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The impact of individual versus group rewards on work group performance and cooperation: A computational social science approach

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ABSTRACT

Purpose: To examine the effect of individual versus group evaluation and reward systems on work group behavior and performance under different task conditions.
Methodology: Uses computational social methods using Agent Based Models to simulate work group interactions as different forms of iterated games.
Findings: Group based systems outperform individual based and mixed systems, producing more cooperative behavior, the best performing groups and individuals in most types of interaction games. A new role emerges, the self-sacrificer, who plays a critical role in enabling other group members and the group, to perform better at their own expense.
Research Implications: Suggest opportunities for model development and guidelines for designing real world experiments.
Practical Implications: Helps firms engineer better performing work groups as well as the design of other business systems.
Social Implications: Identifies mechanisms by which cooperation can be developed in social systems.
Originality/Value: Demonstrates the role and value of computational social science methods and agent based models to business research.

1. Introduction

Much of the work of firms is carried out using work groups or teams of interacting individuals, such as in production processes, the development of products and services, service delivery and in managing operations (Cummings, 2004; de Jong, de Ruyter, & Wetzels, 2005; Kozlowski & Ilgen, 2006). As one manager comments: 'We think everything worth doing is done by groups, not by individuals' (Weber, Holmes, & Palermi, 2005, p. 80). Prior research shows that cooperative behavior among work group members plays an important role with more cooperative groups outperforming less cooperative ones (Kozlowski & Bell, 2003).

Useful as such studies are, they tell us little about how and why cooperative behavior emerges and continues in work groups and how managers can engineer greater cooperation. As Kozlowski and Ilgen (2006) conclude, based on an extensive review of the literature, "the dynamics inherent in team processes are still somewhat elusive" (p 97). Developing cooperative behavior in work groups is not easy because of conflicts between individual and group interests. This is especially so when groups comprise individuals with different backgrounds, expertise and interests. Such groups tend not to share information, not to learn from each other or to be flexible in terms of their workloads (Gratton & Erickson, 2007).

More generally, the evolution of cooperation in society, especially among strangers and anonymous opponents is still an unresolved issue (Hammerstein, 2003). Research shows that in general people show high levels of cooperative and pro-social, behavior towards others, even to strangers and anonymous others (e.g. Henrich et al., 2001). This is true of primitive societies and societies with large scale institutions such as market integration and world religions (Henrich et al., 2010; Woodside & Zhang, 2013).

Managers have several ways of potentially improving work group cooperation and performance. One method is to use group or team rewards but "despite hundreds of studies examining team rewards, the conditions under which team rewards will be effective are unclear" (Aimea, Meyer, & Humphrey, 2010, p 60). Prior research focuses on the moderating effect of task interdependence and the rewards for cooperation versus competition (Aimea et al., 2010; Chan, Li, & Pierce, 2014). For example, Wageman (1995) shows that team effectiveness is highest in work groups in which the rewards and tasks have pure individual designs – those in which individual rewards and performance are

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independent of the performance other group members – or pure group designs, where individual rewards and performance of group members are completely interdependent such that the performance and rewards of one member entirely depends on the others' performance. Chan et al. (2014) show that team based rewards enhance performance when worker ability is heterogeneous, which makes cooperation more important in completing tasks. The problem is that group tasks are usually a mix of group and individual interests, a mixture of cooperative and competitive incentives, which leads to the central research question considered here: For what types of group tasks do group or team based rewards outperform individual based rewards?

Computational social science methods can help answer this question. They involve developing agent based computer simulation models that mimic key features of the behavior of work groups and their interactions (Epstein, 2006; Macy & Willer, 2002). The potential value of such methods to studying work group design and performance has been noted before: "Agent-based models have enormous potential to resolve the problem of system-team design … The high potential of this approach means that it merits much broader attention and application in organization team design" Kozlowski and Ilgen (2006, p. 102) and in the examples of the use of such models to study organizations including that by Chang and Harrington (2006) and Prietula, Carley, and Gasser (1998).

Modeling the complex system of interactions among many individuals that characterize work groups is beyond the scope of traditional mathematical and statistical methods (Deissenberg, van der Hoog, & Dawid, 2008; Leombruni & Richiardi, 2005). This is because work groups are highly nonlinear systems in which group behavior and performance emerges through the interactions taking place over time in a bottom up self-organizing manner in a particular context, including the task and the mix of participants' skills, knowledge, attitudes, predispositions and strategies (Kozlowski & Ilgen, 2006). Instead, the study and understanding of the behavior of complex systems like work groups calls for a different approach to science to the traditional experimental and mathematical methods that have served us well for the last 300 years (Jackson, 1996). Axelrod (1997) describes this approach as a third way of doing science.

To build and analyze computational models requires new types of skills, including programming and algorithmic thinking and ways of understanding that challenge traditional ways of thinking and doing research (Jacobson & Wilensky, 2006). Hence they tend to be resisted, currently, in many social science and business disciplines research using these methods is difficult to publish (Harrison, Lin, Carroll, & Carley, 2007). But the situation is changing, with articles explaining and using these methods now appearing in top journals (e.g. Goldenberg, Libai, & Muller, 2001; Lazer & Friedman, 2007; Macy & Willer, 2002; Rand & Rust, 2011; Trusov, Rand, & Joshi, 2013), and special issues of journals have been devoted to the subject, such as the *Journal of Business Research* (Gilbert, Wander, Deffant, & Adjali, 2007), *Journal of Product Innovation and Management* (Garcia & Jager, 2011), *International Journal of Innovation and Technology Management* (Siebers & Wilkinson, 2013) and *Australasian Marketing Journal* (D' Alessandro & Winzar, 2014).

Computational models are a form of mathematical model written in computer code. Just like any model they represent simplifications in order to focus attention on key aspects of behavior. The major advantage of using them is their ability to model and analyze the behavior of complex nonlinear systems, involving many types of interactions and interdependencies. The modeler does not need to make restrictive assumptions in order to make a model mathematically tractable (Tesfatsion & Judd, 2006). The outcomes of computational models are studied using systematic computational experiments, rather than algebraic methods, to determine the logical outcomes of a model under different conditions. Such outcomes can be counterintuitive, because they are complex, nonlinear models (Tesfatsion & Judd, 2006) and because, as Lord May (1976) notes, the education and training of people and researchers is primarily on a diet of linear models.

Examples of the counterintuitive results of even relatively simple nonlinear models include Axelrod's (1984) computer experiments regarding the emergence of cooperation in Iterated Prisoners' Dilemma games, as will be discussed in more detail later. Similarly Schelling's (1971) classic models of urban segregation, in which he showed that even in the absence of any color prejudice, segregated neighborhoods emerge over time in cities.

An alternative to building computational models is to study the behavior and performance emerging in real work groups under different conditions, or to conduct experiments. But the former restricts research to the study work groups under conditions that exist and the researcher can gain access to which does not include all the types of potential conditions that could exist. And the latter requires a very large number of experiments that would be impossible, too costly or unethical to carry out in the real world. But such experiments can be done using computer models (Axelrod, 1997; Gilbert & Troitzsch, 2005; Gilbert et al., 2007; Tesfatsion & Judd, 2006). Furthermore, the outcomes of such computer experiments complement empirical research because they can identify likely conditions producing desired outcomes, which can then be tested in the real world (Held, Wilkinson, Young, & Marks, 2014).

Research already exists which uses computational methods relevant to the study of work group behavior. Axelrod (1984, 1987, 1997) and Axelrod and Hamilton (1981) undertook important pioneering work using computational methods to study the evolution of cooperation and performance among interacting individuals. They did this using Iterated Prisoner Dilemma (IPD) games to model interactions involving a mix of competitive and cooperative motives. Their computer experiments provide the basis for the research described here, which models work group interactions as forms of interaction games. The research described here builds on and extends the work of Axelrod and his colleagues in many ways, including using examples of all types of games, not just the IPD and to examine the impact of group as well as individual evaluation and reward systems on the emergence of cooperation.

The findings show that group based evaluation and reward systems outperform individual based or mixed reward systems for a large number of group situations. Individual based systems outperform group and mixed systems only when individual and group interests are aligned, that is when the action that benefits an individual also benefits the group. The findings are consistent with empirical research that shows that the group task is an important moderator of the effect of group cohesion and shared knowledge and cognitions on group effectiveness (Kozlowski & Ilgen, 2006). These conditions aid coordination and the cooperation processes within groups when the group task is more complex and greater interdependencies exist. In such situations more opportunities for conflicts of interest arise such that group and individual performance are not aligned.

The findings also reveal the conditions under which no significant difference between the outcomes of group and individual evaluation and reward systems exist. This will help managers to identify and focus attention on work group situations where the design of the reward system matters.

Another finding is that, counter-intuitively, group incentives produce the highest performing individual strategies in many types of games because they produce and sustain better mixes or ecologies of strategies. As in biology, the success of a given type of animal's behavior strategy does not depend only on itself but also on the behavior of other animals and their interactions with them, as well as on the environment in which they operate.

Lastly, the findings suggest the existence of a new type of role in work groups, the self-sacrificer. These individuals induce superior performance in others in the group and the group as a whole at the expense of their own performance. They resemble but are quite different from free-riders, who simply exploit the group for their own benefit. Individualist evaluation and reward systems do not reward and retain self-sacrificers in groups. Instead, they are poorly evaluated and removed

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