive feedback cycles affect investment in the mating domain as well.

5. CONCLUSIONS

Human long-term mating is an extraordinary phenomenon, a rare mating strategy among the 300 plus primate species and among the 5000 plus mammalian species. By way of contrast, consider the mating strategies of chimpanzees, our closest primate cousins with whom we share more than 98% of our DNA. Most mating is exclusively short term. It occurs when females enter estrus. Female chimps often mate with multiple males, although the alpha male typically has some preferential access. Male chimps invest little or nothing in females or their relationships, nor do they invest parentally in offspring.

In sharp contrast, long-term committed mating is a dominant mating strategy of humans (Buss & Schmitt, 1993). It often involves heavy commitment of the partners to each other and to their offspring for years or decades. It typically involves a public commitment, ceremonial in nature, signaling to their social group their new mating status. Ovulation is relatively concealed and sexual intercourse occurs throughout the cycle. Mate guarding and mate retention effort help to preserve mating bonds and ward off potential mate poachers. And for humans, there is relatively low sperm competition, as indicated by relatively low testicular volume relative to body size (in chimpanzee, it is four times that for humans). Consequently, genetic paternal

probability is exceptionally high, typically ranging between 97% and 99% (Anderson, 2006).

This unique strategy of mating, in such stark contrast to chimpanzees, requires scientific explanation. Despite this, there does not yet exist a comprehensive theory of human long-term mating that explains its evolutionary origins, the adaptive problems created once it evolved as a strategy, and the psychological and strategic solutions that evolved to grapple with the multiple challenges entailed. The game-theoretic model proposed here does not pretend to offer a complete or comprehensive theory of long-term mating. However, we propose that it offers a suite of novel insights, along with hypotheses and specific empirical predictions, that advance the scientific understanding of this unusual mating strategy.

Game-theoretic modeling has proven to be indispensable to understanding the evolution of many social relationships. These include dyadic cooperative alliances (Axelrod & Hamilton, 1981), multi-individual coalitional alliances (Tooby et al., 2006), and dominant-subordinate relationships in which antagonistic social conflicts are resolved to avoid mutually costly battles (Maynard Smith & Price, 1973). The current paper extends game-theoretic analysis to human long-term mating relationships. Specifically, public goods modeling provides a way to elegantly explain the adaptive problems solved by long-term mating and the novel adaptive problems created once long-term mating evolved as a strategy, and furnishes hypotheses about evolved psychological solutions to these adaptive problems.

Long-term mating modeled in this way affords key insights, three of which relate to maximizing parental investment. The first is dramatically reduced conflicts of interest from the perspective of evolutionary fitness. The second is the mutual facilitation of investment, which produces a ratcheting effect whereby investments by one partner are compounded by investments by the other, resulting in a greater overall mutual pool. The third is a complementarity of investment that capitalizes on the benefits afforded by a division of labor; each partner can specialize in different modes of resource acquisition that get funneled into the mutual pool. The fitness dividends reaped by investing in the mutual pool are great because the shared pool increases synergistically rather than merely additively.

Reaping these benefits requires solving a collection of adaptive problems created by the evolution of a long-term mating strategy (reviewed in Table 3). Individuals must select and attract mates who make excellent partners in these collaborative alliances, including cooperative dispositions, inclinations toward fidelity, and dependability of psychological, economic,

and physical protection and resource provisioning. They must choose mates who have equitable or even partner-skewed welfare tradeoff ratios and avoid partners who carry a high "relationship load," which includes mutation load, disease load, a selfishly skewed welfare tradeoff ratio, and fitness costs in the form of previously produced children and cost-inflicting former mates.

Partners must also ensure that their mates invest in shared pools rather than allow investments to be diverted to nonshared fitness interests. These include strategies to prevent infidelity, avoid defection, and maintain relationship commitment over long temporal spans. To accomplish these goals, selecting and attracting good relationship partners is not enough. Adaptations are required to monitor partners, to monitor potential mate value discrepancies, and even to monitor the quality of alternative potential mates in comparison with one's current mate.

Critically, long-term mating requires individuals to solve the problem of romantic free-riders—a novel concept provided by the current game-theoretic analysis. These are individuals who partake of the benefits of shared pools without contributing their fair share to those pools. The current model predicts the evolution of adaptations to detect romantic free-riders, to punish these free-riders, and to jettison them when punishment does not work.

The current model also predicts the evolution of internal regulatory variables that monitor long-term romantic relationships. Relationship satisfaction historically has been a central construct and measured variable in research on intimate relationships. Its possible functions, however, have been almost entirely ignored (for one exception, see Shackelford & Buss, 2000). The current model hypothesizes that relationship satisfaction is a core internal regulatory variable, a summary psychological state, that monitors the costs and benefits received from a long-term relationship. Depending on various contexts, such as dramatic or gradual changes in costs and benefits, the availability of alternative mates that offer a different cost–benefit structure, and the perceived ability to alter a partner's net benefits to the shared pool, changes in relationship satisfaction should motivate tactical relationship behavior.

This game-theoretic model of long-term mating does not provide answers to all key questions of long-term high-commitment mating strategies. It does not provide a definitive answer, for example, to the question of why long-term mating evolved in humans and some avian species, but not in chimpanzees or other primates closely related to humans. A definitive answer to this question may remain elusive.

But it does provide an important set of conceptual tools for the analysis of long-term romantic relationships, tools that have proved critical to understanding other core human social relationships. It furnishes a set of insights into novel adaptive problems that humans must solve, such as detecting and punishing romantic free-riders, in order to reap the benefits of shared resource pools inherent in long-term relationships. And it provides a functional analysis of relationship satisfaction—a variable of vital importance to relationship researchers, yet one that has carried intuitive appeal without accompanying insight into its functionality. For its heuristic value alone, we anticipate the current model will provide a roadmap, however sketchy, for a deeper understanding of why people in every known culture form long-term mating relationships and reap the benefits inherent in their shared pools of resources.

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Original Article

Sexual exploitability: observable cues and their link to sexual attraction

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Abstract

Although antiexploitation adaptations, such as cheater-detection mechanisms, have been well explored, comparatively little research has focused on identifying adaptations for exploitation. The present study had two purposes: (1) to identify observable cues that afford information about which women are sexually exploitable and (2) to test the hypothesis that men find cues to sexual exploitability sexually attractive, an adaptation that functions to motivate pursuit of accessible women. Male participants rated photographs of women who displayed varying levels of hypothesized cues to exploitability. We identified 22 cues indicative of sexual exploitability. Nineteen of these cues were correlated significantly with sexual attractiveness, supporting the central hypothesis. Results suggest that sexual attraction to exploitability cues functions to motivate men to employ exploitative strategies towards accessible targets, and contribute foundational knowledge to the diverse classes of cues that afford information about which women are and are not sexually exploitable.

Keywords: Sexual attractiveness; Exploitability

1. Introduction

Exploitative resource acquisition strategies are a class of strategies designed to facilitate resource accrual by taking advantage of other organisms through deception, coercion, or force (Buss & Duntley, 2008). Much of the work examining the domain of exploitability focuses on antiexploitation adaptations, such as cheater-detection mechanisms and mechanisms devoted to reactions to being exploited (e.g., Cosmides & Tooby, 2005; Fehr, Fischbacher, & Gachter, 2002; Price, Cosmides, & Tooby, 2002), rather than on the design of adaptations that produce exploitative strategies. Ancestrally, mate acquisition was one domain in which exploitative strategies could have been an effective means to achieve successful mating outcomes, particularly if the desired outcome was a short-term sexual relationship. Cues of ease of exploitability are one source of information to which mechanisms for exploitation should be sensitive (Buss & Duntley, 2008). We examined three classes of cues that, if detectable by men, could have enabled them to assess a woman's vulnerability to sexual exploitation. In addition to examining cues diagnostic of sexual exploitability, we investigated the hypothesis that men would find women displaying cues of sexual exploitability to be sexually attractive, but not attractive as long-term mates, which provides motivational impetus for pursuing women with an increased probability of sexual access.

1.1. Sexual exploitability

Short-term mate acquisition is one domain in which exploitative strategies would have been adaptive for males. Because ancestral males and females differed in their minimum obligatory parental investment (Trivers, 1972), the calculus for determining whether to engage in a sexual relationship and how much investment to place in a relationship differs between the sexes. The sexual conflict fueled by these differences in mating goals and preferences would have created two general contexts in which an exploitative strategy, rather than a cooperative one, could have been adaptive. First, in situations in which a female did not want to have sex but a man did, a strategy using some form of exploitation could have been a way to achieve his goal. Second, a man might adopt an exploitative strategy when he sought casual sex, but the woman sought a high-investment relationship (Buss, 2003).

Research on forms of sexual exploitation such as rape and sexual coercion suggests that selection could have favored

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rape in contexts that lowered the potential costs associated with using these strategies. Circumstances such as warfare or when women were separated from protective kin could have resulted in lower costs of engaging in exploitative strategies (Figueredo et al., 2001; Gottschall, 2004; Lalumière, Harris, Quincey, & Rice, 2005; Thornhill & Palmer, 2000). This suggests that the assessment of a woman's immediate vulnerability may be central to the activation of psychological mechanisms related to sexual exploitation.

We have thus far broadly referred to "exploitative strategies" without differentiating between potential types of exploitation. We propose that tactics for sexual exploitation fall under four somewhat distinct, although perhaps overlapping, classes: sexual seduction, verbal or nonverbal pressure, deception, and sexual assault. Sexual seduction is the act of charming or convincing someone into having sex. Seduction differs from courtship, which may include long-term commitment and investment as goals. Pressure involves relentless persistence, threats, or coercion to induce an individual into having sex. Deception is dishonesty about intentions, likelihood of further commitment, or personal characteristics such as those sought by members of the opposite sex—a phenomenon well documented in human mating (Haselton, Buss, Oubaid, & Angleitner, 2005). Sexual assault involves using physical force, or the threat of physical force, to force sexual intercourse. Although some cues to sexual exploitability may be uniquely diagnostic of susceptibility to one type of exploitation (e.g., cues to being less physically formidable might make a woman more vulnerable to sexual assault but not deception), others may be indicative of multiple types of sexual exploitability (e.g., lower intelligence may make a woman more susceptible to seduction and deception). Assessing these strategies discretely enabled us to determine cues associated with vulnerability to different types of exploitative strategies that vary in their nature (e.g., psychologically exploitative vs. physically exploitative) and severity (e.g., sexual seduction vs. sexual assault). Although each exploitative strategy may have distinct characteristics, during any given attempt to exploit a woman, a man may employ multiple tactics from different classes of strategies (e.g., an attempt at sexual seduction may also involve the use of deception). Thus, we included all four in the current study to capture a wide array of cues and to better understand which cues are indicative of vulnerability to which strategies.

1.2. Cues to sexual exploitability

1.2.1. Psychological cues

Male adaptations to detect cues to sexual exploitability may be designed to pick up on several classes of cues. First, men may be sensitive to different psychological traits indicating that a woman is sexually exploitable. One category of psychological cues is traits that suggest that a woman is mentally or emotionally manipulable and could potentially be persuaded to engage in sexual intercourse. Low self-esteem and low assertiveness are associated with having experienced sexual coercion (Greene & Navarro, 1998; Testa & Dermen, 1999). Women low in assertiveness and self-esteem may be particular targets of exploitation because they will be less likely to resist exploitative tactics. Cues indicative of immaturity and naiveté also fall into this category. They suggest that a woman has less experience interacting with men, making her more susceptible to exploitation. Low cognitive ability is another cue indicating greater exploitability because it signals ease of manipulability or deceivability. Thus, sensitivity to such cues may be one design feature of male tactics for sexual exploitation.

Another category of psychological cues are those that indicate flirtatiousness, promiscuity, and more permissive sexual attitudes. These characteristics may indicate greater ease of sexual exploitation by (1) causing women to put themselves in situations where they are at a greater risk of sexual exploitation and (2) providing men with opportunities to approach women under the guise of responding to the women's flirtatiousness, thereby facilitating a later attempt at exploitation. Women with unrestricted sociosexuality (indicating a positive orientation towards short-term mating) report a greater likelihood of being approached by a male with sexual intentions (Sakaguchi & Hasegawa, 2006b). Furthermore, more promiscuous women and women with multiple sexual partners report being more likely to have been sexually victimized (Greene & Navarro, 1998; Testa & Dermen, 1999). Research suggests that men can identify women's sociosexual orientation through brief interactions (Stillman & Maner, 2009), and other work has identified a variety of nonverbal cues indicative of flirtatiousness (Moore, 1985, 2002). Being able to identify these traits could serve a dual purpose. These traits may signal that a woman is more prone to engaging in sexual behavior by choice, and by indicating greater ease of sexual access, they also may inadvertently signal greater sexual exploitability.

A third category of psychological traits consists of cues that indicate recklessness or risk taking. This includes personality characteristics such as impulsivity, attention seeking, and being prone to take risks. Although displaying these characteristics may not indicate a woman is currently exploitable, they indicate a greater likelihood she will eventually be in dangerous situations, such as being alone or intoxicated. Drinking alcohol, one form of risky behavior, is positively correlated with sexual victimization (e.g., Testa & Dermen, 1999). In the modern environment, drinking alcohol and engaging in party culture may result in being perceived as reckless and exploitable.

1.2.2. Incapacitation cues

Cues suggesting current incapacitation represent another set of cues to sexual exploitability. Intoxication, fatigue, or other forms of cognitive impairment could make a woman less able to resist tactics of sexual exploitation. Other conditions related

to her current level of physical protection, such as being alone or isolated, compared to being with "bodyguards" such as friends, family members, or a mate, may also provide information about her current sexual exploitability.

1.2.3. Physical cues

Finally, physical traits may indicate a lack of formidability to resist sexual exploitation. Characteristics such as a shorter gait, slower walking speed, and low energy are associated with being rated as easier to attack (Gunns, Johnston, & Hudson, 2002). Women with a shorter gait and slower walking speed are also rated as more likely to be targets of sexual advances (Sakaguchi & Hasegawa, 2006a). Static cues, such as being short or small, may also indicate exploitability.

In sum, cues to sexual exploitability are conceptualized into three broad classes: (1) psychological cues indicating a woman is mentally or emotionally manipulable or is flirtatious or promiscuous, or revealing a risk-taking proclivity; (2) incapacitation cues indicating a woman is temporarily or currently in a state in which she could be exploited; and (3) physical cues indicating a lack of formidability to resist sexually exploitative tactics.

1.3. Sexual attraction to exploitability

Exploitative tactics typically require motivational impetus to fuel their enactment. We hypothesized that the emotion of sexual attraction functions as one such mechanism. Furthermore, we hypothesized that cues in the classes described above would render a woman attractive as a short-term mate, motivating an exploitative strategy. Traditionally, researchers have characterized signs of fertility, health, and other markers of mate quality as indicators of attractiveness (e.g., Fink & Penton-Voak, 2002; Gangestad & Scheyd, 2005; Singh, 1993; Sugiyama, 2005). Recognition of cues to exploitability serves a different function. They are hypothesized to be associated with *sexual attractiveness* because they indicate a woman could be exploited for a short-term sexual opportunity. By making a woman more exploitable, these characteristics might also make her *less* attractive as a long-term mate because a man would be risking investment in a mate who could be sexually exploited by other men. We hypothesized that cues to exploitability would be uniquely related to short-term mate attractiveness and inversely correlated with long-term mate attractiveness.

Although the hypothesized link between sexual exploitability cues and sexual attractiveness has yet to be explored directly, some circumstantial evidence exists. When asked to rate women's facial attractiveness (without differentiating between long-term and short-term mate attractiveness), both men and women found faces with cues to unrestricted sociosexuality more attractive (Boothroyd, Jones, Burt, DeBruine, & Perrett, 2008). However, when asked specifically about long-term mate attractiveness, men found women with facial cues related to unrestricted sociosexuality less desirable as long-term mates (Campbell et al., 2009). This suggests that more permissive attitudes towards short-term mating enhance women's attractiveness in short-term mating contexts. These cues may be seen as more attractive because they signal that a woman is more likely to voluntarily engage in sexual behavior and hence be more sexually accessible, or because they indicate ease of sexual exploitability.

Previous research also suggests that cues to emotional and psychological manipulability may be linked with sexual attractiveness. Cross-culturally, men prefer younger women as mates because they are higher in reproductive value and fertility than older women (Buss, 1989). Youth may also enhance sexual attractiveness because it is a cue to immaturity and naiveté, suggesting a higher probability of payoff for an exploitative strategy. Intelligence is another trait valued in long-term mates; however, men's preference for intelligent mates is relaxed when men are asked about strictly sexual relationships (Kenrick, Groth, Trost, & Sadalla, 1993; Kenrick, Sadalla, Groth, & Trost, 1990). Rather than simply lowering their standards for intelligence in short-term mates, men may prefer (consciously or unconsciously) less intelligent mates in this context because they are more exploitable and therefore more sexually attractive. We suggest that this logic applies to other cues to sexual exploitability—any recurrently observable cue that indicates a man will be more successful when attempting to implement an exploitative sexual strategy will increase perceptions of a woman's sexual attractiveness to motivate him to attempt to use that strategy.

1.4. Current study

We conducted the present study in four steps to identify cues to sexual exploitability and to test the hypothesis that cues to sexual exploitability are indicators of sexual attractiveness. First, we used an act nomination procedure to generate previously undocumented potential cues to sexual exploitability. The research team then assembled digital photographs of women displaying varying levels of these cues. The photographs were coded to identify which, and to what degree, cues were displayed in each image. Finally, male participants rated the attractiveness and exploitability of the women in the photographs.

2. Method

2.1. Participants

Participants were students enrolled in an introductory psychology course and received partial course credit for their participation. Seventy-six males participated, ranging in age from 18 to 47 (M=19.59±3.76). To avoid fatigue effects, participants were randomly assigned to one of three groups. One group viewed a randomized set of 36 photographed women (out of the total of 110), and the other two groups

Table 1
Correlations between hypothesized cues to sexual exploitability and mate attractiveness

Positively correlated cues	Seduce	Pressure	Deceive	Assault	**Overall**
"Easy"	.81***	.73***	.72***	.48***	.75***
Immature	.69***	.63***	.68***	.56***	.69***
Intoxicated	.69***	.66***	.62***	.51***	.67***
Reckless	.70***	.59***	.63***	.38***	.62***
Promiscuous	.72***	.58***	.62***	.33***	.61***
Partying	.68***	.56***	.54***	.35***	.58***
Flirty	.60***	.52***	.48***	.30**	.52***
Promiscuous friends	.53***	.43***	.47***	.18	.44***
Attention seeking	.52***	.33***	.41***	.17	.39***
Young	.17	.31**	.31**	.36***	.31**
Sleepy	.25***	.32***	.27***	.29***	.30***
Come hither look	.35***	.23*	.27**	.09	.26**
Revealing clothing	.35***	.25*	.29**	.07	.26**
Touching breast	.15	.26**	.14	.38***	.24*
Open posture	.38***	.22**	.22**	−.02	.22**
Alone	.18	.17	.11	.13	.16
Ring (wedding/engagement)	.23*	.14	.14	.09	.16
Tight clothing	.27**	.14	.18	−.04	.15
Friendly	.11	.20*	.11	.11	.14
Punk	.17	.11	.21*	.01	.14
Materialistic	.24*	.09	.15	−.04	.13
Touching body	.09	.11	.07	.16	.11
Tattoos	.06	.08	.12	.13	.11
Tucking hair	.13	.10	.05	.10	.10
At a wedding	.15	.04	.00	.15	.09
Over-shoulder look	.06	.06	.05	.09	.07
Fat	.08	.10	.09	−.09	.06
Touching face/hair	.11	.09	.09	−.08	.06
Short	−.06	.06	.01	.15	.04
Lip lick/bite	.02	.04	.01	.01	.02
Touching thigh	.02	−.01	.03	.01	.01
Touching knee	.03	.05	−.04	−.02	.01
Lying back	.03	.00	.02	−.04	.01
Laughing	−.01	−.04	.03	.03	.00

Negatively correlated cues	Seduce	Pressure	Deceive	Assault	Overall
Intelligent	−.63***	−.54***	−.59***	−.31***	−.56***
Shy	−.53***	−.35***	−.42***	−.11	−.39***
Age	−.23*	−.39***	−.36***	−.39***	−.36***
Old	−.18	−.34***	−.32**	−.39***	−.33**
Passed out	−.26**	−.25**	−.24*	−.24*	−.27**
Flushed face	−.30**	−.28**	−.26*	−.14	−.26**
Anxious	−.30**	−.28**	−.23*	−.03	−.23*
Sucking on a straw	−.21*	−.17	−.19	−.22*	−.21*
Being touched	−.21*	−.20*	−.21*	−.10	−.20*
Standing near men	−.16	−.19*	−.11	−.11	−.15
Sad	−.18	−.19	−.11	−.03	−.14
Prostitute	−.12	−.11	−.11	−.12	−.12
Piercings	−.15	−.07	−.16	−.02	−.11
Skinny	−.12	−.15	−.13	.04	−.10
Tall	.01	−.11	−.07	−.22	−.10
Canted neck	−.12	−.08	−.16	−.01	−.10
Flushed neck	−.13	−.08	−.10	−.05	−.10
Dancing	−.11	−.09	−.13	−.01	−.09
Touching others	−.15	−.09	−.14	.05	−.09
Distressed	−.13	−.13	−.06	.04	−.08
Open legs	−.10	−.09	−.09	−.02	−.08
Asleep	.00	−.10	−.08	−.09	−.07
Crying	.00	−.01	−.11	−.06	−.05
Raised arms	−.01	−.05	−.04	−.09	−.05
Mostly with men	.00	−.07	.00	−.05	−.03
Ear piercing	−.11	.03	−.04	.07	−.02

Table 1 (*continued*)

Negatively correlated cues	Seduce	Pressure	Deceive	Assault	Overall
Confident	.12	.02	.02	−.22*	−.01
Smiling	.01	−.05	.02	−.01	−.01
Finger on lips	.00	.00	.04	−.05	.00

Note. Of the 315 correlations presented in Table 1, 66 correlations were significant beyond the .001 level, where <1 would be expected by chance alone; 89 were significant beyond the .01 level, where 4 would be expected by chance alone; and 111 were significant beyond the .05 level, where 16 would be expected by chance alone.

***p<.001; **p<.01; *p<.05.

each viewed a randomized set of 37. Each group constituted approximately one third of the total participant sample.

2.2. Materials

2.2.1. Cue Selection

We determined hypothesized cues based on a literature search and an act nomination procedure (Buss & Craik, 1983). The act nomination procedure is useful because it can provide novel information by pooling the collective insights of large samples of observers—insights that may not yet have been explored in the literature and that researchers may not have been able to theoretically generate themselves a priori. An initial set of 194 (103 male, 91 female, age range 18–52, M=21.63±5.96) participants nominated specific actions, cues, body postures, attitudes, and personality characteristics in three categories: indicators of sexual exploitability, indicators of sexual interest toward one person, and indicators of general sexual availability or openness to sexual activity. Because the study's goals included examining aspects of sexual attractiveness other than just sexual exploitability, we retained cues from all categories in the final list. After combining similar cues and eliminating cues not assessable from a photograph (e.g., feminine voice), these cues were added to a list of cues generated via literature search. This list totaled 88 cues.

2.2.2. Photograph selection

Researchers collected photographs from publically available sources on the Internet (i.e., sites that did not require a password or login). We used a search engine to find images of women displaying varying levels of the hypothesized cues. The researchers independently gathered photos and together selected images of 110 women displaying varying levels of the cues of interest. Photographs were coded to determine the degree to which each woman displayed each of the 88 cues. Two of the researchers independently coded cues that could be objectively observed as present or absent (e.g., tattoos, being touched by others). There were no discrepancies between the two researchers' judgments of these 33 cues. Four raters blind to the study's hypotheses rated the other 55 cues. The raters were asked, "How much do each of the following characteristics describe the individual in the picture?" Raters responded using a 1 (*not at all*) to 7 (*extremely*) rating scale. Following a procedure similar to Vazire and colleagues' (2008) for eliminating cues with low reliability, we calculated the average intraclass correlation coefficient (ICC) for each cue to ensure agreement among the raters. Twenty-five cues had an average measures ICC less than .70 and were eliminated, leaving 30 cues with an average measures ICC ranging from .70 to .90 (mean=.79). To calculate the rating means, rater's responses were averaged for each of these 30 traits. If one rater indicated he or she could not provide a rating for a particular photograph, the average was computed from the three other raters. If two or more raters could not provide a rating, that photograph was excluded from analyses for that particular trait. These 30 cues, along with the 33 cues coded as present or absent by the researchers, resulted in the final assessment of 63 cues in our set of images.

2.2.3. Participant measures

Participants (N=76) responded to seven questions assessing each woman's perceived mate attractiveness and exploitability. The three mate attractiveness questions assessed the women's overall attractiveness ("How attractive is this woman *overall*?"), short-term mate attractiveness ["How attractive would this woman be to a man as a *short-term mate* (e.g., one-night stand, casual sex, etc.)?"], and long-term mate attractiveness ["How attractive would this woman be to a man as a *long-term mate* (e.g., committed romantic relationship, wife, etc.)?"]. The four exploitability questions asked about the four proposed sexual exploitation tactics. Participants were first asked, "How easy would it be for a man to seduce this woman into engaging into sexual intercourse?" The next two questions used the same verbiage, but the word "seduce" was replaced with "pressure" in the second exploitability question and with "deceive" in the third. The fourth question read, "How easy would it be for a man to sexually assault this woman?" Participants responded to all questions using a 1 (*not at all*) to 5 (*extremely*) rating scale. We phrased questions in the third person rather than first person to avoid underreporting due to the sensitive and taboo nature of the questions being asked. Participants also completed a brief demographics questionnaire.

2.3. Procedure

A research assistant assigned the participant to a computer terminal with a prepared slideshow of the photographs. The research assistant instructed the participant on how to advance through the slideshow of images and record his responses on a

Table 2
Correlations between hypothesized cues to sexual exploitability and mate attractiveness

Positively correlated cues	Short-term mate	Long-term mate
"Easy"	.65***	−.60***
Immature	.62***	−.62***
Intoxicated	.49***	−.40***
Reckless	.58***	−.69***
Promiscuous	.63***	−.64***
Partying	.51***	−.46***
Flirty	.54***	−.37***
Promiscuous friends	.54***	−.49***
Attention seeking	.49***	−.56***
Young	.25**	−.12
Sleepy	.24*	−.17
Come hither look	.29**	−.26**
Revealing clothing	.47***	−.48***
Touching breast	.00	.06
Open body posture	.39***	−.29**
Alone	.09	−.07
Ring (wedding/engagement)	.10	.01
Tight clothing	.36***	−.33**
Friendly	.08	.30**
Punk	.19*	−.45***
Materialistic	.24*	−.30**
Touching body	−.05	.15
Tattoos	−.01	.02
Tucking hair	.14	−.13
At a wedding	.15	−.07
Over-shoulder look	.15	−.09
Fat	−.11	.02
Touching face/hair	.06	−.03
Short	.07	.07
Lip lick/bite	−.02	−.09
Touching thigh	−.07	.08
Touching knee	.07	.18
Lying back	−.07	−.06
Laughing	.14	−.24*
Negatively correlated cues	**Short-term mate**	**Long-term mate**
Intelligent	−.60***	.67***
Shy	−.48***	.51***
Age	−.27**	.12
Old	−.22**	.11
Passed out	−.12	.20*
Flushed face	−.15	.06
Anxious	−.18	−.05
Sucking on a straw	−.26**	.07
Being touched	−.21*	.03
Standing near men	.00	−.05
Sad	−.17	−.14
Prostitute	−.10	.18
Piercings	−.18	.26**
Skinny	.10	−.10
Tall	−.08	.00
Canted neck	−.18	.12
Flushed neck	−.16	.10
Dancing	−.04	.12
Touching others	−.12	−.09
Distressed	−.05	−.23*
Open legs	−.12	.16
Asleep	.00	−.07
Crying	.14	.01
Raised arms	−.07	.02
Mostly with men	.08	−.10
Ear piercings	−.02	.01
Confident	.17	−.04
Smiling	.12	−.23
Finger on lips	−.01	−.02

Note. Of the 126 correlations presented in Table 2, 27 correlations were significant beyond the .001 level, where <1 would be expected by chance alone; 38 were significant beyond the .01 level, where 2 would be expected by chance alone; and 45 were significant beyond the .05 level, where 7 would be expected by chance alone.

***p<.001; **p<.01; *p<.05.

provided grid, and then left the room to allow the participant to privately record his responses. To avoid fatigue effects, after 25 min, the research assistant reentered the room with the demographics questionnaire and instructed the participant to complete it before viewing the remaining images. Participants were thanked and debriefed upon completion.

3. Results

To ensure that there were no systematic differences in attractiveness or exploitability ratings based on which of the three groups of pictures was viewed, we conducted a one-way analysis of variance to compare means between the three groups for each measure of mate attractiveness and exploitability. There were no significant group differences for any of the dependent measures except for the questions about seducing (Group 1: M=3.09±.46; Group 2: M=3.18±.39; Group 3: M=2.89±.38; $F_{2,109}$=4.73, p<.05) and pressuring into sex (Group 1: M=2.95±.46; Group 2: M=2.87±.39; Group 3: M=2.66±.43, $F_{2,109}$=4.49, p<.05). Because there was no reason to believe that these differences would affect interpretation of the study's results and because the majority of our measures were void of between-group differences, we proceeded with analyses as planned.

To determine which cues were diagnostic of exploitability, Pearson correlation coefficients were calculated between the rating means for each cue and the mean of participant responses for each exploitability measure for each picture (Table 1). Because the exploitability measures were highly correlated with one another (M=.90, range: .79–.97), a measure of overall exploitability was calculated by averaging the means of the four exploitability measures for each picture and correlating those averages with the cue ratings means. The participant means were also correlated with the dichotomous cues coded by the researchers. Overall attractiveness was strongly correlated with long-term mate attractiveness [r(108)=.91, p<.01] and short-term mate attractiveness [r(108)=.95, p<.01], but not with most measures of exploitability [seduce: r(108)=.15, p=.12; pressure: r(108)=.09, p=.36; deceive: r(108)=.09, p=.36; assault: r(108)=.41, p<.01]. Because the goal was to independently isolate each cue's relationship with

exploitability and mate attractiveness, we partialed out participants' ratings of overall attractiveness when calculating the correlations. Because each correlation between the specific cues and the exploitability and attractiveness ratings represents a test of an independent prediction and because the number of significant correlations far exceeds what would be expected by chance alone (see Notes, Tables 1 and 2) and were predicted a priori, we report the data without applying a statistical correction.

Fourteen cues were significantly positively correlated with at least three of the four measures of exploitability and with overall exploitability: attention seeking, come hither look, "easy," flirty, immature, intoxicated, open body posture, partying, promiscuous, promiscuous friends, reckless, revealing clothing, sleepy, and young. To test the prediction that cues positively correlated with exploitability would be positively correlated with short-term mate attractiveness but not correlated with, or negatively correlated with, long-term mate attractiveness, we correlated each cue with participants' measures of mate attractiveness.

All 14 of these cues conformed to the pattern of also being positively correlated with short-term mate attractiveness while being either negatively or not significantly correlated with long-term mate attractiveness (Table 2). The following cues

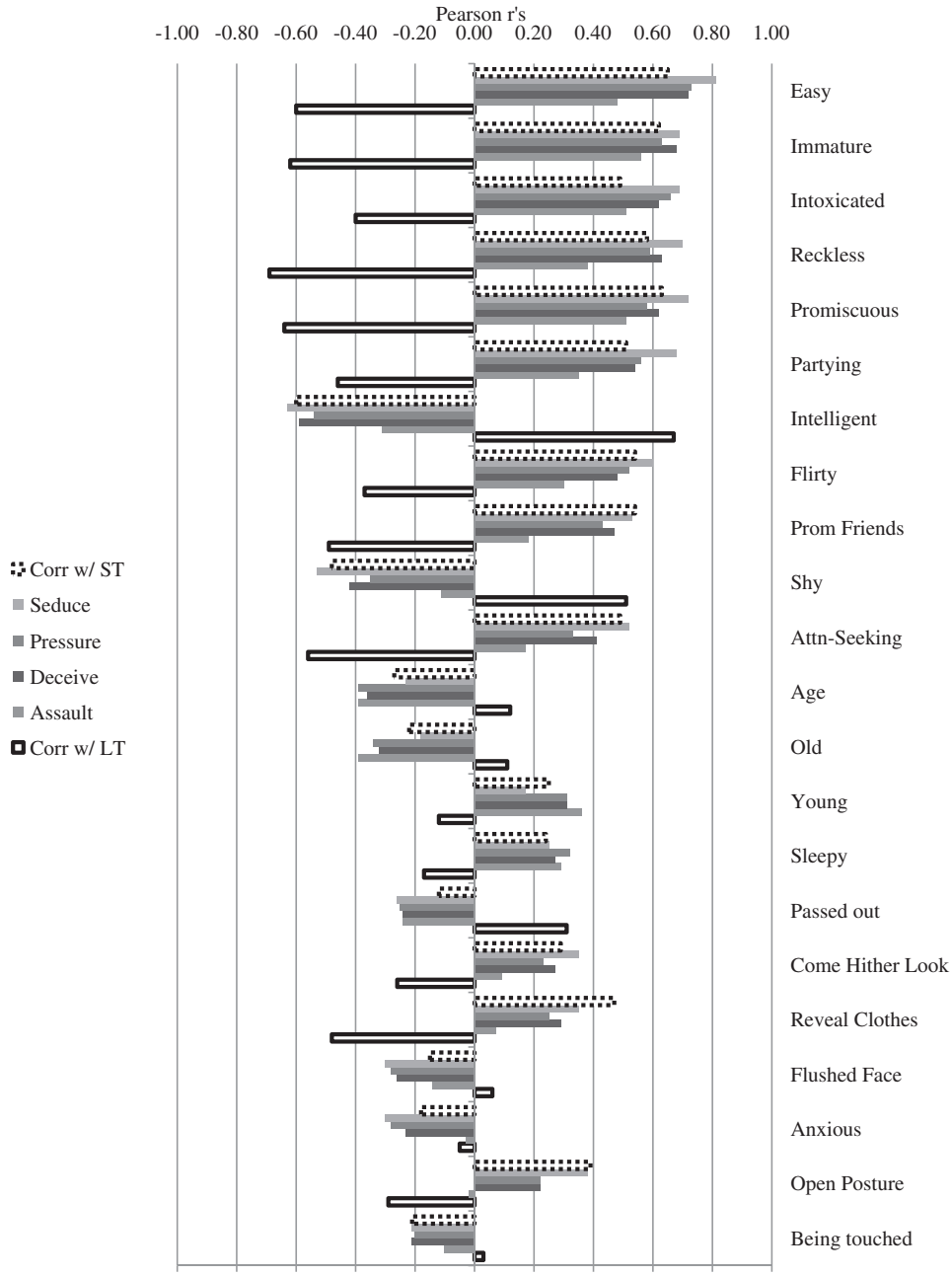

Fig. 1. Cues significantly correlated with exploitability.

were significantly negatively correlated with at least three of the four measures of exploitability and with overall exploitability: age, anxious, being touched, flushed face, intelligent, old, passed out, and shy. Only three of these did not conform to the predicted pattern: flushed face and anxious were not significantly correlated with either short-term or long-term mate attractiveness, and passed out was not significantly correlated with short-term mate attractiveness but was positively correlated with long-term mate attractiveness.

In summary, 22 cues were significantly correlated with three of the four measures of exploitability as well as overall exploitability. Nineteen of these 22 cues also supported the central hypothesis: that cues correlated with exploitability would be linked with perceptions of sexual attractiveness (Fig. 1).

4. Discussion

We investigated cues from three broad categories to determine which were diagnostic of sexual exploitability. Cues from two of these categories, psychological traits and cues to incapacitation, were strongly correlated with sexual exploitability. Specifically, psychological traits indicative of ease of mental or emotional manipulation (e.g., intelligence, immaturity), flirtatiousness and promiscuity (e.g., promiscuous, flirty, having promiscuous friends, wearing revealing clothing), and recklessness (e.g., reckless, partying) were significantly linked with perceptions of exploitability. Cues to currently being incapacitated, such as sleepy and intoxicated, were also correlated with perceptions of sexual exploitability. These findings suggest that men are sensitive to cues in a variety of domains when assessing the sexual exploitability of women. Past research on the psychology of male sexual aggressors has focused on the effect of individual differences and situational contexts on likelihood of committing sexual aggression (e.g., Abbey, Jaques-Tiura, LeBreton, 2011; Malamuth, 1996). This research instead expands our knowledge of victim-related cues that may activate mechanisms for exploitation. Focusing on the *function* of exploitative tactics reveals new cues in several domains that predict perceptions of sexual exploitability. Our results highlight the utility of examining cues that, from a man's perspective, suggest an exploitative strategy may be successful.

Although cues indicating physical weakness were predicted to indicate sexual exploitability, none of those cues were significantly correlated with the measures of exploitability. It is possible that the strength difference between men and women is so large (Lassek & Gaulin, 2009) that size and strength differences among women are irrelevant when assessing their exploitability. Gunns et al. (2002) found that weight was a predictor of ease-of-attack for male targets, but not for female targets, suggesting that female size, contrary to our initial expectation, may not be a cue to exploitability. It is also possible that the current methodology did not present or ask about cues related to physical formidability in a way that effectively captured their importance. Video or in-person interactions may be required for men to perceive these cues and relate them to exploitability. In-person interactions may be particularly important if it is relative difference in formidability that matters. Additionally, we only included the physical cues of tall, short, skinny, and fat. Other cues, such as low levels of muscularity, athleticism, and physical formidability, may be more strongly associated with perceptions of sexual exploitability.

The second purpose of this study was to test the hypothesis that cues to exploitability represent previously unexamined indicators of sexual attractiveness. Nineteen of the 22 cues correlated with sexual exploitability were also correlated with women's sexual attractiveness, strongly supporting this hypothesis. Furthermore, many of the cues that were not correlated with exploitability also did not correlate with short-term mate attractiveness. This suggests that the correlations with short-term mate attractiveness were not driven by men simply relaxing their preferences when evaluating women as short-term mates. The present findings contribute novel insights to the burgeoning literature on the science of attraction and attractiveness (Sugiyama, 2005; Swami & Furnham, 2008). In addition, these findings provide circumstantial support for one hypothesized function of the emotion of sexual attraction—to motivate men to pursue women for exploitative, short-term mating opportunities when there are cues suggesting that exploitative strategies are likely to be effective.

4.1. Limitations and future directions

Although our sample was limited to university students, we expect the ability to detect cues to sexual exploitability to be universally present. Future research should include men from different age groups and socioeconomic backgrounds. One benefit from using a young, university-attending sample is that these men may be particularly sensitive to cues to exploitability because (1) they are frequently in contact with younger women who exhibit more of these cues because of their youthful appearance and (2) they have lower status and fewer resources and may experience more difficulty attracting a high-quality mate through nonexploitative means.

The use of photographs provided consistent stimuli to examine cues to exploitability; however, some cues may not be assessable in a photograph. This may explain why some of our hypothesized cues to exploitability were not correlated with measures of sexual exploitability. Many behavioral cues (e.g., touching body, touching others, crying) may be more salient in in vivo social interactions. Future research could profit from using dynamic stimuli or live interactions to further expand knowledge about exploitability cues and to assess their relationship with sexual attractiveness.

Also needed is research that directly examines sexual attraction as a motivator for pursuing exploitable women. Investigating men's approach likelihood or arousal level when exposed to women displaying cues to exploitability will shed

light on the behavioral output that results from this attraction. Furthermore, it is possible that the experience of sexual attraction overrides the guilt or remorse men would feel from using a set of tactics that, while beneficial from a fitness perspective, are morally reprehensible, some of which are criminal (e.g., rape). Future work also could profitably examine men's conscious awareness of the relationship between perception of cues to exploitability and the sexual attraction they experience, as well as the potentially conflicting emotions they experience when presented with the opportunity to engage in a sexually exploitative strategy.

Generally, a cue's correlations with the four measures of exploitability were very similar. However, for some cues, the correlations with perceptions of ease of sexual assault differed from the other three exploitability measures—most were weaker than correlations with the other three measures. Perhaps cues to sexual exploitability are better characterized dichotomously—cues that suggest that a woman can be sexually assaulted versus cues that suggest that she could be sexually exploited in another way. This distinction may be driven by individual differences in men's likelihood of implementing these strategies. Only certain men may be motivated to implement strategies that require violence, such as sexual assault (Lalumière et al., 2005; Malamuth, 1996). Future research could fruitfully examine which men in which social circumstances adopt which exploitative tactics. Indeed, some tactics might be deployed in a hierarchical fashion, with increasingly cost-inflicting tactics being used only if milder forms of sexual exploitation fail.

This study provides a first step towards understanding the psychological mechanisms underlying men's sexually exploitative strategies. By examining the specific design features of mechanisms for sexual exploitation, this research reveals particular cues that activate these mechanisms, allowing the prediction of which cues put women at risk for sexual exploitation. The link between cues to exploitability and sexual attractiveness paves the way for future studies of sexual attraction as a mechanism motivating men's tactics of sexual exploitation.

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ORIGINAL PAPER

Women's Perceptions of Sexual Exploitability Cues and Their Link to Sexual Attractiveness

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Abstract Two studies examined women's perception of the relationship between sexual exploitability and sexual attractiveness and women's use of cues to sexual exploitability to signal sexual accessibility. Study 1 ($N = 77$) found that women accurately assessed other women displaying cues to sexual exploitability both as sexually exploitable and sexually attractive to men. Study 2 ($N = 74$) tested the predictions that women who were dispositionally inclined toward short-term mating, who were not in a committed relationship, and who perceived themselves to be low in mate value would be more likely to display cues to sexual exploitability as a mate attraction tactic. Results supported the first prediction. These results suggest that a subset of women, those dispositionally inclined toward a short-term mating strategy, employ the risky strategy of signaling sexual accessibility using cues to exploitability to advance their mating goals.

Keywords Sexual exploitability · Sexual accessibility · Mate attraction · Individual differences · Signaling

Introduction

It is now well documented that a woman's sexual attractiveness is predicated on fitness-based indicators of mate quality, such as cues to fertility, youth, and health (e.g., Fink & Penton-Voak, 2002; Gangestad & Scheyd, 2005; Sugiyama, 2005). Cues to mate quality, however, may not fully explain perceptions of women's sexual attractiveness. A woman's sexual attractiveness also appears to be based, in part, upon cues to her apparent sexual accessibility. In a study of mate attraction tactics, those rated most effective were signals of sexual accessibility (Greer & Buss, 1994). Men may find cues to sexual accessibility attractive because of their functional effect on mating motivation—the pursuit of women who represent a greater likelihood of payoff compared to women who are less sexually accessible (Clark, 2008).

Commonly examined cues to sexual accessibility are those that indicate a woman is *interested* in a sexual relationship. However, one relatively unexplored domain of cues to sexual accessibility consists of cues indicating a woman could be sexually *exploited* (Buss & Duntley, 2008). Recent work has empirically documented a novel finding in the attractiveness literature—that men find cues to sexual exploitability to be sexually attractive (Goetz, Easton, Lewis, & Buss, 2012). Stated differently, men will perceive two different women with identical mate qualities cues as differentially sexually attractive depending on which one displays more sexual exploitability cues. Currently unknown are (1) whether women similarly identify women displaying cues to exploitability to be sexually attractive to males and (2) whether some women use the intentional display of sexual exploitability cues as a mate attraction strategy that functions to capitalize on men's mate preferences. These were the central goals of the current research.

Cues to Sexual Exploitability and Their Link to Sexual Attraction

Goetz et al. (2012) had male participants rate the sexual exploitability, long-term mate attractiveness, and short-term mate attractiveness of photographed women pre-determined to be displaying varying levels of hypothesized exploitability

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cues. Men found women displaying cues to sexual exploitability to be attractive as short-term mates, but, importantly, not attractive as long-term mates. This evidence was consistent with the hypothesis that men have an evolved psychological mechanism designed to perceive cues to sexual exploitability as sexually attractive, presumably to motivate their pursuit of sexually accessible women.

Although these findings address men's perceptions of cues to exploitability, women's interpretation of these cues remains unknown. Because exploitability cues enhance a woman's sexual attractiveness to men, we hypothesized that women have coevolved mate attraction mechanisms designed to capitalize on this feature of male sexual psychology. Women are not passive pawns in men's game of mating (Buss & Duntley, 1999). Rather than these cues being solely markers of vulnerability, we hypothesized that women would have benefited from displaying exploitability cues to advance their own mating and relationship goals.

Exploitability as a Mate Attraction Strategy

Prior research on mate attraction tactics suggests that some women engage in mate attraction tactics that signal their sexual accessibility by advertising cues related to vulnerability to sexual exploitation. For example, some women report acting "ditzy" or "air-headed" as mate attraction tactics (e.g., Buss, 1988; Schmitt & Buss, 1996). Men may interpret these behaviors, veridically or non-veridically, to indicate these women could be more easily deceived, pressured, or coerced into sex. Although women report employing these sorts of tactics, a key question is whether they recognize that these cues' relationship with exploitability cause men to find them attractive.

Historically, women would have benefited from knowledge about the exploitability-attractiveness link in two ways. First, understanding which cues activate men's mate attraction mechanisms would have allowed them to manipulate their behavior to appear sexually attractive to men. Second, women would have benefited from understanding other women's mating behavior and intentions since women's primary competitors in mating are other women. In a study examining indirect aggression in women, female participants were exposed to a confederate dressed in revealing, "sexy" clothing or in conservative clothing and their reactions were video recorded. Women exposed to the sexy confederates made negative statements and engaged in more indirect aggression toward the sexy confederate than women exposed to the conservatively-dressed confederates (Vaillancourt & Sharma, 2011). This suggests that women are sensitive to other women's attempts to sexually attract men and behave negatively towards those engaged in such pursuits. Understanding that women who displayed cues to sexual exploitability were perceived as sexually attractive to men could have allowed women to better assess potential rivals and competitors for mates.

Individual Differences in the Use of Sexual Exploitability to Attract Mates

Advertising cues to exploitability is a mating strategy that comes with potential risks and costs. By signaling accessibility using these cues, a woman may attract men who are more prone to using coercion or force to exploit her, regardless of her desires. Appearing sexually accessible may also result in reputation damage in the eyes of other women (Campbell, 2002). Because men value sexual fidelity in long-term mates (Buss, 1989; Buss & Schmitt, 1993), gaining a reputation as being sexually exploitable may decrease a woman's attractiveness as a long-term mate. Finally, if a woman already has a mate, broadcasting sexual accessibility may incur additional costs, including coercive mate guarding, decreased investment, retaliation, or relationship termination (Buss, 2003; Buss & Duntley, 2011).

We hypothesized that women's mate attraction adaptations are designed to be sensitive to these potential risks and costs. Consequently, rather than a context-blind decision rule, we hypothesized that only certain women in delimited contexts would view tactics of displaying sexual exploitability to be an effective mate attraction strategy. Specifically, we hypothesized that three individual differences would predict which women would be more likely to report using mate attraction tactics that advertise cues to exploitability: propensity towards short-term mating, relationship status, and self-perceived mate value.

Individual differences in desire to engage in casual, uncommitted sex may influence which women will be more likely to use exploitability-related tactics to attract a mate. A variety of benefits to women for short-term mating have been hypothesized, including obtaining economic resource benefits, protection from other males, and genetic benefits for her offspring (Greiling & Buss, 2000; Thornhill & Gangestad, 2008). Women more inclined toward casual sex are more likely to implement mate attraction tactics that highlight their sexual accessibility (Bleske-Rechek & Buss, 2006). Women inclined toward short-term mating may be less concerned with the reputational costs that accompany advertising cues to sexual exploitability because such a reputation could enhance their ability to attract men who pursue short-term exploitative mating strategies. Research suggests that women with a greater inclination towards casual sex prefer more masculine men (Provost, Kormos, Kosakowski, & Quinsey, 2006; Provost, Troje, & Quinsey, 2008) and masculinity in men is associated with a greater number of reported short-term sex partners and a greater inclination toward short-term mating (Boothroyd, Jones, Burt, DeBruine, & Perrett, 2008; Rhodes, Simmons, & Peters, 2005). These findings suggest that women pursuing a short-term mating strategy target similarly inclined men. Displaying exploitability cues could be particularly useful to women inclined towards short-term mating because it may be especially effective in attracting men also interested in casual sex.

Single women may also value the benefit of being perceived as sexually accessible more than mated women, since mated women are generally less likely to be attempting to attract new mates. Mated women also face costs associated with their current partner perceiving they are sexually accessible, such as increased mate guarding from their partner and increased risk of partner violence (Cousins & Gangestad, 2007; Daly & Wilson, 1988; Kaighobadi, Starratt, Shackelford, & Popp, 2008). Because of these potential risks, mated women may perceive the costs associated with signaling accessibility as greater and, consequently, be less likely to display exploitability cues to attract mates.

Women low in mate value may be more inclined to employ riskier strategies than women high in mate value because they have more difficulty attracting and retaining mates. Mate value reflects an individual's current desirability on the mating market and is based on multiple components, including what members of the opposite sex perceive as sexually attractive in a partner, the specific preferences of each individual of the opposite sex currently seeking a partner, and other contextual features, such as operational sex ratio in the mating pool (Buss, 2003; Symons, 1987). There is mixed evidence about the influence of women's mate value on mating strategy. Some studies have found no significant relationship between women's self-perceived mate value and an inclination towards short-term mating (e.g., Clark, 2006; Landolt, Lalumiere, & Quinsey, 1995). One study found that women with a high number of lifetime sex partners had lower, and thus more attractive, waist-to-hip ratios than women with a low number of lifetime sex partners, suggesting a relationship between mate value and mating strategy in the opposite direction from what we hypothesized (Mikach & Bailey, 1999). Mikach and Bailey also reported no significant differences between women with a high or low number of sex partners on a variety of other mate value measures. However, these studies did not address the effect of self-perceived mate value on likelihood of implementing a risky, but possibly effective, mate attraction strategy. Because displaying exploitability cues could be a risky strategy, we hypothesized that women who perceived themselves as being lower in mate value would be more likely to endorse using this strategy than other women, who may be able to successfully rely on other, less risky, mate attraction strategies.

Present Studies

The present set of studies had two objectives. Study 1 tested if women identified other women displaying cues that men perceived as diagnostic of sexual exploitability and sexual attractiveness to be sexually exploitable and sexually attractive. Replicating the procedure employed by Goetz et al. (2012) with male participants, female participants viewed and rated images of women displaying hypothesized cues to exploitability. In Study 2, we examined individual differences in women's use of mate attraction tactics that involved the display of sexual exploitability cues.

Method

Participants

A total of 77 female students enrolled in an introductory psychology course participated and received partial course credit. The recruitment ad and consent form informed participants that the study's goal was to examine the relationship among women's perceived attractiveness and mating strategies and different physical and behavioral characteristics. Participants ranged in age from 18 to 26 years ($M = 18.7$, $SD = 1.34$). Two participants reported a sexual orientation other than heterosexual and two did not respond to the question assessing sexual orientation. Excluding these participants did not alter the study's findings in anyway and they were included in the analyses presented here. Participants were randomly assigned to one of three groups and only viewed about one-third of the total images to avoid fatigue effects. Group 1 ($n = 23$) viewed a randomized set of 36 photographed women while Group 2 ($n = 28$) and Group 3 ($n = 26$) each viewed a randomized set of 37 photographed women.

Measures

We used the identical set of 105 pictures (containing 110 women to be rated) and 63 hypothesized cues to exploitability evaluated by male participants in Goetz et al. (2012). These images were originally selected from publically available sources on the Internet because they contained women displaying hypothesized cues to exploitability. Two of the researchers coded cues that could be determined as present or absent in the pictures (e.g., touching hair, finger on lips). To quantify the degree to which women in the photographs displayed cues that could not simply be coded as present or absent (e.g., immature, intelligent), the researchers employed four independent raters to rate the presence of these cues in the images. Cues that did not receive a high enough level of agreement among the raters were eliminated. This allowed for the calculation of an average rating of each cue in each image to quantify how much a cue was displayed. This process resulted in 63 cues that were reliably present in the images (see Goetz et al. for reliability analyses associated with the cues and a detailed explanation of the picture selection process).

Participants answered the same four questions about the women's perceived exploitability and the same five questions about attractiveness as did male participants in Goetz et al.

(2012). The first exploitability question asked women to evaluate, "How easy would it be for a man to seduce this woman into engaging in sexual intercourse?" The next two questions were phrased the same way but replaced the word seduce with "pressure" and "deceive." The fourth question asked, "How easy would it be for a man to sexually assault this woman?" The attractiveness questions assessed the target woman's perceived long-term mate attractiveness ("How attractive would this woman be to a man as a long-term mate [e.g., committed romantic relationship, wife, etc.]?"), short-term mate attractiveness ("How attractive would this woman be to a man as a short-term mate [e.g., one-night stand, casual sex, etc.]?"), and physical attractiveness ("How attractive is this woman's face?", "How attractive is this woman's body?", and "How attractive is this woman overall?"). Participants responded to all questions using a rating scale ranging from 1 (not at all) to 5 (extremely). Participants also completed a demographics questionnaire to record their age, ethnicity, sexual orientation, and relationship status.

Procedure

A research assistant explained to the participant how to advance through a prepared PowerPoint slide show of the set of images the participant was assigned to view. The research assistant then left the participant alone in the room to record her responses privately. After viewing each image, the participant rated the woman in the image on the exploitability and attractiveness measures. If a picture contained more than one woman, the image was clearly labeled with which woman should be evaluated. To avoid fatigue effects (the entire procedure took approximately 45 min), the research assistant interrupted participants after 25 min and provided them with the demographics questionnaire and instructed them to complete that before returning to the picture rating task.

Results

Because participants only viewed a subset of pictures, we conducted a one-way analysis of variance between each group on the four exploitability and three attractiveness measures to ensure that there were no systematic differences based on set of pictures viewed. There were no significant differences between groups except for the measures of assault (Group 1: $M = 2.87$, $SD = .54$; Group 2: $M = 3.18$, $SD = .45$; Group 3: $M = 2.59$, $SD = .50$, $F(2, 109) = 12.83$, $p < .05$) and long-term mate attractiveness (Group 1: $M = 3.05$, $SD = .64$; Group 2: $M = 3.06$, $SD = .68$; Group 3: $M = 3.45$, $SD = .80$; $F(2, 109) = 3.88$, $p < .05$). Because the majority of the measures (seven out of nine) did not show between groups differences, and because there was no reason to suggest that the existing differences would affect interpretation of the study's results, we proceeded with analyses as planned.

Data were organized and analyzed to correspond with analysis of male participants in Goetz et al. (2012). Participant ratings were averaged to generate a score for each measure of exploitability for each image. Because these four exploitability measures were highly correlated with one another ($M = .89$, range: $r = .79$–$.97$), the scores were averaged to generate an overall exploitability score for each image. We calculated Pearson correlation coefficients between the rating means for each cue and the overall exploitability scores to determine which cues women viewed as diagnostic of exploitability. To isolate the relationship between each cue and each woman's perceived mate attractiveness and exploitability, we statistically partialed out participant's ratings of overall physical attractiveness when calculating the correlations. Overall physical attractiveness was highly correlated with facial attractiveness, $r(108) = .96$, $p < .001$, and body attractiveness, $r(108) = .94$, $p < .001$, prompting its use as our measure of physical attractiveness. Physical attractiveness was significantly correlated with both long-term and short-term mate attractiveness, but not exploitability: long-term: $r(108) = .72$, $p < .001$; short-term: $r(108) = .70$, $p < .001$; exploitability: $r(108) = .12$. Because each correlation between a cue and the participant ratings represented a test of an independent prediction, because the number of significant correlations far exceeded what would be expected by chance, and because they were all predicted a priori, we report the data without applying a statistical correction (see the footnote in Table 1). Furthermore, we wanted to keep analyses equivalent to those employed by Goetz et al. to allow for comparison between men and women.

To ensure there was overall agreement between men's and women's assessments, we calculated the single measures intraclass correlation between the women's average ratings for each image and the men's average ratings computed by Goetz et al. (2012). There was a high level of agreement between men and women on all measures (short-term mate attractiveness: .82, long-term mate attractiveness: .83, exploitability: .83).

Sixteen cues positively correlated with exploitability. Fourteen of these cues were the same cues determined to be diagnostic of exploitability by Goetz et al.'s (2012) male participants: Attention seeking, Come hither look, "Easy," Flirty, Immature, Intoxicated, Open body posture, Partying, Promiscuous, Promiscuous friends, Reckless, Revealing clothing, Sleepy, and Young. Two additional cues, Tight clothing and Materialistic, were also positively correlated with perceptions of exploitability. Fifteen of these cues conformed to the hypothesized pattern and were significantly positively correlated with short-term mate attractiveness and were either negatively or not significantly correlated with long-term mate attractiveness. The cue Young was not significantly correlated with short-term mate attractiveness, but was negatively correlated with long-term mate attractiveness.

Eight cues negatively correlated with perceptions of exploitability: Age, Anxious, Being touched, Flushed face, Intelligent, Old, Passed out, and Shy. These paralleled the eight cues

Table 1 Correlations between cues, sexual exploitability, and mate attractiveness

	Exploitability	STM attractiveness	LTM attractiveness
Positively correlated cues			
"Easy"	.85***	.80***	−.71***
Promiscuous	.74***	.78***	−.73***
Immature	.69***	.69***	−.70***
Intoxicated	.69***	.56***	−.43***
Reckless	.69***	.73***	−.77***
Partying	.61***	.61***	−.48***
Flirty	.57***	.61***	−.46***
Promiscuous friends	.55***	.69***	−.58***
Attention-seeking	.53***	.60***	−.64***
Revealing clothing	.49***	.55***	−.49***
Open posture	.38***	.46***	−.32**
Tight clothing	.36***	.46***	−.38***
Sleepy	.34***	.23*	−.14
Come hither look	.29**	.31**	−.31**
Materialistic	.28**	.39***	−.40***
Young	.25**	.18	−.28**
Alone	.15	.11	−.07
Punk	.14	.30**	−.50***
Touching face/hair	.14	.28**	−.02
Ring (wedding/ engagement)	.13	.06	−.07
Confident	.12	.29**	−.14
Finger on lips	.12	.14	−.01
Touching breast	.10	.28**	−.02
Mostly with men	.09	.12	−.15
Tattoos	.09	.01	−.03
Tucking hair	.09	.12	−.10
Smiling	.08	.07	−.26*
At a wedding	.06	.10	−.20
Over-shoulder look	.06	−.01	−.04
Skinny	.05	−.03	−.17
Fat	.05	.07	.18
Friendly	.04	−.04	.25**
Laughing	.03	.08	−.09
Tall	.00	−.01	−.05
Negatively correlated cues			
Intelligent	−.70***	−.76***	.71***
Shy	−.49***	−.60***	.58***
Age	−.27**	−.23*	.29**
Flushed face	−.27**	−.17	.11
Passed out	−.27**	−.21*	.21*
Anxious	−.26**	−.26**	.03
Old	−.25**	−.17	.24*
Being touched	−.20*	−.21*	.07
Dancing	−.17	−.11	.02
Prostitute	−.16	−.20*	.18
Sucking on a straw	−.15	−.19	.11
Sad	−.14	−.25**	−.09
Flushed neck	−.13	−.08	.10
Open legs	−.12	−.14	.09
Standing near men	−.12	−.05	−.05
Canted neck	−.11	−.09	.19
Piercings	−.11	−.20*	.28**
Lying back	−.11	−.06	−.06
Touching others	−.11	−.10	.00
Asleep	−.08	−.06	−.07
Crying	−.07	.09	.01
Touching thigh	−.07	−.12	−.00
Raised arms	−.06	−.08	−.02
Touching knee	−.06	.07	.11
Ear piercing	−.05	−.08	.04
Distressed	−.04	−.14	−.20*
Short	−.03	−.02	.12
Touching body	−.02	−.06	.11
Lip lick/bite	−.01	−.05	−.09

Of the 189 correlations presented, 46 correlations were significant beyond the .001 level, where <1 would be expected by chance alone; 66 were significant beyond the .01 level, where 2 would be expected by chance alone; and 77 were significant beyond the .05 level, where 10 would be expected by chance alone

*** $p < .001$, ** $p < .01$, * $p < .05$

reported by Goetz et al. (2012) as being negatively correlated with perceptions of exploitability. Six of these cues conformed to the hypothesized pattern and were significantly negatively correlated with perceptions of short-term mate attractiveness and either positively, or not correlated with, perceptions of long-term mate attractiveness. Flushed face and Old were negatively correlated with exploitability, but neither were significantly correlated with short-term mate attractiveness (Table 1).

In sum, we predicted that women's assessments of these cues would concur with men's assessments. Only two cues were significantly correlated with exploitability in the women that were not significantly diagnostic of exploitability by men (Tight clothing and Materialistic). All 14 of the cues men perceived as positively correlated with exploitability were also perceived as positively correlated with exploitability by women. All 8 cues men perceived as negatively correlated with exploitability were perceived that way by women as well.

Discussion

We examined hypothesized cues to sexual exploitability to determine whether women's perception of these cues showed concordance with men's perception of these cues. All 22 of he

cues originally determined to be correlated with perceptions of exploitability by Goetz et al.'s (2012) male participants were also judged as indicative of exploitability by the female participants in the present study. Women also rated the majority of these cues as being correlated with sexual attractiveness, but not long-term mate attractiveness. This suggests that women were aware of how certain body postures, actions, and characteristics enhance or detract from a woman's perceived sexual exploitability to men. Furthermore, women recognized these cues also influenced a woman's perceived sexual attractiveness.

One limitation was that our participants were limited to university undergraduates who may have limited mating experience. However, the results suggest that extensive mating experience may not be required to recognize these associations. Nonetheless, future research would benefit from examining the effects of age and sexual experience on her perception of these cues.

Study 2

Because of the link between exploitability and sexual attractiveness, some women may use sexual exploitability as a tactic to attract men. We hypothesized three individual differences that would predict a greater usage of using exploitability cues to signal sexual accessibility as a mate attraction strategy. We predicted that women more inclined towards short-term mating, unmated women, and women with lower self-perceived mate value would report that they would be more likely to use mate attraction tactics that advertise sexual exploitability. In Study 2, we used the cues determined to be diagnostic of sexual exploitability in Study 1 to generate potential mate attraction tactics. We also assessed mate attraction tactics not associated with exploitability to compare women's reported use of these tactics to their reported use of tactics related to exploitability. We hypothesized that these individual differences would affect women's evaluations of their prospective usage of exploitability-related tactics, but not their evaluations of their prospective usage of non-exploitability related tactics.

Method

Participants

A total of 74 women ranging in age from 19 to 60 years ($M = 30.05$, $SD = 8.86$) completed the survey. Twenty other potential participants were excluded from analyses because they did not complete the entire instrument ($n = 6$) or they reported a sexual orientation other than heterosexual ($n = 14$). Women self-reported their relationship status as single ($n = 22$), dating ($n = 3$), exclusive relationship ($n = 19$), married ($n = 30$), or other ($n = 0$). We classified single or dating participants as "Unmated" and participants in an exclusive relationship or married as "Mated."

To assess a sample of women from a greater age range than the participants in Study 1, we recruited participants through Amazon's Mechanical Turk (MTurk). MTurk is a small-task crowdsourcing marketplace operated through Amazon.com. Requesters can distribute small tasks to a large number of workers online for a small price. For the current study, participants were required to be female, English speaking, and have an approval rating of 95 % from previous requesters of their work. Participants received $.40 for completion of the task, a rate similar to other tasks on MTurk that take the same amount of time to complete. Research into the efficacy of MTurk suggests that participants recruited via MTurk at this approval rating level generate data as reliable as data collected via traditional offline methods (Burhmester, Kwang, & Gosling, 2011).

Measures

Using the cues found to be correlated with perceptions of sexual exploitability in Study 1 and by Goetz et al. (2012), we generated potential tactics a woman could use to sexually attract a mate. Each cue was used to generate a possible behavior or action. For example, the cue "Reckless" was used to generate the tactic "Act recklessly." Some cues generated more than one tactic (e.g., the cue "Intoxicated" generated the tactics "Act intoxicated" and "Get intoxicated"). We omitted three cues, Flushed face, Passed out, and Promiscuous friends, because of difficulty in translating them into implementable tactics. In total, this generated 20 tactics (Table 2). Participant responses to these 20 tactics were averaged (the tactics "Act anxious," "Act shy," and "Allow others to touch you" were reverse-scored because of their associated cues' negative correlations with exploitability) to generate an exploitability-tactics score for each participant ($\alpha = .85$). Six additional tactics were included. The tactic "Act like you could be sexually exploited" assessed women's explicit endorsement of using exploitability to sexually attract a mate. The other five tactics have not previously been associated with sexual exploitability: Act friendly, Act kind, Make yourself look more attractive, Smile, and Talk about interests you share with the person you are interested in. Including these allowed us to compare women's endorsement of tactics associated with exploitability to tactics not associated with exploitability. We averaged participant responses to these five tactics to generate a score for tactics not related to exploitability for each participant ($\alpha = .83$). In all, participants rated 26 tactics.

Instructions to participants read: "Listed below are possible tactics you could use to make yourself appear more sexually attractive to a potential mate. Imagine you may have the opportunity to interact with potential mates that you are interested in. Please rate the likelihood that you would engage in each of the following tactics to make yourself sexually attractive to a potential mate or mates." Participants rated each item on 7-point scale that ranged from "Very unlikely" to "Very likely." Participants

Table 2 Tactics for signaling exploitability

Cue	Associated tactic
Attention-seeking	Seek attention from others
Anxious	Act anxious
Being touched	Allow others to touch you
Come hither look	Give men a "come hither" look
"Easy"	Act "easy"
Flirtatious	Act flirtatiously
Immature	Act immature
(not) Intelligent	Act less intelligent than you are
	Act less intelligent than other women around you
	Act less intelligent than the person you are interested in
Intoxicated	Act intoxicated
	Get intoxicated
Open body posture	Have open body posture
Partier	Act like a partier
Promiscuous	Act promiscuous
Reckless	Act recklessly
Revealing clothing	Wear revealing clothing
Shy	Act shy
Sleepy	Act sleepy
Young	Act young

completed the tactics survey first to ensure their contemplation of their sexual history and mate value did not influence their evaluation of their mate attraction tactics.

Participants completed a demographics questionnaire assessing their age, ethnicity, sexual orientation, and relationship status, as well as the revised Sociosexual Orientation Inventory (SOI-R), which measures inclination towards short-term, casual sex by assessing sexual attitudes, behaviors, and desires (Penke & Asendorpf, 2008). The SOI-R consists of nine items. Three items assess frequency of sexual behaviors and number of sexual partners on a 5-point numerical scale anchored at "0" and "Eight or more." The three items assessing attitudes ask participants how much they agree with statements about causal sex such as "I can imagine myself being comfortable and enjoying casual sex with different partners" and are scored on a 5-point Likert scale. The three items assessing desires asked about the frequency of sexual fantasies and arousal and were scored on a 5-point scale ranging from "Never" to "Nearly every day." Responses to each item were coded as 1–5 and summed to generate an overall score. Three subscores can also be computed that reflect behaviors related to casual sex, attitudes towards casual sex, and desire for casual sex by summing the values three items that relate to each construct. Low scores on the SOI-R indicate an individual is less inclined towards short-term mating while high scores indicate an individual is more inclined towards short-term mating.

Participants completed three measures to assess their self-perceived mate value. Because of the previous mixed findings with respect to women's mate value and sexual strategies in the literature, we assessed mate value in a number of ways to test our mate value prediction. Participants completed the Mate Value Inventory (MVI) (Kirsner, Figueredo, & Jacobs, 2003), which asks participants to rate themselves on 17 traits theoretically linked to assessments of mate quality, such as intelligence, attractiveness, and health. Participants responded to the question "How well do you feel that these attributes apply to you currently?" on a scale of −3 (extremely low on this trait) to +3 (extremely high on this trait). Ratings were summed to generate an overall mate value score. They also completed the Components of Self-Perceived Mate Value Survey (CMVS) (Fisher, Cox, Bennett, & Gavric, 2008), which consists of 22 items that measure seven factors associated with mate value, including perceived attractiveness, relationship history, and how the opposite sex views the person taking the survey. Participants rated how much they agreed each statement applied to them using a Likert-type scale ranging from 1 (strongly disagree) to 7 (strongly agree) Items were summed to generate an overall self-perceived mate value score. Finally, participants completed the Body Esteem Scale (BES) (Franzoi & Shields, 1984), which asked participants to rate their feelings about 35 of their body parts. Participants rated each body part on a 5-point scale ranging from 1 (have strong negative feelings) to 5 (have strong positive feelings). Thirteen of these items sum to create a Sexual Attractiveness subscale for females. We used this subscale as the third measure of self-perceived mate value, as it reflected women's self-perceived sexual attractiveness.

Procedure

Participants viewed the study description on MTurk, which explained that they would provide their perceptions of different mate attraction tactics and answer questions about their personality and behaviors. The description provided a link to the survey hosted at Qualtrics.com. Participants read the consent page and, after agreeing to participate, continued to the tactics survey. After completing the tactics survey, participants completed the demographics questionnaire, the MVI, the CMVS, the SOI-R, and the BES. Participants viewed a debriefing page that explained the goal of the study was to assess individual differences in women's endorsement of different mate attraction tactics and thanked them for their participation.

Results

First, we compared participants' overall evaluations of the likelihood of using exploitability-related tactics to using non-exploitability related tactics by performing a paired samples t test on the participants' averaged scores on these two set of tactics. Women reported a higher likelihood of using non-exploitability related tactics ($M = 5.98$, $SD = .75$) than exploitability related tactics ($M = 3.40$, $SD = .84$), $t(73) = -17.24$, $p < .001$.

Table 3 Regression of likelihood of using exploitability-related tactics on relationship status, self-perceived mate value, and inclination towards short-term mating

Model	*B*	*SE*	β	*t*	*p*
Constant	1.56	.44		3.58	.001
Relationship status	−.05	.18	−.03	<1	ns
Mate value (CMVS)	.01	.01	.21	1.95	.06
SOI	.05	.01	.45	4.02	<.001

Next, we performed multiple regression analyses to examine the effect of a woman's score on the SOI-R, relationship status, and self-perceived mate value on endorsement of mating tactics indicative of sexual exploitability. The relationship status variable, $\beta = -.08$, $t(72) < 1$, scores on the MVI, $\beta = -.01$, $t(72) < 1$, and scores on the Sexual Attractiveness subscale of the BES, $\beta = .17$, $t(72) = 1.68$, $p = .10$, did not yield significant results. The CMVS was used as the measure for mate value for the subsequent analyses. Tests for multicollinearity indicated that a low level of multicollinearity was present (tolerance = .92, .82, .76 for relationship status, CMVS, and SOI, respectively).

The CMVS resulted in a trend just short of conventional significance such that women with a higher self-reported mate value reported they would be more likely to use exploitability related tactics (Table 3). SOI-R scores alone significantly predicted prospective usage of exploitability tactics. Women more inclined towards short-term mating indicated that they would be more likely to use exploitability related tactics when trying to sexually attract a man, $\beta = .54$, $t(72) = 5.50$, $p < .001$, $R^2 = .30$, $F(1,72) = 30.27$, $p < .001$. Because the SOI-R is comprised of three subscales measuring behavior, attitudes, and desires, we examined each subscale by replacing the total SOI score with each subscale in the model to determine which were driving this relationship. All three subscales showed the same significant relationship as the total SOI-R score, behavior: $\beta = .38$, $t(72) = 3.44$, $p < .01$, $R^2 = .14$, $F(1, 72) = 11.84$, $p < .01$; attitudes: $\beta = .41$, $t(72) = 3.77$, $p < .001$, $R^2 = .17$, $F(1, 72) = 14.19$, $p < .001$; desires: $\beta = .56$, $t(72) = 5.71$, $p < .001$, $R^2 = .31$, $F(1, 72) = 32.57$, $p < .001$.

To determine whether a woman's score on the SOI-R predicted likelihood of using the mate attraction tactics not related to exploitability, we performed a linear regression on the sum of the non-exploitability related tactics with SOI-R scores as the predictor. No significant relationship existed between SOI-R scores and prospective usage of these tactics, $\beta = -.14$, $t(72) = -1.21$, $R^2 = .02$, $F(1, 72) = 1.45$.

Finally, we examined women's responses to the single item explicitly assessing their usage of signaling sexual exploitability to attract a mate. We found the same significant relationship in this explicit item as in the sum of the exploitability related tactics—women inclined toward short-term mating indicated they would be more likely to act like they could be sexually exploited to attract a mate than women less inclined to short-term mating, $\beta = .48$, $t(72) = 4.69$, $p < .001$, $R^2 = .23$, $F(1, 72) = 21.95$, $p < .001$.

Discussion

We explored women's assessments of mate attraction tactics related to sexual exploitability and tactics not related to exploitability. Individual differences emerged when examining the likelihood that a woman would use exploitability-related tactics. The key finding was that women more inclined towards short-term casual sex exhibited a higher probability of using exploitability-related mate attraction tactics than their long-term mating counterparts. This suggests that women who employed different mating strategies deployed exploitability-related tactics to different degrees. Women less inclined toward short-term mating may be less willing to appear sexually exploitable because of the potentially negative effects on their long-term mate attractiveness. Women more interested in short-term mating, on the other hand, may benefit from using tactics associated with sexual exploitability to sexually attract men. Furthermore, these women were also more likely to explicitly acknowledge that they would act sexually exploitable to attract a mate. These findings support the general hypothesis that women differ predictably in their tactics of attraction and the more specific hypothesis that women who were more inclined to use a short-term mating strategy were more likely to take advantage of men's attraction to sexual exploitability to advance their own mating goals.

Alternatively, women's experience with implementing these tactics may have influenced their prospective use of them. Women who have successfully attracted mates by behaving in an exploitable manner in the past may view this as a more effective strategy than women who have attempted to implement this strategy with little success. However, the current findings suggest that it is not only a woman's behavioral history that drives her assessment of signaling accessibility using exploitability-related tactics, because the attitudes and desires subscales of the SOI-R showed the same trends as the behaviors subscale. Future research could profitably examine women's reported experience with each of these tactics and women of varying sexual experience levels to further determine the effect of experience with these tactics on the likelihood of their use.

Overall, participants indicated that they would be more likely to use non-exploitability related tactics than exploitability-related tactics. Moreover, women's prospective usage of tactics not related to exploitability did not differ based on their dispositional inclination towards short-term mating. This suggests that it was specifically within tactics associated with being perceived as exploitable where individual differences based on mating strategy existed.

Two a priori predictions received no empirical support—there were no significant differences in prospective use of exploitability-related tactics based on relationship status or self-perceived mate value. There may be other contextual ele-

ments of a woman's relationship status that influence her likelihood of using exploitability cues to attract mates. For example, women less satisfied with their current relationships may be more likely to use risky strategies to attract a new mate. Conversely, women high in relationship satisfaction may be less likely to use these strategies because of the potential relationship-jeopardizing risks associated with them. Similarly, unmated women who are dissatisfied with their relationship status may, over time, expand the range of their tactics of attraction to include those that signal sexual exploitability. Future research using a longitudinal design to examine changes in women's behaviors correlated with changes in relationship status or satisfaction could more fruitfully address these questions.

Our measures of self-reported mate value did not predict the prospective use of exploitability-related tactics, which was consistent with existing work showing no significant relationship between women's self-perceived mate value and preferred mating strategy (Clark, 2006; Landolt et al., 1995). This lack of significant findings suggests that a woman's self-perceived mate value does not predict her usage of signaling exploitability. However, these null findings may have stemmed from inaccuracies in women's judgments of their own mate-value (Back, Penke, Schmuckle, & Asendorpf, 2011). If there are real differences in women's use and endorsement of exploitability-related tactics based on mate value, a non-self-report methodology may be needed to reveal them. Women may engage in self-deception about their mate attraction tactics. Self-deception in this context would be beneficial because it would allow women to believe that their mate attraction tactics do not involve portraying themselves as exploitable (for a review of the adaptive benefits of self-deception, see von Hippel & Trivers, 2011).

The current methodology relied on women's conscious perception of their prospective behavior. This may have limited our findings to reveal differences only in women who were aware of their use of behaving sexually exploitable as a mate attraction strategy or who believed they would behave that way. Long-term mating inclined women may employ this strategy but be unaware of their behavior or unwilling to admit it. If so, our findings underestimated the number and types of women that did use exploitability-related tactics to attract mates. Perhaps women inclined toward short-term mating were more self-aware of their mate attraction tactics than other women. It is also possible that women's beliefs about what mate attraction tactics they would employ in a given situation were inaccurate. Our findings instead would have captured differences in women's beliefs about their likelihood of advertising exploitability, rather than their actual likelihood of behaving in ways that would do so. Future research would benefit from objective observation of women actively engaged in mate attraction to assess their use of signaling accessibility by using cues to exploitability although these sorts of in vivo studies carry their own formidable limitations, since participants might alter their behavior when under direct observational scrutiny.

General Discussion

The present set of studies offered several novel insights into a previously unexamined mate attraction strategy in women. Findings from Study 1 suggested that women recognized the same cues to sexual exploitability and sexual attractiveness as do men. Findings from Study 2 suggested that a predictable subset of women used this knowledge to their advantage. Women with a greater interest in casual sex reported a greater prospective likelihood of using mate attraction tactics related to sexual exploitability more than other women. Because these women may achieve their mating goals through appearing sexually attractive, appearing sexually exploitable may benefit them, even if it detracts from their attractiveness as a long-term mate.

These studies highlight a unique class of mate attraction tactics that some women employ. Previous work has found that men's and women's mate attraction tactics are dependent, at least in part, on the desires and preferences of the opposite sex (Buss, 1988). Findings from the current studies suggest that mate attraction tactics may be further tailored based on the type of relationship a person is seeking. This key conclusion was supported by other work on mate attraction tactics that suggests that women vary their mating tactics based on the level of investment they expect from potential mates—women expecting high levels of investment act chaste and emphasize their fidelity whereas women who do not expect investment flaunt their sexuality to extract pre-reproductive investment from as many males as possible (Cashdan, 1993). The current studies added another nuance to women's context-dependent adjustment of their use of a unique mate attraction strategy. This mate attraction strategy is particularly important to understand because of the likely costs women incur when employing it. These studies provide initial insight into which women are more likely to use tactics that put them at a greater risk for exploitation. They also lay the groundwork for research extending these findings by examining specific contexts in which women implement an exploitability-displaying strategy, the efficacy of such a strategy, and the downstream effect that advertising exploitability has on a woman's reputation.

These findings also expand our knowledge of the domain of sexual exploitability. Much of the research in this area has focused on individual differences in men and situational contexts that affect the likelihood of men committing sexual aggression (e.g., Abbey, Jaques-Tuira, & LeBreton, 2011; Malamuth, 2005). Some studies have also focused on the victim-related cues related to risk of being sexually exploited (Goetz et al., 2012; Greene & Navarro, 1998; Testa & Dermen, 1999). The current studies examined previously unexplored component of exploitability—the way in which women perceive cues that are diagnostic of exploitability, and capitalize upon being perceived as exploitable to advance their own mating goals.

These studies provided a first step in understanding women's perception of cues to sexual exploitability. Our findings suggest

that not only are women aware of the cues that men use to evaluate sexual exploitability and sexual attractiveness, but also that a predictable subset of women uses the relationship between the two to their advantage.

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