Building Extreme Teams: Simulating Team Composition Effects in Isolated and Confined Environments

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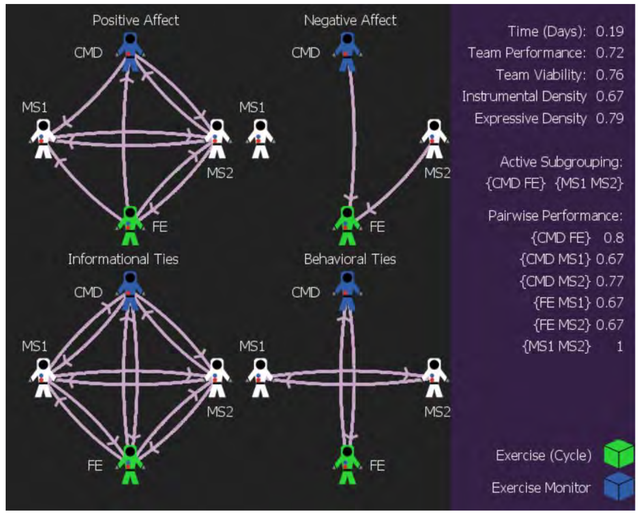
Introduction

We explore the impact of team composition, the attributes of members selected for teams, on their performance in isolated and confined environments (ICE). We leverage prior research that has studied these effects in less extreme environments. Meta-analysis (Balkundi & Harrison 2006) indicates that network in teams are a stronger predictor of team performance and viability. Hence we extend team composition research to include the emergence and effects of affective and instrumental network ties among team member. and develop a novel theoretical framework for the emergence of teaming capital.

We draw upon prior theoretical and empirical research to develop an agent-based model (ABM) for the emergence of affective and instrumental ties and their impact on performance. We use empirical data collected in HERA to parameterize the ABM.

We conduct virtual experiments to help NASA explore how changes in team composition will impact performance.



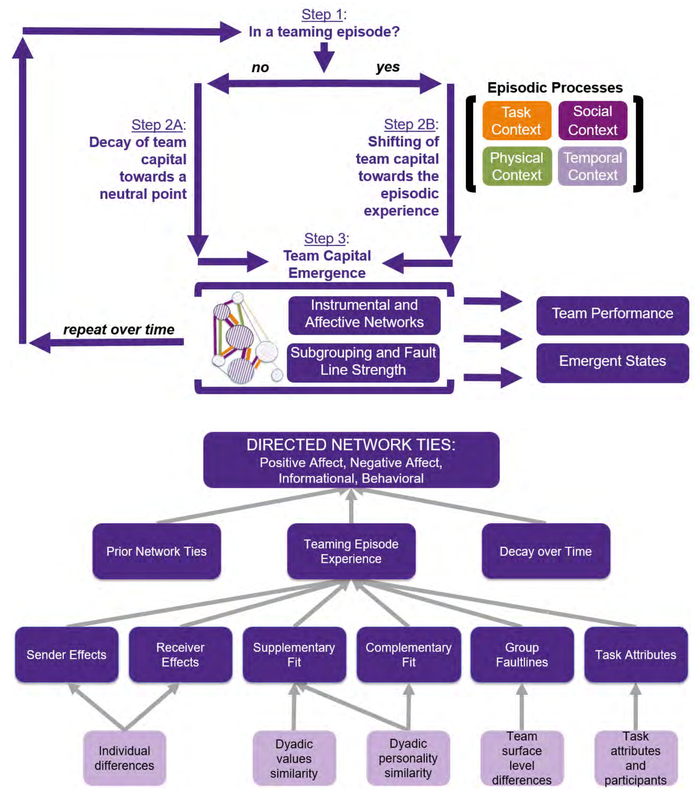
We model how multiplex relationships develop over time using affective (**positive** and **negative**) and instrumental (**informational** and **behavioral**) ties.

Network Ties	Binary Response Question Text
Positive Affect	"Who do you enjoy working with?"
Negative Affect	"Who makes tasks difficult to complete?"
Informational Ties	"Who is a valuable source of information?"
Behavioral Ties	"Who do you work effectively with?"

Agent-Based Modeling Framework

We model team member relationships as four networks of directed ties. Changes in ties are modeled using a discrete-event simulation approach. A **teaming episodes** occurs when two or more members collaborate on a task for a finite duration. For each teaming episode, we calculate a **teaming episode experience value** representing that event's influence on the network ties among those in that teaming episode

The variables that influence episodic experiences are the attributes of members, shared attributes between members, network relations among them, and attributes of the tasks engaged in during the teaming episode. The specific variables were selected based on theoretical and empirical literature reviews and meta-analyses.

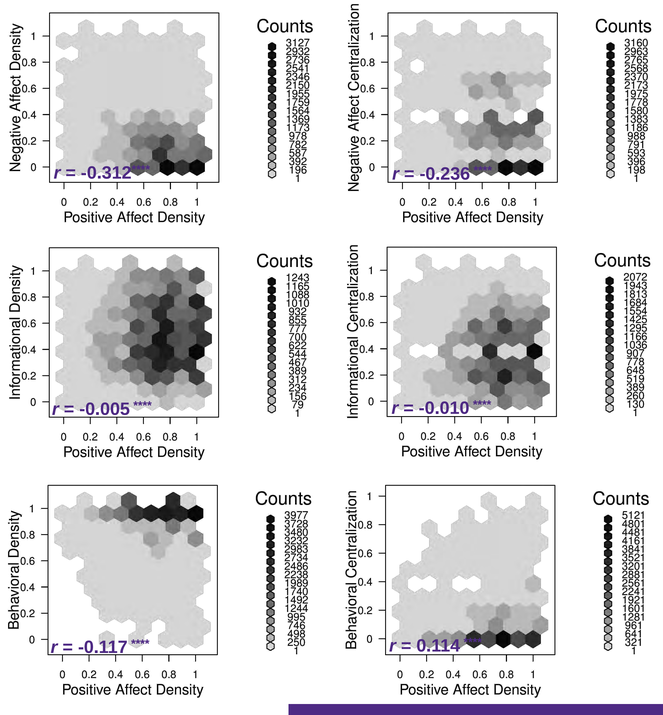


Validation and Virtual Experiments

We parametrized the ABM using empirical data collected at 7 time points over 30 days from each of four HERA crews. Model weights were fitted to minimize the prediction's sum of squared errors (SSE) using a genetic search algorithm. 35 searches of 30,000 simulated model runs were conducted for each of the ties.

Network Tie	Fit Accuracy	Precision	Recall
Positive Affect	93.16%	96.17%	95.83%
Negative Affect	86.61%	85.71%	42.86%
Informational	88.40%	90.00%	97.21%
Behavioral	91.07%	91.56%	98.99%

To develop an understanding of how different initial team composition factors impact long term performance and viability, we conduct virtual experiments with 30,000 model simulations. We use regression to assess how different personality and network variables influence team performance and viability.



Discussion

We compute effect sizes from 30,000 virtual experiments to predict performance and viability:

Effect Sizes on Team Performance (*r*)

Excitement Seeking Mean	Benevolence Mean	Morality Mean	Religion Value Mean
0.596****	-0.299****	0.276****	0.246****
Universalism Mean	**Gregariousness Std. Dev.**	**Gregariousness Mean**	**Self-Monitoring Ability Std. Dev.**
0.190****	-0.185****	-0.150****	-0.132****
Positive Reframing Mean	**Norm Acceptance Mean**	**Excitement Seeking Std. Dev.**	**Traditionalism Std. Dev.**
-0.121****	-0.107****	-0.098****	-0.088****

Effect Sizes on Team Viability (*r*)

Excitement Seeking Mean	Benevolence Mean	Universalism Mean	Religion Value Mean
0.658****	-0.403****	0.180****	0.179****
Gregariousness Std. Dev.	**Morality Mean**	**Excitement Seeking Std. Dev.**	**Traditionalism Std. Dev.**
-0.147****	0.145****	-0.106****	-0.098****
Modesty Mean	**Gregariousness Mean**	**Trust Mean**	**Self-Monitoring Ability Std. Dev.**
0.094****	-0.076****	0.073****	-0.072****

Significance Level: **** $p < 0.0001$

Our framework quantifies the relative effects that different personality traits, initial network ties, and task characteristics have on team performance and viability. We demonstrate how the dyadic-level affective and instrumental bonds between teammates emerge as they engage in teaming episodes and how this predicts long term team viability and performance.

Our approach provides a tool to support team functioning:

Descriptively, to increase our understanding of general patterns and trends across teams.

Predictively, as a "what-if" decision support tool during crew selection to compare the potential performance and viability of candidate teams.

Prescriptively, to suggest future task and teaming assignments to optimize performance and viability and mitigate potential conflict.

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