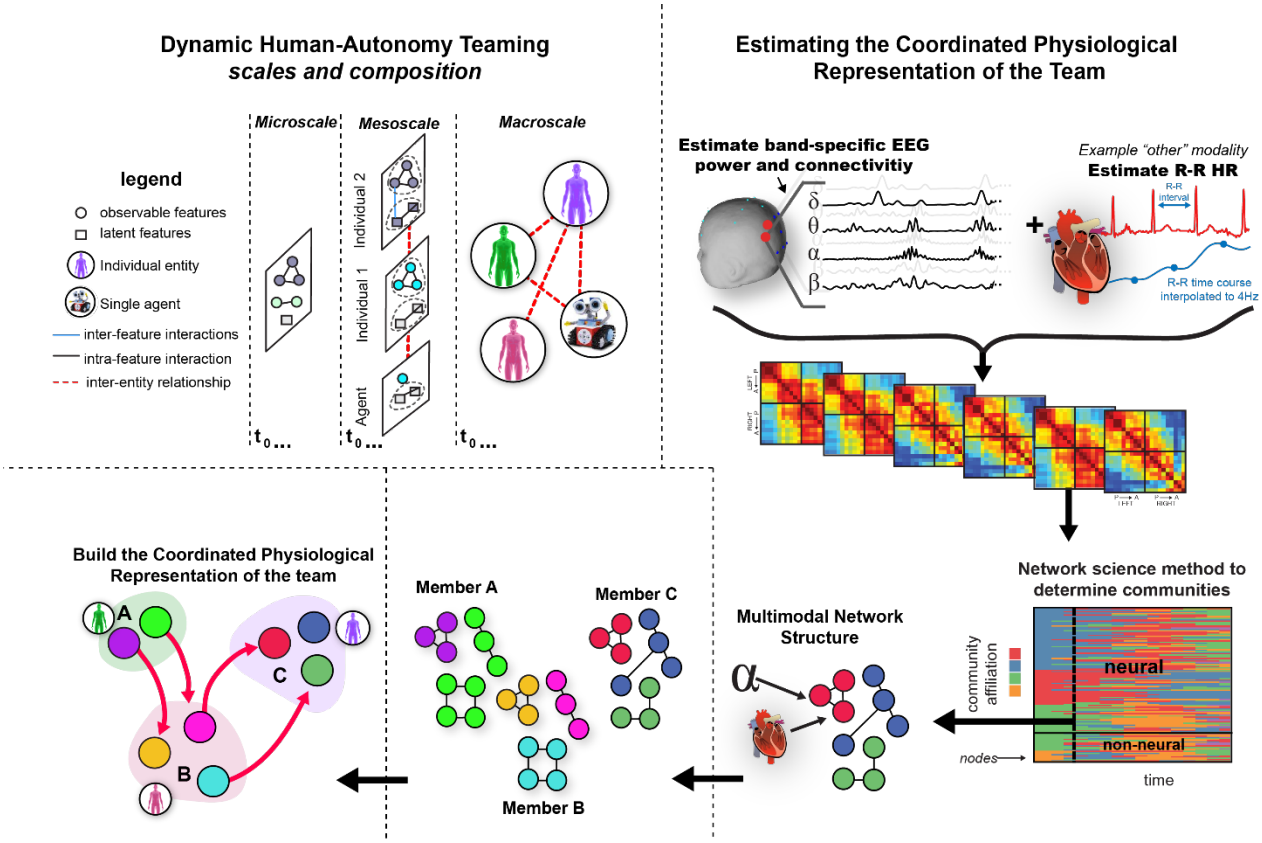
# STRONG - Cycle 1, FY19

## On a generalized framework of physiological synchrony underlying coordinated physiological representations in human-autonomy teams

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**Summary:** The human brain is a complex dynamical system composed of a collection of heterogeneous elements that decode environmental features to enable effortless interaction in a complex world. Neural representations are the intricate set of neural elements (and the coordination of them) that uniquely describe features of this environment. Social interaction amongst humans colors our environment and its



associated neural representation to such an extent that the interaction itself must be neurally represented. Social neuroscience efforts, by investigating these neural events from simultaneously monitored brains of interacting individuals (a.k.a., hyperscanning), have indeed shown unique neural coordination (between individuals) to be associated with a variety of social and/or group behavior.

Moreover, this socially-entangled environment is ever-increasing in complexity where humans are experiencing several transformative changes. (i) Intricate tasks are routinely implemented in multi-team systems, and (ii) modern technology has infiltrated nearly every facet of the human experience. The current and future battlefield is no exception. Advances in AI and computer science are enabling intelligent, autonomous agents to join military teams. As part of this current and future battlefield, we must understand how future human-autonomy teams (HATs) operate to create effective HAT technologies and gain superiority in this domain.

We propose that foundational to future HAT technologies must be a means by which we may understand and capitalize on the complex and unique processes covertly operating within each human and autonomous agent (and also between) in the HAT. Similar to how a neural representation uniquely describes the neural process underlying an environmental feature, **a coordinated physiological representation (CPR)** is defined as a pattern of physiological activity and behavioral interaction that stands for the internal workings of a team, constrained by individual team member's physical composition. Using the strict criteria of previous physiological representations, we propose to develop and validate a generalized framework to study the CPRs that uniquely and robustly describe quantifiable attributes of a team that consists of both humans and autonomy. Our work will implement a variety of data fusion/integration techniques and borrow methods from network science and dynamical systems research.

**Impact/Building Block:** Neural and other physiological signals provide a unique glimpse into the covert mental events (or dimensions) of team members, especially as they interact with others (including autonomy), and will be crucial to the design and implementation of the individualized teaming technologies of the future. This proposal aims to develop and validate an approach to access the coordinated physiological representations (CPRs) underlying team processes in heterogeneous human-autonomy teams (HATs), and to extract effective features from these coordinated physiological representations associated with team-level processes.

**Schedule/Milestones:** Year 1: Test and modify the initial developed technique on small human teams and simple team processes, Year 2: Extend method to a variety HATs and complex covert team processes, Year 3: Expand method to multiple coordinated HATs.