factors apart from preferences that determine choices – see the devastating "rational fools" article by Sen (1978).

7. The possibility of systematic irrationality, or of demonstrating it empirically, has been questioned, notably by Broome (1991), Cohen (1981), and Stein (1996).

8. See, for example, Bicchieri (1993, Chs. 2, 3); Colman (1997; 1998); Cubitt and Sugden (1994; 1995); Hollis and Sugden (1993); McClennen (1992); Sugden (1991b; 1992). The common knowledge assumptions are sometimes relaxed in recent research (e.g., Aumann & Brandenburger 1995).

9. In other circumstances, experimental evidence suggests that human reasoners do not even come close to full common knowledge (Stahl & Wilson 1995).

10. The theory is determinate for every strictly competitive (finite, two-person, zero-sum) game, because if such a game has multiple equilibria, then they are necessarily equivalent and interchangeable, but this does not hold for other games.

11. See Colman (1995a, pp. 169–75) for a simple example of an empty core in Harold Pinter's play, *The Caretaker.*

12. Even Hume nods. Port comes from Portugal, of course.

13. Janssen's (2001b) principle of *individual team member rationality* is slightly weaker (it does not require equilibrium): "If there is a unique strategy combination that is Pareto-optimal, then individual players should do their part of the strategy combination" (p. 120). Gauthier's (1975) *principle of coordination* is slightly stronger (it requires both equilibrium and optimality): "In a situation with one and only one outcome which is both optimal and a best equilibrium . . . it is rational for each person to perform that action which has the best equilibrium as one of its possible outcomes" (p. 201).

14. If e and f are any two equilibrium points in a game, then e risk-dominates f if and only if the minimum possible payoff resulting from the choice of the strategy corresponding to e is strictly greater for every player than the minimum possible payoff resulting from the choice of the strategy corresponding to f. According to Harsanyi and Selten's (1988) risk-dominance principle, if one equilibrium point risk-dominates all others, then players should choose its component strategies. It is used when subgame perfection and payoff dominance fail to yield a determinate solution.

15. According to the sure-thing principle, if an alternative a_i is judged to be as good as another a_j in all possible contingencies that might arise, and better than a_j in at least one, then a rational decision maker will prefer a_i to a_j. Savage's (1954) illustration refers to a person deciding whether or not to buy a certain property shortly before a presidential election, the outcome of which could radically affect the property market. "Seeing that he would buy in either event, he decides that he should buy, even though he does not know which event will obtain" (p. 21).

16. I am grateful to Werner Güth for this insight.

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Cooperation, evolution, and culture

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Abstract: Rejecting evolutionary principles is a mistake, because evolutionary processes produced the irrational human minds for which Colman argues. An evolved cultural ability to acquire information socially and infer other's mental states (mind-reading) evokes Stackelberg reasoning. Much of game theory, however, assumes away information transfer and excludes the very solution that natural selection likely created to solve the problem of cooperation.

Colman rejects the relevancy of evolutionary game theory to his argument that rationality is not a general characteristic of human social interaction. Although the evolutionary process of natural selection is indeed mindless, as Colman notes, it is useful to consider that mindless evolutionary processes produced human minds. Human minds, and the behaviors that they produce, remain the focus of our interests. If people are less than rational in social interactions, as Colman suggests, it is because we evolved that way. The fact that rationality leads to inferior outcomes in social dilemmas, compared to alternative forms of reasoning, lends support to the idea that selection might have favored something other than strict rationality in our evolutionary past. Many of the ad hoc principles of psychological game theory introduced at the end of the target article might be deductively generated from the principles of evolutionary theory.

An evolutionary approach encourages the use of the comparative method. The ability of humans to cooperate to achieve common goals is nearly unique among animals and is perhaps matched in scope only by the social insects (Hill 2002). While insects accomplish their collectivity through rigid genetic rules, there is much to suggest that we are able to achieve our level of ultrasociality via cultural mechanisms (Richerson & Boyd 2001). Exactly how humans accomplish this is one of the key questions of the social sciences.

Researchers interested in the evolution of cultural abilities – culture is defined as the social transmission of information – should be particularly intrigued by the issues related to coordination that Colman raises. Among other advantages, cultural mechanisms provide people the ability to infer each other's mental states, to preferentially assort with others who have similar (or complementary) intentions or capabilities, and to reap the advantages of coordinated activities (Alvard, in press; Boyd & Richerson 1996; Tomasello 1999). Focal point selection is facilitated by cultural mechanisms that create shared notions among individuals. Colman hints at this himself when he says, "To remove . . . the culturally determined labeling of strategies, is to filter out the focal points" (target article, sect. 5.4, last para.). Having shared notions greatly enhances the ability to solve simple yet common and important coordination games.

The forms of psychological games Colman describes as alternatives to the classic game forms depend on psychological expectations. Stackelberg reasoning, for example, involves anticipating the other player's choices. Such reasoning requires a sophisticated theory of mind where others are viewed as intentional agents. It also suggests the related concept of mind-reading (Baron-Cohen 1995; Cheney & Seyfarth 1990). Not nearly as mysterious as it

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sounds, though perhaps a uniquely human capability, mind-reading is the ability to reason about the otherwise unobservable mental states of others and make predictions about their behaviors based partly on the awareness that others are intentional agents with general goals similar to one's own. Colman uses the phrasing of mind-reading in his description of how a Stackelberg-reasoning player might deliberate.

It seems that cultural mechanisms solve cooperative problems so transparently, however, that many do not recognize them as solutions at all. Broadly speaking, communicating via spoken language can be construed as mind-reading. I can utter a sound and others can predict my intent based on that sound, unless they do not share my otherwise arbitrary association between sound and meaning. Part of the problem of classic analytic game theory revolves around the standard assumption that players do not speak to one another. This assumption is put into practice in experimental game research where subjects usually do not communicate during experiments. It seems that pre-game communication among subjects is such a simple solution to many games that researchers routinely disallow it in order for the "truly" interesting solutions to emerge (van Huyck et al. 1990). Although "cheap talk" solutions may seem trivial to game theoreticians, because all extant humans can easily communicate this way, from a comparative evolutionary perspective, such a solution is far from trivial. Although simple communication among players is often sufficient to generate complexly coordinated behaviors, speaking is anything but simple. Such a research design excludes the very solution that natural selection likely created to solve the problem. Experimental social games in which subjects are not allowed to speak to one another are a bit like sports competitions where subjects must compete with their legs shackled together.

Verbalizing intent may be feasible in small groups, but how do humans communicate expectations between members of large cooperative groups like those that characterize most human societies – ethnic groups, for example – in which many interactions are seemingly anonymous? How do fellows know that they share beliefs concerning behavior critical for coordination? How can individuals predict what others think and will do in such large groups? There are a number of options. One could attempt to learn, on one's own, the beliefs of all the potential cooperative partners. This could prove difficult, time-consuming, and error-prone (Boyd & Richerson 1995). In addition to speaking, however, humans use symbols and markers of group identity to transmit information that helps them make predictions about the otherwise unobservable mental states of others. McElreath et al. (2003) argue that group markers, such as speech or dress, function to allow individuals to advertise their behavioral intent so that individuals who share social norms can identify one another and assort for collective action. Although cheaters are a problem if interaction is structured like a prisoner's dilemma, McElreath et al.'s critical point is that group markers are useful if people engage in social interactions structured as coordination games. Colman notes the advantages of making predictions about the behavior of others based on information acquired culturally.

The great potential payoffs from successfully navigating real-life coordination games may have been part of the selective pressure favoring the evolution of language and culture. Coordination problems abound, and their solutions are facilitated when players have the ability to quickly acquire expectations about fellow players' behavior. Whether such adaptations are rational or not, ignoring the evolutionary mechanisms that produced these cognitive abilities is a mistake.

Humans should be individualistic and utility-maximizing, but not necessarily "rational"

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Abstract: One reason why humans don't behave according to standard game theoretical rationality is because it's not realistic to assume that everyone else is behaving rationally. An individual is expected to have psychological mechanisms that function to maximize his/her long-term payoffs in a world of potentially "irrational" individuals. Psychological decision theory has to be individualistic because individuals make decisions, not groups.

Game theoretical rationality in the service of personal profit maximization is not an adequate model of human decision-making in social bargaining situations. This proposition is a large part of Colman's thesis, and we have no quarrel with it. Does anyone? The point is proven whenever experimental subjects reject offers in Ultimatum Games, share the pot in Dictator Games, or cooperate in one-shot Prisoner's Dilemmas (e.g., Frank et al. 1993; Roth 1995). The idea that this simple game theoretical account is descriptive rather than normative is surely dead in experimental economics and psychology. Evolutionary models are an important exception, because they purport to describe what strategies will be selected for. However, in these models, the concept of "rationality" is superfluous, because the selection of superior strategies occurs by a mindless, competitive process (Gintis 2000).

One way in which rational choice theory (RCT) is problematic is the default expectation that all other players will behave "rationally." Individuals can be expected to occasionally make decisions that are not in accordance with predictions of RCT because of incomplete information, errors, concern for the welfare of others (such as friends or relatives), or manipulation by others. Also, individuals may be expected to act irrationally if that irrationality is more adaptive than rationality. For example, Nowak et al. (2000) show that the "irrational" behavior of demanding fair offers in the Ultimatum Game is evolutionarily stable if each individual has knowledge about what kind of offers each other individual will accept. Similarly, aggressive behavior or punishment, while not "rational" in the game theoretic sense, can evolve if the costs of being punished are high (Boyd & Richerson 1992), because the punished individual learns (potentially via operant conditioning) to desist from the behavior that brought on the punishment.

Given that others are sometimes not strictly rational, an instrumentally rational individual should reevaluate his/her situation and act accordingly (Colman hints at this in sect. 8.4). We argue that rationality should not even be the default assumption because individuals are repeatedly faced with evidence (from real life) that others are not always rational, and this affects the strategy that a profit-maximizing individual should take. For example, when playing an iterated Prisoner's Dilemma against what appears to be a conditional cooperator (such as a Tit-for-Tat player), a rational and selfish player should cooperate for a while. Even if the rational actor is cheated in later rounds, he/she has still done better than if he/she had never cooperated. Thus, a rational player should attempt to determine the likely responses of others, rather than assume that (despite past experience to the contrary) they will be "rational." Henrich et al. (2001) argue that when people play experimental games, they compare the games to analogous situations with which they have experience. If different people have had different experiences because of different backgrounds, then they will have different beliefs about how others will behave. Thus, in iterated games, each player may be acting rationally with respect to his/her past experience. Recent experiences have large effects on how people play experimental games (Eckel & Wilson 1998a), possibly because players use their experience in the games to update their beliefs of what others will do.

This does not explain behavior in one-shot games, but we would

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