Introduction: Game Theory and the Strategy of Conflict

Thomas Schelling’s The Strategy of Conflict (hereafter SoC) remains one of the most successful applications of game theory. Over half a century after its first publication in 1960, SoC’s insights into the logic of disarmament and deterrence stand out as an early and brilliant example of the important—sometimes vital—benefits that can be gained by analyzing strategy as a rational form of behavior. Highlighting the scope of his contribution, Schelling’s work has been duly heralded for its practical influence on U.S. national security doctrine and foreign policy in the nuclear age (Ayson, 2004; Freedman, 1989; Trachtenberg, 1989), as well as for the pioneering role it has played in the development of game theory (Crawford, 1991; Dixit, 2006; Myerson, 1999, 2009; Zeckhauser, 1989).

However, SoC also raises significant theoretical questions that have yet to be fully addressed. At a more immediate level, it seeks to determine the kind of rationality involved in strategic interaction. At a more fundamental level, it asks whether game theory can provide an appropriate framework for dealing with problems of interdependent decision in domains as applied and diverse as economics, politics, and military warfare. Many economic readers of SoC assume that these questions have been successfully answered and that game theory, by formalizing many of Schelling’s ideas, has realized his vision for the discipline. In doing so, they tend to underestimate the originality of Schelling’s project and overlook its relevance to current research. As such, the lessons SoC holds for game theory and for the study of strategic decision-making deserve to be revisited.

Two points must be kept in mind when assessing SoC’s contribution. First of all, Schelling’s study of strategy has a strong behavioral aspect. One of its main goals is to identify the actual processes that constitute strategic reasoning. Indeed, many of the moves and tactics typically encountered in the context of bargaining and conflict are difficult to square with standard assumptions about rational play and cannot be properly understood without a deeper investigation. Examples include commitments, threats and promises; brinkmanship; and various instances of the “hands-tied” paradox which consists in influencing outcomes by weakening one’s position (reducing one’s options, relinquishing initiative, and so on). These processes also play a central role in Schelling’s analysis of another important phenomenon:

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Second, Schelling’s study of strategy has a broader theoretical ambition. By integrating strategic processes and content into game theory, Schelling hopes not only to improve the discipline’s practical applicability but to establish it as a theory of interdependent decision that can help make sense of complex interactions in a wide range of domains. In this respect, SoC is as much about the implications of strategy for game theory as it is about the application of game theory to strategy.

To provide a clearer assessment of SoC and of its complex legacy, I address three questions successively in this article. What does Schelling’s theory of interdependent decision consist in? What research program does it belong to? And what does it contribute to game theory? In the section “Schelling’s Project: Bringing Strategy Into Game Theory,” I present Schelling’s project as developed in SoC. In my view, Schelling’s theory of interdependent decision does not simply restate game theory in slightly less abstract terms, but proposes to reconstruct it in line with a more realistic understanding of strategy. In “Schelling’s Research Program: An Ecologically Rational Perspective on Strategy” section, I show that while Schelling’s theory of interdependent decision draws on psychological and contextual elements, it still refers to a meaningful conception of rationality. In this respect, it can be related to Gigerenzer and Selten’s “ecological rationality” program. In the section “Schelling’s Contribution: A Behavioral Model of Strategic Reasoning,” I argue that SoC delivers results under the form of a heuristic model of strategic reasoning. The final section “Conclusion: Drawing Lessons From SoC” concludes by reassessing SoC’s legacy on three points: its relation to game theory, how Schelling’s model of strategic reasoning compares to competing economic models, and the possibility of extending this model.

Schelling’s Project: Bringing Strategy Into Game Theory

**Strategy as a Starting Point for Game Theory**

Schelling’s conception of strategy is highly original. He does not think of the notion in usual game-theoretic fashion as a plan or rule of action that can be directly derived from the player’s available information and set of feasible choices—given individual preferences and prior assumptions about rationality. Instead, he considers it as a mode of decision-making that relates to interactive contexts. Strategy, for Schelling, is not ordinary instrumental rationality as it applies to the pursuit of long-term goals or to competitive activities in the field of battle or play. It is what becomes of rationality “[when a player’s best course of action] depends on the choices that others will make or are making” (Schelling, 2006, p. 3), an idea first formulated in Schelling (1960, pp. 9-10). As such, the analysis of strategy constitutes a necessary first step toward understanding how rational individuals take decisions in “an environment that consists of other people responding to their environment, which consists of people responding to an environment of people’s responses” (Schelling, 2006, p. 14).

Schelling’s intuition is that the processes through which rational individuals take decisions in interactive contexts are specific and need to be identified as part of the analysis. This intuition is supported by a number of different observations:

- Interactive contexts confront players with a well-defined task. When players are interdependent, taking decisions becomes less a question of determining which course of action is best for oneself and more a matter of predicting what others will do. In this respect, strategy draws attention to the way in which players form expectations in social settings.
- Players adopt particular forms of reasoning in these contexts. These forms of reasoning are distinctly strategic. The most notable example studied in SoC is that of “focusing,” which involves predicting the behavior of others we are interacting with by anticipating the expectations they may have of us. These forms of reasoning are also problematic from the point of view of game theory, as they often rely on contextual variables (labels, background elements, and so on) that are not captured by the game’s formal description and payoff structure.
- Strategic reasoning of this kind can contribute to the emergence of social order. SoC establishes a link between significant macro-phenomena, such as the informal regulation of conflict (including nuclear deterrence) or the robustness of large-scale schemes of voluntary cooperation, and players’ ability to jointly negotiate mutual expectations—through tacit as well as explicit means—and single out particular outcomes as a solution to common coordination problems.

This conception of strategy provides the cornerstone for Schelling’s project of establishing game theory as a theory of interdependent decision. It unites SoC’s two main parts: (a) its criticism of game theory and (b) its proposed reorientation of the discipline.

**Schelling’s Criticism of Game Theory**

Schelling criticizes different aspects of game theory in SoC: the discipline’s focus on zero-sum games; its lack of practical applicability in non-zero-sum contexts; and the limits of its mathematical approach to strategic behavior. These critical themes, some of which have been addressed by modern game theory, reflect a common underlying argument that remains potent, namely that game theory’s traditional methodology is ill-adapted to the interactive dimension of strategy.
The crux of Schelling’s argument lies in the distinction he makes between zero-sum and non-zero-sum games. In Schelling’s view, zero-sum games constitute a special case and cannot be used as a starting-point for understanding strategic behavior because of the role played by the minimax theorem in these contexts. The minimax theorem provides players with a rule of action for zero-sum games (minimize your potential losses) that is both optimal in terms of expected utility and, more importantly, independent of what others do. In this respect, what makes zero-sum games more tractable for game theory also limits their practical value by taking the interactive element and much of the uncertainty out of the game.

Rational players engaged in a zero-sum game do not need to consider their opponents’ expectations and actual choices. Indeed, they can factor them out of their decision-making: All that really matters to them is the other’s payoff function and the particular way in which it relates to their own. Moreover, players have no incentive to coordinate decisions and no reason to communicate. Consequently, the equilibrium solution defined for zero-sum games by the minimax theorem is not only unique and rational, it is one that cannot be improved on by joint action. In other words, the strategy of zero-sum games is self-centered and interdependence has no influence on decision-making, at least in any positive sense.

The same conclusions no longer hold in non-zero-sum games. Here, decision-making is more complex: It covers situations where the best course of action can be inseparably linked to what another does, where mutual expectations are key to coordinating on an efficient outcome and players have an interest in communicating. By failing to sufficiently adjust its methodology to reflect this greater complexity, early forms of game theory have bypassed the interactive dimension of strategy rather than addressing it.

The methodological differences between Schelling’s approach and that of traditional game theory are further underlined by his focal-point explanation of bargaining. Traditional theories of bargaining start by identifying either the formal characteristics of a general solution for non-zero-sum games or a rational rule of action that applies to these contexts. It is then assumed that rational players can reconstruct the solution based on these characteristics or select the appropriate rule of action and, in doing so, align their expectations of each other so that they achieve the equilibrium predicted by the theory. Schelling argues instead that solutions to actual bargaining problems do not seem to share any particular characteristics other than being recognized as such by the players. In this view, what makes a given solution rational to a set of players is something simpler and more fundamental: the fact that it is “salient” or “uniquely prominent” for them in some commonly understood way which leads them to form concordant mutual expectations of each other.

Salience, however, is a deeply problematic property. It cannot easily be formalized, nor can it be attributed ex ante to an outcome with any certainty. Indeed, although salience is often attached to a discernible variable in the game’s environment, formulation, or contextual background, it does not overlap with any objective quality in particular. It cannot be assimilated to a subjective trait of the players either, though it can be influenced by who they are and what they know about each other. Instead, the type of salience involved in focal-point coordination is constructed “on the spot” by the strategic reasoning of players as part of a common exercise in coordinated problem-solving.

The implications of Schelling’s criticism of game theory are most evident here. To properly understand how rational individuals make choices in non-zero-sum contexts, game theory must be able to analyze what their strategic reasoning consists in. For Schelling, this cannot be done by purely mathematical means. When game theory seeks to formalize strategic reasoning in mathematical terms, it sets itself at a level of abstraction that misses the “essentials of the situation and of the behaviour in question” (Schelling, 1960, p. 13). By doing so, it leaves itself unable to properly grasp the nature of the processes involved in interactive decision-making or the contextual variables that are relevant to its outcome. What Schelling proposes is another option, which aims to model strategic reasoning at a level of lesser abstraction. To achieve this aim, he adopts a richer non-mathematical approach that takes account of the environmental and behavioral aspects of strategy.

**Schelling’s Proposed Reorientation of Game Theory**

What shape this alternative approach might take is outlined in the second part of SoC (chaps. 4–6), devoted to a reorientation of game theory. It includes an attempt to reclassify games and a proposal to enrich game theory along at least two axes.

Schelling’s reclassification of games builds on his distinction between zero-sum and non-zero-sum games. It highlights a key aspect of strategic behavior, namely that it is sensitive to the degree of conflict and collaboration inherent to a game, as measured by the commonality and divergence of interest between players. Commonality and divergence of interest are understood here as broad features of the game which influence the behavior of players at a deeper level than simple individual payoffs. Most significantly, they affect the nature of communication between players. In this respect, what constitutes rational play varies depending on whether the essence of the game consists in revealing one’s intentions to a partner (pure collaboration), concealing one’s intentions from a rival (pure conflict), or selectively communicating them to someone who is both a partner and a rival (mixed motives).

This reclassification clarifies the sense in which non-zero-sum games are more complex than zero-sum ones. Communication and enforcement play a crucial role in interactive contexts that they do not have otherwise. In
bargaining games, communication has a tactical as well as an informational significance. Players not only need to find ways to communicate with others, they must also ensure that their communication is credible. Pure collaboration presents an analytically useful limiting case for non-zero-sum play where the bargaining element is absent. In this simplified case, the players still need to coordinate decisions around a common interest and the only feature of relevance to them in the game’s structure is the communication system. In the zero-sum game by contrast, there is no scope for communication between rational players and no need for enforcement. In theory therefore, communication and enforcement systems are not part of the structure of zero-sum games and can be abstracted away from their analysis without loss.

Schelling’s proposals for enriching game theory introduce two additional components designed to help it match the complexity of strategic behavior in non-zero-sum games. A theory of interdependent decision must thus include, first of all, a perceptual axis which addresses the way in which players identify each other’s intentions, what resources they rely on to do so, and what expectations they can form on this basis. A theory of interdependent decision must also include a communicational axis, whose object is to specify the means of communication and enforcement that are available to players, as well as the opportunities these moves create for influencing the expectations and actions of others. This implies looking beyond the easily separable “institutional” channels provided for by the rules of the game or the design of the experiment. Indeed, one of SoC’s main conclusions consists in showing that, far from constituting “cheap talk,” tacit and informal modes of communication not only influence behavior but often underpin more overt and enforceable forms of communication.

**Schelling’s Research Program: An Ecologically Rational Perspective on Strategy**

*Strategic Environments and Reasoning in SoC*

Schelling’s quest for greater realism sees him introduce psychological elements and contextual variables into the framework of game theory without renouncing the latter’s reference to individual rationality. His theory of interdependent decision is meant to be a theory of rational choice in contexts of interdependent decision. However, it draws significant conclusions about the nature of rational choice in contexts of interdependent decision from the empirical study of strategy. These conclusions shed light on the type of rationality Schelling is referring to and on the research program his project belongs to.⁵

Most importantly, Schelling takes the cognitive limitations of players as an integral part of the analysis of strategy. The coordination problems players encounter in contexts of interdependent decision place heavy demands on them as strategic choices often have to be made in real-time, with limited information and scope for learning. Yet, the experimental evidence also confirms that players routinely overcome coordination problems of this kind in a wide range of settings, and that the outcomes they achieve can be surprisingly efficient and robust. The challenge for Schelling consists in explaining how players whose cognitive abilities are finite manage to solve such problems without the help of complex calculations, high levels of foresight, and exacting standards of mutual knowledge. In other words, how players coordinate decisions using processes that are psychologically realistic, computationally fast, and informationally frugal.

Schelling’s non-mathematical approach to strategy is sufficiently flexible to address this challenge. It does so by combining two lines of inquiry: (a) into the actual abilities of players and (b) into the nature of strategic environments. The result is an *ecologically rational* perspective on strategy.⁶ Ecologically rational models explain behavior based on two sets of factors: “[the heuristic processes through which] a judgment or decision is reached [and] the class of environments in which these heuristics will succeed or fail” (Gigerenzer & Selten, 2001, p. 4). What sets ecological rationality apart from other versions of bounded rationality is its evolutionary perspective and strong emphasis on the adaptive aspects of human behavior. Ecological rationality bets on the capacity of rational individuals to simplify their decision-making process by using contextual resources when faced with complex tasks, rather than counting on pure cognitive ability and sophisticated reasoning. The effectiveness of these ecologically rational modes of behavior derives from a match between the structure of the heuristics individuals apply to a given task and the structure of the environments in which they have to perform this task.

Schelling draws on both sets of factors in SoC. First of all, he redefines strategic reasoning on more detailed procedural grounds. His analysis of strategy brings two basic mental faculties into the picture: mutual perception and pattern recognition. Pattern recognition is a simple and well-established phenomenon which reflects the ability to discover and infer predictable regularities in one’s environment and in the behavior of others. It falls under the perceptual component of Schelling’s theory of interdependent decision and is not problematic. SoC provides further evidence of players’ propensity to use pattern recognition as a basis for reasoning in strategic settings.⁷

Mutual perception plays an even more important role in Schelling’s understanding of strategic reasoning. It consists in a type of joint awareness through which players are able to recognize the relevance of particular variables to a common coordination problem, attribute the same recognition to others, and adjust their sense of what is relevant in light of the inferences they can make about these others. This “joint awareness” underpins the construction of salience and the profoundly interactive modes of reasoning that constitute
strategic behavior in non-zero-sum games. When successful, it allows players to form mutually consistent expectations of each other and take decisions as if they were acting according to a concerted plan.\(^8\)

Mutual perception is more difficult to analyze than pattern recognition and its implications for game theory are less straightforward. Schelling views it as an intuitive faculty that is undemanding in informational and cognitive terms, and whose reliability can be demonstrated under experimental conditions. In this respect, he considers that rational players have, within their perceptual apparatus, a *mind-reading* ability which endows them with the “capacity to determine introspectively the choices that a partner would make.”\(^9\) Consequently, SoC’s account of strategic reasoning introduces into game theory something like a *theory of mind* mechanism to explain how players predict the behavior of others and form mutual expectations.\(^10\)

Second, Schelling pays greater attention to the nature of the contexts within which strategic reasoning takes place. Game theory usually defines a strategic environment as “any situation in which individuals are affected by each other’s decisions” (Crawford, 1991, p. 267). Schelling introduces a further distinction between two senses in which decisions can be interdependent. The first “strict” sense of interdependence requires that players be bound by a relation of mutual contingency—in which case they need to know what choices others are making to take their own decisions. The second “wide” sense implies only that individual decisions involve externalities—meaning that players simply care about the choices others make without these choices being essential to their course of action.

This distinction becomes explicit in Schelling (2006, pp. 28, 213-216), but it is already present in SoC. Its importance is often overlooked, yet I would argue that it is fundamental to Schelling’s theory of interdependent decision since SoC builds on the assumption that strategic behavior can be related to contexts of strict interdependence. Indeed, mutual contingency features as a condition for effective coordination.\(^11\) It also enters into the definition of key concepts such as “games of strategy,” “theory of strategy,” strategic behavior and moves, and is what gives the notion of deterrence and the game of pure collaboration their strategic dimension (Schelling, 1960, pp. 3 fn1, 13, 15-16, 46, 86). From there, it can be concluded that Schelling identifies strategic environments with a special class of games. These games are referred to simply as “games of strategy,” but they can more appropriately be described as “games of mutual contingency.”

**Games of Mutual Contingency and Their Characteristics**

Games of mutual contingency provide an abstract representation of the complex social environments which give rise to interactive decision-making. As such, they allow us to characterize strategic environments in terms that are tractable for game theory. These games do not capture the material content and contextual resources that are essential to rational play in real strategic environments, but valuable lessons about the logic of strategic reasoning can be drawn from the study of their general structure.

Games of mutual contingency form a broad class which cuts across coordination, bargaining, and conflict. What these games have in common is the fact that the “need to know” condition is written into their payoff structure. A game of mutual contingency is a game in which payoffs are configured in such a way that they exclude dominant individual strategies. Schelling studies a number of these games in SoC, including such typical cases as the *Rendez-Vous game*, the *Assurance game*, the *game of Chicken*, and the *Matching Pennies game*.\(^12\)

The lack of individually dominant strategies presents players with a problem, as can easily be verified from Figure 1. The game either lacks an equilibrium in pure strategies—in which case players cannot solve it without using more sophisticated mixed strategies,\(^13\) or it has multiple equilibria, in which case players must find a way to correlate their choices. This immediate problem (defining or selecting an equilibrium without dominant strategies) is further compounded by the fact that players are interdependent not only in terms of the decisions they take (the best course of action for each player depends on the choice she expects another to make), but also in terms of the expectations they can form about each other (what choice a player can expect another to make depends on what that other expects the player’s course of action to be, knowing that the player is in a similar situation to start with). In this respect, interdependence of expectations represents the main and irreducible feature of mutually contingent choice. Game theory has found it particularly difficult to define rational behavior under these conditions, because it cannot explain how players form mutual expectations and reach a determinate outcome without specifying a common principle of choice for them—through rational deduction or by social convention.\(^14\)

Games of mutual contingency are highly indeterminate from a formal point of view. At a more practical level, however, they have other characteristics that can be more readily exploited by players. Most importantly, they are situations in which players find themselves unable to compare alternative courses of action because interdependence of expectations prevents them from mapping their choices to outcomes with any degree of certainty. Out of the numerous options available, what action to play is not a question of frequency or probability, but of what the other will do and what that other will expect us to do. In this respect, games of mutual contingency are situations in which *predictors* for the behavior of others constitute the main—in some cases sole—reasons to act and players need to identify *cues* to take decisions. As a result, the nature of the decision-process itself changes in situations of mutually contingent choice.
Equally significant, non-zero-sum games of mutual contingency are situations in which players can benefit from making their intentions or expectations known to those they are interacting with. These are “desperately cooperative
situations,” to borrow Schelling’s expression, in which action is de facto endowed with a signaling value. Individual action of any sort, insofar as it provides information about a player’s intentions or expectations, also provides other players with a reason to act. The rationale for strategic moves can be found here: They are cues for the action of others and means of leading them to make particular choices by playing on the expectations they have of us.

**Schelling’s Contribution: A Behavioral Model of Strategic Reasoning**

**The Foundations of Schelling’s Model**

Schelling’s core aim throughout SoC is to model strategic reasoning as part of a wider effort to make sense of interactive behavior. By adopting an ecologically rational perspective, he is able to establish the psychological and environmental foundations on which such a model can be built. This model allows us to reconstruct strategic reasoning as a simple heuristic process which governs the way in which players search for information and take decisions in contexts of mutually contingent choice. It posits that players are capable of mutual perception—implying the existence of a theory of mind mechanism—and that they are rational in the limited sense that they exploit the underlying characteristics of their environment to achieve their goals. In this respect, SoC successfully accomplishes Schelling’s project and uses the analysis of strategy as a basis for developing a more realistic behavioral form of game theory.

The first element in this model derives from the fact that the structure of information is specific in contexts of mutually contingent choice. Indeed, mutual contingency defines the type of information that players can search for. In strategic environments, search concerns cues rather than alternatives. Players cannot simply compare payoffs when deciding between given courses of action; they must also determine adequate reasons for their choices. Their main task does not consist in exploring or expanding their opportunity set in search of an optimal outcome for themselves, but in finding a set of predictors associated with the different courses of action available to them and to those they are interacting with.

To do so, players must either

- obtain cues from their environment that will enable them to form expectations about the choices others are making or will make.15
- or, provide cues that will enable others to predict the choices that the player is making or will make, through the use of strategic moves.

The search for cues does not take place at random, as mutual contingency also helps define what constitutes a “valid” cue. For players who need to coordinate their choices to reach a particular outcome, a valid cue is one that gives at least one of them a reason to act and can be recognized as such by both, allowing them to form concordant expectations of each other. In other words, it must be a common signal that both players can perceive as relevant to the coordination problem they face. Environmental cues can therefore be measured along a single dimension, that of salience. Players who are capable of mutual perception can identify this dimension and use it to guide their search for cues.16

Similarly, to constitute a valid cue, a strategic move must act as a credible signal. That is, it must convey the player’s intentions or expectations in a way that can be recognized by the other and affect his expectations of the player’s own behavior—either by fostering an expectation or by dislodging an existing one. It should be noted that mutual contingency only defines the form of cues (commonality and salience for environmental cues; credibility for strategic moves), not their content. What is salient and what is credible depends on the players as well as on the situation and can vary from case to case. Whether the players succeed in coordinating on a common cue or not, and what that cue consists in, remain inherently empirical questions for Schelling.

In a second crucial foundation for this model, SoC offers psychologically plausible bases for understanding how boundedly rational players can limit their search, select cues, and take decisions. Mutual perception also plays an important role here. The ability to attribute perceptions of salience to others, to form beliefs about the way in which their expectations are influenced by the common environment and updated in the course of interaction, provides players with a simple and natural stopping rule that limits the search process. In contexts of mutually contingent choice, this search process is conducted by both players and ends as soon as they perceive themselves to be acting on the same cue—that is, as soon as they identify a cue salient enough to focus the mutual expectations they have of each other.

The existence of cues also dispenses with the need for complex decision rules. By allowing players to form defined expectations of each other’s behavior, environmental cues, coordinated problem-solving, and strategic moves reduce the indeterminacy of games of mutual contingency and make “solutions” more easily identifiable. In bargaining for instance, strategic moves can narrow the choice between a potentially unlimited set of options down to a single binary decision: take it or leave it. Two cases apply here. Players must either solve the simple maximization problem that others have posed them or that they have constructed together. Or else, if possible, they can engage in further strategic maneuvering to change the outcome to their potential benefit. This can be done by providing another cue to those they are interacting with or by neutralizing an existing cue.

**Strategy as Heuristics of Mutually Contingent Choice**

Taking the above into account, I argue that strategic reasoning, as presented in SoC, can be modeled in the following way:
In the model presented in Figure 2, strategic reasoning combines three types of rules to produce applied heuristics for mutually contingent choice:

1. A simple search rule that is adapted to the specific structure of strategic environments.
2. A simple stopping rule that can be referred to as *take the most salient*. In contexts of mutually contingent choice, the object is not to determine which cue is most salient from the player’s own point of view, but which one is most likely to be jointly recognized as such. Mutual perception allows players to adjust their sense of what is salient, by placing themselves in the other’s position. The *take the most salient* rule is perfectly tailored to the type of fast and frugal decision-making that is often required in strategic interaction. It is sensitive to the constraints under which a player operates (in terms of time, energy, and material resources) when stopping the search for information. In this respect, salience can function as an “aspiration level” for partial or interrupted search (*stop search as soon as a suitably striking cue is found*) or as a criterion for assessment in a full search (*assess all available cues and select the most salient*).

3. Simple decision rules which imply only that players act on the strongest cue and choose their preferred outcome given the other’s predicted behavior. No more than they need complete information to take a decision, players do not make complex calculations of utility or probability in this model. The model simply requires that they be able to compare outcomes in a way that allows them to solve reduced maximization problems (*what course of action is better if the others act in a given way?*). Furthermore, where moves are costly as is generally the case in bargaining, players must be able to compare costs in such a way that they can make broad estimates about the efficiency of a strategic move (*How likely is a threat or promise to be believed? Is the move worth making to obtain a particular outcome?*).

Schelling’s theory implies that the status of cues will likely be influenced by the nature of interaction and that the expectations players form about each other’s reactions and modes of thinking will vary between contexts of Collaboration, Bargaining, and Conflict. Similarly, the availability, cost, and effectiveness of moves will depend on the particular characteristics of the communication and enforcement systems. The theory leads to one general conclusion however, which the present model seeks to highlight, namely that strategic reasoning has a common basic structure which reflects a logic of mutually contingent choice.

**Conclusion: Drawing Lessons From SoC**

Schelling’s attempt to engage strategic behavior more directly in SoC has presented game theory with something of a dilemma. On one hand, the depth and influence of Schelling’s analysis have helped establish the practical value of game theory and open up a wide range of real-world applications. On the other, much of the theoretical underpinning for this analysis, including Schelling’s investigation of the actual processes involved in strategic reasoning, is still considered
problematic and remains at the margins of the discipline. Conflicting interpretations of SoC in the literature, between those who claim Schelling as a user and inspiration for game theory and those who view him instead as a critic or as a producer of game theory, illustrate this continued ambivalence. The present article revisits this debate by paying closer attention to Schelling’s theory of interdependent decision. It argues that SoC develops a coherent and innovative behavioral basis for analyzing strategy, which is more properly understood in connection with the bounded rationality program as put forward by Gigerenzer and Selten (2001). Read in this light, SoC can be shown to anticipate on notions such as ecological rationality, fast-and-frugal heuristics, and theory of mind by several decades.

This connection is important to make for several reasons. Historical first of all, as it allows us to situate Schelling’s contribution in response to the debate mentioned above. In this perspective, Schelling should be seen neither simply as an applied user nor as an outside critic, but truly as a producer of game theory—albeit one who belongs to a branch of the discipline that is experimental in method and behavioral in outlook.18 Conceptual also, as the reference to ecological rationality and fast-and-frugal heuristics allows us to clarify some of the key aspects of Schelling’s theory. The former notably underlines the essential link which Schelling makes in SoC between the process of strategic reasoning and the particular information structure of interactive social environments. While the latter can help us organize the various non-standard elements (salience, focusing, mutual perception) introduced by Schelling’s analysis into a defined and realistic model of strategic reasoning.

Interesting as these considerations may be in terms of how we read Schelling and assess his contribution, the most important lessons to be drawn from SoC concern its implications for experimental research. Schelling’s theory of interdependent decision, as modeled here, makes a number of predictions regarding strategic behavior and interaction which can be used to highlight avenues for research and outline areas in which Schelling’s project could be taken up by the ecological rationality program.

1. Schelling’s theory of interdependent decision is built around the assumption that strategic reasoning can be modeled by heuristics that reflect a logic of mutually contingent choice.

The heuristic nature of strategic reasoning is well established experimentally. Evidence of players’ ability to solve complex coordination problems with limited information and time can be found going back to SoC and has been confirmed by subsequent studies, including Mehta, Starmer, and Sugden (1994). SoC adds to our understanding of strategic reasoning by connecting it to the information structure of interactive environments and by defining mutual contingency as its basic logic. Both of these dimensions offer opportunities for research, regarding the way in which players treat information and cues in different contexts or the way in which changes in conditions relating to mutual contingency affect strategic reasoning.19

Furthermore, Schelling’s model maps the decision-making process for a wide class of games that cover several registers of interaction (coordination, bargaining, conflict) and translate into different modes of strategic behavior. In this respect, it does not necessarily compete with other existing models which operate within more restricted contexts but can potentially integrate them into a broader framework. Schelling’s model might notably accommodate cognitive hierarchy models (Camerer, Ho, & Chong, 2004), which are used to explain behavior in p-beauty games, under the category of conflict game theory and team-reasoning models (Bacharach, 1999; Bardsley, Mehta, Starmer, & Sugden, 2010), which apply to coordination games, as an example of strategy in collaborative contexts.

2. Schelling’s model predicts that perceptual and communicational elements should influence strategic reasoning.

Schelling’s proposal to include more applied questions of perception and communication within the framework of game theory has interesting consequences which deserve to be explored more thoroughly. It implies first of all a recognition of the highly context-dependent nature of ecologically rational heuristics. Insofar as these elements have an informational or signaling value which players can use to interpret the nature of interaction, they can contribute to trigger strategic reasoning (does the choice-situation involve mutual contingency?) and determine which mode of mutually contingent choice applies (is the logic of play dominated by conflict, collaboration, or a mix of both?). Experimental evidence showing that both perception and communication influence strategic behavior and outcomes can therefore be tied in to Schelling’s model.20 In this respect, it can also engage with another important aspect of the ecological rationality program—the role of non-cognitive factors such as frames and emotions in decision-making—while suggesting new research questions to investigate—such as the extent to which the trustworthiness of communication can act as an indicator of others’ intentions and a basis for inferring the nature of interaction.

3. Perceptual and communicational elements can contribute to social order by extending the logic of mutual contingency beyond the original class of games defined as strategic environments in SoC.

Another central assumption of Schelling’s model is its identification of strategic environments with games of mutual contingency. In this respect, SoC’s conclusions could be summarized as follows: When players need to know what...
choices others are making or will make in order to take their own decisions, they adopt a specific mode of reasoning which enables them to overcome the coordination problems that arise in interactive social settings. Interestingly, Schelling proceeds to extend these conclusions beyond the two-player games of mutual contingency defined in SoC as “games of strategy” and on to situations that are marked by wide—rather than strict—interdependence:

- In a first extension, Schelling (1960, pp. 48-52) shows how signaling can help players achieve cooperation in a two-player Prisoner’s Dilemma. Here, mutually contingent choice is not a natural feature of the game but can be imposed on it through the use of strategic moves which modify the payoff structure.
- A second extension of the model consists in using mutually contingent choice to explain how cooperation emerges in an n-player version of the Prisoner’s Dilemma. This second case is more complex. With a large number of players involved, the problem of individual choice with externalities takes on an added dimension which gives it the characteristic aspect of a social dilemma. Players have no immediate basis for strategic reasoning (the n-player Prisoner’s Dilemma is not a game of mutual contingency). Moreover, they cannot alter the structure of the game with strategic moves (as in the two-player version of the game) because they only interact through a common aggregate that none of them can influence single-handedly. Yet even here, Schelling argues that players engage in coordinated problem-solving and collective forms of bargaining that can give rise to “social contracts.”

These extensions of Schelling’s model imply that the link between strategic environments and games of mutual contingency is an analytical rather than a practical one. What defines a strategic environment is the use of mutually contingent choice as a logic of play, not simply the game’s payoff structure. This logic of play can be sustained by communicational elements (such as strategic moves), as well as by social objects such as norms or conventions insofar as they transform the way in which players perceive the nature of interaction. In this respect, as Schelling himself suspected, strategic modes of reasoning and the heuristics of mutually contingent choice which they rely on may have an important part in the emergence of cooperation and social order.

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Notes
1. Strategy of Conflict (SoC) tests and demonstrates the extent of this ability using simple experimental games. Schelling (1960, p. 57) summarizes the results on tacit coordination as follows: “People can often concert their intentions or expectations with others [in pursuit of a common interest] if each knows that the other is trying to do the same.” This conclusion is then extended to conditions of tacit bargaining (p. 60) where substantial divergence of interest may exist and, using real-world examples, to conditions of explicit bargaining (p. 70) where direct means of communication are available.
2. Schelling (1960, p. 163): “In a zero-sum game the analyst is really dealing with only a single center of consciousness, a single source of decision. True, there are two players, each with his own consciousness; but minimax strategy converts the situation into one involving two essentially unilateral decisions. [In a non-zero-sum game, by contrast.] two or more centers of consciousness are dependent on each other in an essential way. Something has to be communicated; at least some spark of recognition must pass between the players. There is generally a necessity for some social activity, however rudimentary or tacit it may be.”
3. See Mehta, Starmer, and Sugden (1994) for a detailed explanation of what distinguishes salience in Schelling’s sense from ordinary salience and experimental evidence on the role played by “Schelling salience” in pure-coordination games.
4. Schelling (1960, pp. 88-89) distinguishes cases of pure collaboration at one end of the spectrum, in which players’ payoffs are perfectly and positively correlated and where, for both players, winning means winning together and never relative to one another. At the other end of the spectrum are cases of pure conflict, in which players’ payoffs are perfectly, but negatively, correlated and where the only sense in which a player can win is relative to—and at the expense of—the other. In between are what Schelling calls mixed motive cases, in which players are presented with both commonality and divergence of interest. Schelling can thus divide game theory into three distinct areas: a coordination game theory which deals with the strategy of pure collaboration; an already well-developed conflict game theory whose object is the strategy of zero-sum games; and a bargaining game theory which studies the strategy of mixed motive games. This last class of games represents the most practically significant, as well as the most widespread case. Schelling neatly illustrates this by pointing out that what we typically think of as “conflict” in any domain requires both commonality and divergence of interest—something to bargain for collectively and something to bargain over individually.
5. In this respect, I do not consider Schelling primarily as a critic of game theory, whose contribution comes mainly from pinpointing the limits inherent to the discipline’s deductive
approach to decision-making. Nor would I place Schelling’s theory of interdependent decision outside game theory. This view of Schelling is defended however by Robert Sugden, notably in Sugden (1995, pp. 549-550) and Sugden and Zamarrón (2006, pp. 617-620).

6. On ecological rationality as an offshoot of Herbert Simon’s bounded rationality program, see Gigerenzer (2001, pp. 36-39, 45ff).

7. Schelling (1960, pp. 93fn8, 104-107). It is also interesting to note that the sources Schelling refers to here indicate close intellectual ties with the bounded rationality program. Schelling notably quotes Herbert Simon and makes extensive use of Gestalt psychology—in particular the work of Kurt Koffka.

8. Part of the reason mutual perception has been overlooked by traditional game theory may be due to the fact that it plays no apparent role in zero-sum games. Indeed, the object of strategy in zero-sum games consists in thwarting the other’s capacity to perceive our intentions or exploiting that capacity to mislead him. Randomization constitutes the essence of strategy in zero-sum games precisely because it represents the most effective way of negating mutual perception.

9. Schelling (1960, p. 150). As McCabe, Smith, and LePore (2000, p. 4404) put it in very similar language, mind-reading represents “the capacity to read another person’s thoughts or intentions by placing [oneself] in the position and information state of the other person.” See also Smith (2009, pp. 260-265, 316-317) on the role of mind-reading in strategic interaction and its importance for the analysis of trust games.

10. On the notion of a theory of mind mechanism and its neurophysiological foundations, see Baron-Cohen (1995, 2012), McCabe et al. (2000), and McCabe, Houser, Ryan, Smith, and Trouard (2001).

11. Schelling (1960, p. 57): “People can often concert their intentions or expectations with others if each knows that the other is trying to do the same” (italics added).

12. The Rendez-Vous game is used to illustrate pure collaboration (Schelling, 1960, pp. 54, 94, 295). The Assurance game is used to illustrate the problem of surprise attack (Schelling, 1960, p. 210). A variant of the game of Chicken is presented as part of Schelling’s discussion of problems of symmetry and discrimination in bargaining (Schelling, 1960, p. 286 fn18). The Matching Pennies game is introduced as a zero-sum “pursuit” version of Schelling’s Holmes/Moriarty coordination problem (Schelling, 1960, p. 87).

13. Furthermore, these mixed strategy equilibria are often less stable and less efficient than the conventional solutions achieved by players in games of mutual contingency using pure strategies—that is without basing their choice on subjective probabilities. See for instance Sugden (1986, pp. 40-45) on the limits of mixed strategies in the context of a game of Chicken.

14. See for instance Walliser (1998, 2003) on the spectrum of high- and low-rationality solutions game theory has used to address the problem of interdependent expectations. Dupuy (1989) argues that “specular” modes of reasoning, which try to deduce players’ expectations from the game’s payoff structure, inevitably degenerate into a game of empty-mirroring, even under the assumption of common knowledge. Conversely, “conventional” solutions such as the one proposed by Dupuy, which allow for the role of social objects as contextual coordinating principles, generally fail to account for the actual decision-making process underlying strategic reasoning and mutually contingent choice.

15. “Environment” must be understood here in a broad sense covering not only the game and its background but also the players themselves, as the search for cues can take place both inside and outside the mind. Memory can be an effective source of cues in this respect and players can coordinate on the basis of shared experience or precedent, as well as on the basis of any element of contextual detail available to them as part of the game or of its description.

16. Interestingly, the reverse may also be true, in the sense that mutual contingency might constitute a necessary condition for a theory of mind mechanism to operate effectively. Players can put themselves in the place of others, and predict their behavior with sufficient accuracy to assist decision-making, precisely because they are doing so within a context where the information structure is simplified and reduced to the possible set of commonly perceived cues. The effectiveness of mutual perception and of the underlying mind-reading ability it relies on may therefore depend on context. This context-dependent aspect of mind-reading may help explain some of the difficulties encountered when testing for it empirically. The experimental literature has presented mixed results on this account. For instance, McCabe et al. (2000) provide evidence in support of effective mind-reading in a repeated game of mutual contingency, while Costa-Gomes and Weizsäcker (2008) find that players have only a limited ability to predict the behavior of others in a series of one-shot games and, moreover, that this ability has little impact on decision-making.

17. On search, stop and decision rules as building blocks for simple heuristics, see Gigerenzer and Selten (2001, pp. 8-9).

18. Vernon Smith proposes a similar reading of Schelling. See for instance McCabe et al. (2000) and Smith (2009, pp. 264-267).

19. Neuro-imaging studies suggest for instance that failure to understand mutual contingency due to social cognitive impairment significantly affects the logic and outcome of interaction in trust games. See McCabe et al. (2001) and Moretto, Sellitto, and Di Pellegrino (2013).

20. See for instance Bardsley, McCabe, and Smith (2000), Jaworski and Wilson (2013), and Wilson, Jaworski, Schurter, and Smyth (2012) on players’ ability to perceptually transform the nature of interaction in social environments, and Kimbrough, Smith, and Wilson (2010) on the effects that informal communication can have on interactive behavior and outcomes in experimental games.

21. Schelling (2006, p. 224): “[What induces players to cooperate here is not an] enforceable contract, or someone’s coercing them, [but] the belief that if they do others will but not if they don’t, or [ . . . ] a golden rule” (italics added). This solution is developed in greater detail in Schelling (1973).

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