The Effect of Behavioral Assortment on Selection Dynamics: Externalities, Information Processing and Subjective Commitment

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Introduction

The role of group selection in the evolution of social adaptations is a contentious issue. It is unclear whether all adaptations for social interaction should be considered group selected or whether the title 'group selection' should be confined to cases in which selection acts at the level of the group (i.e. interdemic selection). No matter what definition of group selection one uses, it is nevertheless clear that social evolution often involves selection at various levels of organization. The focus of this paper is on the roles of externalities, information processing and subjective commitment in creating situations in which multilevel selection and social evolution take place. Many of the mechanisms through which social evolution occurs require the processing of information about the behavior of others and the ability to selectively interact with individuals based on that information. This can enable agents to assort based upon behavior, which opens up the possibilities for group selection at the level of the behaviorally formed group.

The thesis of this paper is that behavioral assortment (particularly assortment according to behavioral strategies) can change the dynamics of selection, making group selection more likely. However, there are some difficulties with the view that behavioral grouping results in group selection. Groups that are formed behaviorally are often temporary, lasting shorter than the lifetime of an individual (not long enough for there to be differences in productivity between groups). Nevertheless, the cumulative effect of temporary behavioral grouping on productivity can be essentially the same as it would be in multigenerational groups. It is unclear *exactly* how groups of this nature fit within the framework of group selection. However, it is apparent that behavioral grouping can create circumstances that favor interdemic selection. By grouping based on behavior, significant between-group differences in cooperativeness can result.

It is suggested in this paper, that group selection probably played a role in shaping the capacity for subjective commitment. Individual level selection for ability to detect genuine commitment can cause behavioral assortment that can result in group selection favoring groups made up of individuals capable of commitment. Commitment can be thought of as internalization of some of the social externalities associated with an action. Modeling the evolution of commitment might be possible by allowing for the coupling of utility functions of agents in dyads or larger groups. Computer simulations that model such mechanisms and their role in social evolution should be helpful in understanding adaptations for social interaction in humans and other species.

The Role of Externalities

The notion of externalities is important for understanding the process of multilevel selection because it encompasses all situations in which the actions of one individual can affect other individuals' fitness. However, most of the models that have been developed within game theory for looking at situations in which there are externalities associated with the actions of individuals are two player models (e.g. the prisoner's dilemma). Also, most of them assume that payoffs are symmetrical for both players. These models are simple enough to be relatively easy to model and applicable to a wide range of situations, from economic interactions to political conflict (Axelrod 1997). Although these models have been useful and insightful, their simplicity has also limited their ability to model real-world phenomena on a more complex level.

The real world is characterized by a large number of multi-player games that can be extraordinarily asymmetrical for the players involved and in very few situations are there only two interacting individuals who impose externalities upon one another. Two player symmetrical games are limited in their ability to model the majority of the payoff structures inherent in real world situations. The framework of externalities, however, is wide enough to encompass both of these kinds of games as well as other situations involving more than two individuals and asymmetrical payoffs. Also, by examining evolutionary dynamics that result form situations involving asymmetrical payoffs, one can gain information about the ways in which the payoff structures themselves effect selective forces (i.e. whether certain kinds of payoff structures increase the likelihood that interdemic selection will act).

It might be worthwhile to investigate such situations in an agent-based computer simulation by setting up externalities in a random way and letting replication as a unit with another particular agent (or group of agents) be one of the characteristics upon which selection could act. One reason to expect that this would be an interesting simulation is that the evolutionary transitions in the history of life on earth were probably the result of the pattern of distributions of positive and negative externalities associated with the actions of agents, combined with the potential of these agents to replicate as a unit with other agents. According to Smith & Szathmáry (1995) and Michod (1999), payoff structures that allowed for benefits from cooperative interaction are the basis for the integration of lower level units into higher level units and the evolutionary transitions that result from these integrations.

A simulation of this sort would start with asymmetrical and random payoff structures. These payoff structures would simply be the result of the externalities assigned to the actions of individual agents (for simplicity one can assume only two actions, one that is individually beneficial and one that is not). The values for the externalities, and therefore the payoff structures that emerge from those externalities, would not be subject to evolutionary change. Agents would be able to reproduce only when they had accumulated enough fitness through the effects associated with their action (individually beneficial or individually costly) and the effects of the externalities associated with the actions of the other agents. One of the traits subject to selection here is the action (whether it is individually beneficial or individually costly) that a given agent will perform. However, each of the agents would also be able to evolve the capacity to constrain the replication of another agent, so that the other agent can only reproduce with the first agent.

This would make possible a number of interesting situations where agents replicate together. For example, certain agents could be prevented from realizing benefits associated with acting in an individually beneficial way if it resulted in the imposition of costs on another individual who could constrain the first agent's replication. Also, it would be possible to examine the kinds of strategies (the strategy being the combination of the individual action and the constraint to replicate as a unit) that lead to the emergence of groups of agents replicating as a unit.

Since there would be a random array of payoffs, there would necessarily be a few situations between individuals that are characterized by zero sumness and more that are characterized by non-zero sumness (because there is a low likelihood that the overall costs and benefits would be equivalent). There would also be other payoff structures existing at different levels of organization. Different size groups and groups of differing compositions (in terms of externality structure) would have the potential for the realization of different nonlinear effects that would result in differential survival and reproduction of the new group-level replicating units, or 'individuals' made up of agents that replicate only as a unit.

Information Processing and Behavioral Assortment

The process of replicating as a unit is one example of a regulatory mechanism that can increase the likelihood of group-level selection. There are a wide variety of other regulatory mechanisms that can make group selection more likely and many of them involve the capacity for information processing, from the 'Tit-for-Tat' strategy to direct punishment to discussions of social reputation. The focus here is on the way that information processing allows for behavioral assortment, which in some circumstances leads to group selection.

By selectively interacting with cooperative individuals, cooperators can exclude defectors from interactions, thereby reducing the payoffs defectors can realize. Once the ability to assort based on behavior has arisen, it can dramatically change the dynamics of selection. When the ability to process information about the behavior of other agents allows cooperative individuals to interact only with others who are cooperative, this results in the emergence of groups in which cooperative strategies have higher payoffs than they would in the general population.

Not only does behavioral assortment make it more likely that cooperative strategies will be successful, it also increases the likelihood that selection will act at the group level.. Behavioral grouping can result in situations in which groups meet criteria for group selection set out by Wilson (1983): genetic variation between groups and changes in allele frequencies as the result of differential productivity or extinction of groups. Behavioral grouping allows for the formation of groups that can compete with one another over resources and genetic differences between groups (e.g. differences in cooperativeness) that can be acted upon to produce genetic change.

Even though the ability to assort behaviorally can be explained at the level of individual advantage, it is likely that this ability lead to group selection for the mechanisms that underlie social interaction. The ability to recognize cooperators need not be group selected, but once cooperators can find each other, groups emerge that can be acted upon by interdemic selection.

Another aspect of information processing that increases the capacity of agents to behaviorally assort is the capacity for sharing reputational information. When individuals have the ability to share information they have gathered about the reputation of others, this further decreases the likelihood that defection will be an advantageous strategy. Information sharing allows individuals to learn the reputations of others without having to take the risks that are usually associated with interacting with a new partner.

Simulations involving information sharing between agents would likely yield interesting results and would also allow one to investigate the effects spatial structure and behavioral assortment on the evolution of the capacity for information exchange.

The Emergence of Subjective Commitment

One mechanism for the mediation of social interaction that might have been group selected (at least to a certain degree) because of the ability of agents to group behaviorally is the capacity for subjective commitment. The capacity for subjective commitment can be quite costly at the individual level. Positive attachments can cause individuals to make huge sacrifices for one another through emotions like love and concern. Also, the enforcement of contracts in the face of defection can often involve costly retaliation mediated by emotions such as anger, jealousy and a desire for revenge. These emotions can all be considered part of the phenomenon of subjective commitment (Frank 1988, Nesse 1990).

The concept of a utility function, or an internal representation of potential fitness consequences of behavior, adds an interesting twist to the notion of subjective commitment. In a sense, subjective commitment is the result of the incorporation of another agent's utility function into one's own utility function, with appropriate weight assigned to the utility of individuals in the social environment based on the level of commitment. This results in the internalization of the externalities associated with potential actions of the agent, at least to a certain extent. Commitment might be thought of as the coupling of another individual's utility function into one's own in a positive way (e.g. love) or a negative way (e.g. revenge and punishment).

Feelings of commitment, such as an unwillingness to impose costs on those close to you, are efficient heuristics for managing social relationships because they keep one from performing actions that could result in a bad reputation. However, they might be more than just that. Because following through on commitment can often result in performing behaviors that are very costly (e.g. taking care of a terminally ill spouse or spending a great deal of time and energy seeking revenge) they might not always lead to the most advantageous outcome for the individual.

One view of commitment is that it is a signal that can be observed by others that increases the likelihood of cooperation by ensuring future cooperation or punishment of defection (Frank, 1988). In some cases commitment to future action is directly observable through behavior (e.g. ripping out ones steering wheel before a game of chicken or putting oneself under the control of regulatory mechanisms). However, this isn't the case for subjective commitment; it must be inferred, either from behaviors or through other cues. This makes the evolution of the capacity for subjective commitment much more difficult to explain on an individual level. Even if one accepts the idea that commitment (or behavior indicating commitment) serves as a signal, this still doesn't fully explain why genuine subjective commitment exists. It would presumably be advantageous to signal subjective commitment without genuinely being committed (i.e. be 'nice' until one is in a position where one would have to incur a large cost to maintain the illusion that one is indeed committed to the other individual).

The evolutionary basis for subjective commitment probably lies in the co-evolution of the capacity to detect individuals who are capable of genuine subjective commitment (selected at the individual level) and the capacity for subjective commitment (selected at the group level because of behavioral assortment and between-group fitness differences). In a sense, individual selection drives group selection by increasing the likelihood that groups of committed individuals will form and be selected for.

It is true that other forms of commitment can be viewed in this same light. These other forms of commitment are different from subjective commitment in that they can function as directly observable signals that can be interpreted by others. Like subjective commitment, these forms of commitment can result in the formation of groups that can realize group-level advantages. However, the there are differences in the selection dynamics that act on subjective commitment and those that act on other forms of commitment. After the formation of behaviorally assorted groups, group selection can act on subjective commitment to make it more flexible and subtle. However, other forms of commitment don't undergo further evolution as the result of this behavioral assortment. When commitment can be directly observed from the outset there is no real selection between groups of individuals, only selection for the ability to see commitment and enter into situations in which commitment is mutually beneficial. On the other hand, the capacity for subjective commitment was probably shaped by the group-level selection pressures that resulted from behavioral assortment.

Understanding the evolution of commitment, particularly subjective commitment, is clearly a complex issue. Distinguishing the individual-level and group-level selective forces underlying the evolution of the capacity to be committed to another individual is not an easy task. Computer simulations might provide insights about both the evolutionary dynamics underlying commitment as well as the nature of subjective commitment.

By modeling agents with utility functions that (can be selected to be) coupled with each other via the transfer of (potentially deceptive) information, it would be possible to experimentally investigate the roles of group selection and individual selection in the emergence of the capacity for subjective commitment. Perhaps even more interesting would be the qualitative insights about subjective commitment that might be gained through such simulations. Questions about the relationship between subjective commitment and deception (and perhaps even self-deception) might be able to be addressed by creating simulations in which agents have 'virtual' utility functions (that are the result of the coupling of their own 'base' utility function with the utility function of others).

It would also be possible to examine the role of positive or negative feedback in virtual utility formation using agent-based simulations. If the formation of virtual utility functions involves the coupling of one's own utility function with the virtual utility function of another (which already contains information about the weighted utility functions of others in the social environment) as opposed to the just the 'base' utility functions of the other agents, then feedback might result in interesting group-level effects. The nonlinear effects that result from such situations might help to explain the dynamics underlying certain phenomena observed in experimental social psychology (e.g. clique formation and attitudes towards 'out-group' members).

Conclusion

According to Wilson (1983) interdemic selection requires that there be genetic differences between groups, competition between groups, and differential productivity or survival of groups in such a way that changes in allele frequency result. The main thesis of this paper is that the capacity for behavioral assortment increases the likelihood that groups meet those criteria. The ability to process information about social interaction and form groups according to behavior can result in differences between groups in behavioral strategies. This results in the potential for higher success of groups with certain strategies and can result in changes in allele frequencies (assuming that differences in strategies have a genetic basis) through interdemic selection.

The role of behavioral grouping in creating the conditions for interdemic selection could be investigated through computer simulations of information processing agents. If interdemic selection does result from certain kinds of behavioral grouping, including temporary groups, this would have interesting implications for our understanding of selection pressures that have shaped human psychological mechanisms, as well of those of other species that engage in information processing of social information. Behavioral assortment is probably an important influence on social evolution because it can result in circumstances that favor group selection.

It is also suggested that interdemic selection can result in selection for the capacity for subjective commitment even if it is costly at the individual level (and therefore difficult to explain at the individual level). Subjective commitment can be thought of as the (usually partial) internalization of certain social externalities associated with the actions of an agent through weighted coupling of utility functions. By modeling agents with utility functions that can be coupled to each other, it would be possible to simulate the evolution of subjective commitment (assuming that one accepts the notion of coupled utility as being central to subjective commitment). This kind of model might also make it possible to address questions about group attitudes and the dynamics of group formation.

Because agent-based artificial life simulations allow for the modeling of individuals with complex information processing capabilities and computer simulations allow one to examine the evolution of behaviors in ways that are intractable using purely mathematical models, the approach used in artificial life research might be useful for understanding the evolution of behavior. The computational power and qualitative insights that evolutionary simulations bring to questions about behavioral adaptations make them an important complement to purely theoretical/mathematical work and experimental work.

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