A Multiplex Lens on Influencer Performance, Group Synergy, and Network Centralization

Keywords: Multiplex Networks, Team Performance, Group Synergy, Motivation, Influence

Extended Abstract

Team synergy – the phenomenon where teams exceed the level of performance expected from their members working independently – depends not only on a team's composition but also on the configural properties of its members' interactions [1, 2]. Networks capture these properties by revealing how influence is distributed and how interaction patterns shape the integration of contributions. Teams adapt their internal networks in response to perceived member performance and contribution. Such adaptation both reflects and shapes team functioning, as network features such as centrality, cohesion, and efficient communication have been linked to team effectiveness [3], suggesting that synergy is most likely when performance and network influence are aligned. Our study builds on this premise by examining teams' performance on structured problem-solving tasks and dynamic sociometric surveys throughout an extended duration space analog mission to identify whether such alignment predicts group performance above the aggregated individual scores baseline.

Data were collected from three teams over eight months: the six-member isolated *SIRUS-21* crew and two seven-member Twin Teams (*TWIN-Black* and *TWIN-Silver*) consisting of non-isolated Northwestern University undergraduate students. Each week, teams completed tasks designed to test problem-solving capabilities. Participants first completed the tasks individually before discussing their solutions as a group to submit a collective response. Team synergy was calculated as the difference between team performance and the average performance of individual members. These values were then normalized across teams using z-score normalization: (synergy score - global synergy mean) / global synergy standard deviation. After each task, members identified which team members' ideas were integral and who kept the crew motivated during the task, generating idea and motivation networks, respectively.

To examine the relationship between influence and team synergy, we constructed a multiplex network by intersecting the motivation and idea networks, since effective leadership requires both the provision of high-quality ideas and the ability to energize others to act upon the ideas A directed tie between two individuals in the multiplex network was included only if both networks contained directed connections between the same dyad in the same direction. We then identified multiplex influencers as individuals with the highest in-degree centrality, representing those who received the most nominations in the multiplex network. If multiple individuals tied for the highest in-degree centrality, we took the average of their performance. Using a team-specific mean split of task performance, influencers were classified as high or low-performing relative to their team's average. For each team, we plotted their network in-degree centralization against globally normalized synergy scores to test whether the alignment between influencer performance and centrality predicted differences in collective outcomes, while controlling for the synergistic effects of multiplex network positions.

Our analysis revealed a divergence between "high-performing" and "low-performing" influencers. Low-performing influencers showed a significant positive association between synergy and network centralization: as they became more central, team synergy increased. This phenomenon could reflect a discrepancy between perceived and actual sources of ideas within the teams. Low-performing influencers may not have generated correct solutions themselves, but their central position may have enabled them to facilitate the exchange of ideas and motivation among teammates. Rather than acting as originators of knowledge, they may have

functioned as catalysts who structured interactions in ways that allowed others' contributions to be expressed and integrated, thereby fostering greater team synergy.

Intentionally shaping team networks based on performance raises important ethical concerns. If performance metrics undervalue less visible contributions, then promoting individuals to central roles solely according to performance can reinforce inequities. In high-stakes contexts, this can suppress diversity of thought and creativity, limiting adaptability. Moreover, because such analyses rely on fine-grained interaction and performance data, they raise privacy concerns around surveillance and the potential misuse of sensitive information. Ethical team design must therefore strike a balance between efficiency, inclusivity, and data protection to ensure an equitable and responsible application. Future work in this area could incorporate analysis of objective interaction data (e.g., sensor data, conversational transcripts, etc.), using natural language processing or other computational approaches to determine differences between high and low performing leaders.

References

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Table 1. **Regression Slopes and Significance Tests.** Linear Regression Estimates for In-Degree Centralization Predicting Team Synergy by Leader Performance Group.

Network	$\beta_{\text{High Performing Influencer}}$	$\beta_{\text{Low Performing Influencer}}$
Motivation	-1.514	3.220
Idea	2.898	3.029
Motivation x Idea	-1.213	3.898*

* $p < 0.05$ (two-tailed tests).
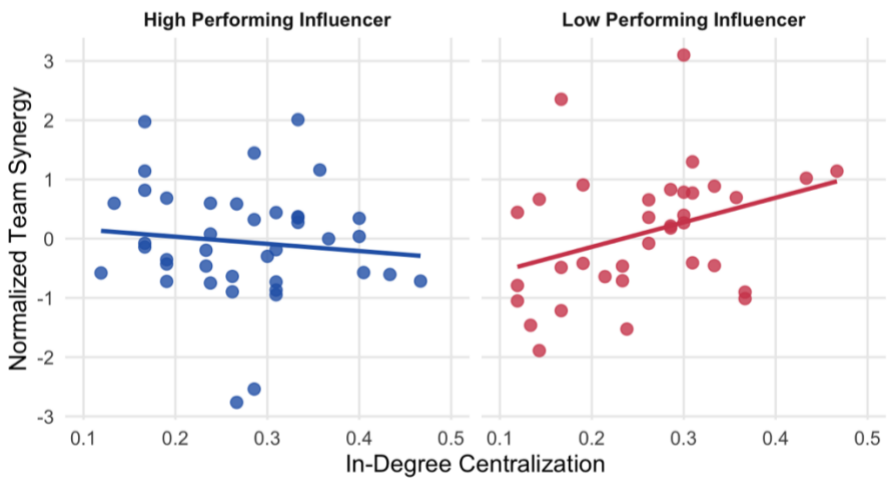
Figure 1. **Normalized Synergy vs. Indegree Centralization Model for Motivation x Idea Multiplex Network.**