Chapter 12

Theory of Intelligent Collectives: An Experimental Physiological Approach to Group Decision-Making

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ABSTRACT

We review our theory of robust intelligence (RI) for groups. We examine the quality of decisions by groups in the laboratory under either majority rule (MR) or consensus rule (CR). Theoretically, engagement in decision-making becomes a factor depending on whether an individual is in a group or in competition between groups. From earlier research, measures of engagement in three-person groups included self-reports, counts of utterances during discussions, and changes in electro-dermal activity (i.e., galvanic skin responses, or GSR). We predicted engagement (number of utterances) would be greater under CR than MR; under MR, we predicted that GSRs would be greater (more attention). Based on partial analyses, participants under CR spoke significantly more often during discussions than MR. As predicted, after de-trending GSR data, we found MR produced higher GSRs and shorter discussions. Our recent work in group size has increased to five participants working on Wason Selection Tasks.

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INTRODUCTION

The last author stumbled onto the importance of this decision-making problem after blowing the whistle on the Department of Energy (DOE) for its destruction of the environment at its Savannah River Site (SRS) and across DOE’s very large complex in the United States, and DOE’s later attempt at cleaning up the environment with citizen advisory boards (Lawless et al., 2005). Field work with citizens advising the Department of Energy on its environmental cleanup of radioactive wastes indicated that groups attempting to solve problems with uncertain solutions under majority rule (MR), compared to consensus rule (CR), may work more efficiently and produce better, more practical decisions (Lawless et al., 2008). On the cost side, MR introduces more conflict. For solutions to uncertain problems, leaders under MR drive their groups to a decision by sharply contradicting the views of each other, producing a stable Nash equilibrium, but sharply increasing the cost for other participants of merely entering the discussion. In contrast, since no one is allowed to be contradicted under CR, more participants are willing to freely engage in open-ended, unfocused discussion compared to MR. Thus, under both uncertainty and MR, the number of factual statements should increase and the time to reach a decision should decrease, while under CR, the overall number of utterances should increase.

Overview of Our Paper

We review the literature on the study of interdependence in groups and multitasking; our theory, concepts and the mathematics of interdependence in multitasking; laboratory experiments with groups along with the issues we have encountered; a discussion of theory and laboratory research; and our future research into both, including our initial foray into computational models of groups.

We propose a solution for dynamic interdependence under uncertainty that more closely models human cognition and behavior, guided by the mistakes common to both. If successful, the result should be improved metrics for and mathematics of hybrid teams, firms and systems of teams and firms performing under uncertainty. An established mathematics of teams would lead to the ability to improve trust among humans, machines and robots. An integral part of our solution, data aggregation and analyses that include interdependence, would advance the science of data fusion and decision-making. Finally, a valid computational model of interdependence would advance the physics of the natural limits in the understanding of organizational science; economics of systems of firms; and the computational science of hybrid teams, firms and systems.

Although we discuss theory in this paper, our focus is primarily on a laboratory model of group decision-making under uncertainty. In particular, we restrict ourselves to small groups’ research of decision-making with either the cooperation inherent in consensus-rules (CR) and the conflict inherent in majority rules (MR). The present report is part of an ongoing series of studies attempting to replicate our field research with the Department of Energy in a laboratory setting (Enslein et al., 2011; McKoy et al., 2012), while examining relevant variables affecting group decision-making.

Background

Our ultimate goal is to construct the mathematics of decision-making for hybrid teams consisting of an arbitrary combination of humans, machines and robots. This mathematics would characterize a team with robust intelligence (RI). To develop a theory of RI under uncertainty, we continue to advance our