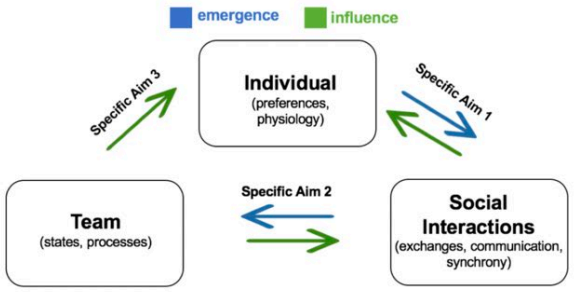
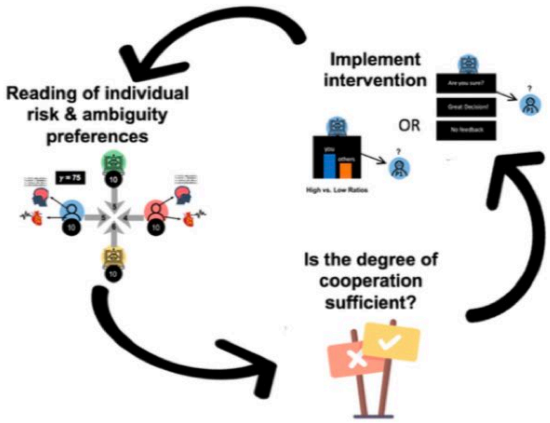
STRONG - Cycle 1, FY19

Adaptation of Social Decision Making under Uncertainty in Human-Agent Teams



LSB Multilevel Theory of Human-Agent Teams



Individualized adaptive interventions within a social resource sharing game

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Summary: With the development of AI systems, future Army teams will comprise both humans and non-human agents. To foster the development of cooperative human-agent teams and to facilitate their dynamic reconfiguration within operational environments, it is critical to develop individualized, adaptive technologies to enhance team processes and states. We propose an expansion of the multilevel theory of organizational systems. This expanded theory allows us to develop testable hypotheses for how individual-level factors manifest in social interactions and team state. We also use techniques from multiagent systems to tailor interventions at the individual-level based on real-time inference of individual and team states using continuous, non-invasive neurophysiological measures. In this project, we propose to demonstrate the *emergence* of cooperative team states among human-agent teams via real-time individualized, adaptive interventions that *influence* individual decisions.

We propose a novel multilevel theory of human-agent teams (see Figure 1) that underscores *emergence* (bottom-up processes) across the individual, social, and team levels. We also posit

the importance of *influence* (top-down processes), in which higher-level states influence lower-level states. In the extant perspective, there are three levels that describe the emergence of team phenomena: micro (individual), meso (social interactions), and macro (team states, team processes). Existing theory provides a rich account of the dynamics within the macro-level but less detail of the specific factors involved in the meso- and micro-levels. The proposed theory provides testable hypotheses for how specific individual properties—namely, uncertainty preferences and their neurophysiological correlates—influence social interaction (*e.g.*, goods sharing) dynamics and the emergence of future team cooperation. In addition, the theorized *influence* provides a pathway for individualized, adaptive technologies to shape the *emergence* of team states through tailored interventions.

We will focus on examining how individual preferences for risk and ambiguity predict individual policies toward social cooperation in human-agent teams. We will leverage economic paradigms and formal computational models of planning and decision-making from multiagent systems to study the individual and group interactions that lead to team state. With this interdisciplinary approach—and in close coordination with our collaborators—we aim to illustrate how individual responses to uncertainty in social environments contribute to the emergence of social cooperation within both economic and more complex tasks.

We further propose that individual preferences for risk and ambiguity may be critical inputs for individualized, adaptive technologies to anticipate future decisions of human teammates and even discern individual, social, and team states. We hypothesize that non-invasive measures of neurophysiological activity represent strong candidate markers of uncertainty preferences that future technologies can use to make continuous, iterative inferences about future decisions of human teammates and emergent changes in team cooperation.

Impact/Building Block: Future Army teams will comprise human and non-human agents. Just as in human teams, emergent states and processes will contribute to the success or failure of those teams. This project contributes testable theory based on existing work in human teams research for understanding how individual factors and social interactions manifest in team states and processes. It also hypothesizes a mechanism for intelligent technologies to intervene at the individual-level to shape outcomes at the team-level. Although this project focuses on individual preferences for decision-making under uncertainty, if successful, it will provide a theory with which to test other individual factors. The systems-level perspective will also provide a framework with which to develop individualized, adaptive technologies for more complex team tasks.

Schedule/Milestones: Year 1: Test emergence from individual to social interactions and influence from social to individual using two-player cooperative game; Year 2: Test emergence from individual to social interactions and social interactions to team state using multi-player cooperative game; Year 3: Test influence from team to social interaction and team to individual using multi-player cooperative game.