Re-examining Group Development Theory

A Recurrence Quantification Analysis of Interactional Dynamics and Performance in Newly Formed Teams

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Re-examining Group Development Theory: A Recurrence Quantification Analysis of Interactional Dynamics and Performance in Newly Formed Teams

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Introduction

In contemporary organizations, teams are continually (re-)formed to address new and complex tasks, necessitating effective performance from the outset, often under strict time constraints (Wheelan, Åkerlund & Jacobsson, 2025). The Integrated Model of Group Development (IMGD; Wheelan, 1994a) is one of the most widely utilized developmental frameworks for examining how teams move through distinct, predictable stages to achieve both high performance and maturity as well as improved well-being among members (Wheelan, Åkerlund & Jacobsson, 2025). The central claim of this line of research is that for teams to function effectively, they must successfully address the challenges inherent in earlier stages to advance to later, more productive stages (although temporary advancements and setbacks may occur). However, empirical testing by Wheelan and colleagues showed that high team functioning is relatively uncommon and requires time to develop. In a U.S. multi-sector dataset of teams (N = 815), 20.8% were classified as high performing, with newly formed teams taking 8.5 months on average to reach this level. Figures in Sweden show similar patterns, with rates of 20.0% and an average duration of 8.2 months (Wheelan, Åkerlund & Jacobsson, 2025). The misalignment between the demands for immediate high performance in contemporary organizations and the observed developmental trajectories of teams necessitates a closer examination of dynamics, especially in newly formed teams. Could early, task-focused behaviors be identified using methods sensitive to temporal organization, and subsequently leveraged to intervene and support teams in reaching their potential?

It is becoming increasingly common in the literature to describe teams as adaptive systems. The functioning of an adaptive system emerges from interdependent interactions over time, where members share a collective goal and shared accountability, coordinating and adapting their actions over time to achieve and maintain outcomes (Delice, Rousseau & Feitosa, 2019). However, most empirical applications have used static survey measures that do not capture change over time, leaving the fine-grained temporal dynamics of team behavior undermeasured. This obscures the trajectories when and how teams become high performing. Scholars increasingly recommend research designs and analyses that preserve temporal order and accommodate non-linearity, rather than relying on cross-sectional or static summaries. For instance, in an early empirical illustration, Wheelan and Williams (2003) used a wavelet transform analysis to characterize non-linear interaction patterns of different teams and related them to different levels of performance.

Building on these illustrations and further addressing the theory-method gap, the aim of our study is two-fold: First, it offers an IMGD-anchored replication by testing whether behavioral compositions associated with development are evident in the context of newly formed teams under time constraints and whether these relate to performance. Second, it explores the temporal patterns of coded interaction using Recurrence Quantification Analysis (RQA), a non-linear technique that summarizes structure in time-ordered behavioral sequences without imposing linearity assumptions.

Methods

The present study used an observational, simulation-based design to explore the interactional dynamics based on team behaviors and performance outcomes in newly formed teams. The study was conducted in a controlled laboratory environment where teams of four postgraduate students engaged in a time-constrained, collaborative problem-solving task (i.e., escape-room-in-a-box simulation "Exit: The Game"; Kosmos Games, 2017). Participants were recruited through posters put up around the Lund University campus, inviting graduate students to participate. Following eligibility screening, we selected 120 participants from 50 different nationalities in 30 teams. Participation was voluntary, and participants provided informed consent.

Audio recordings were verbatim transcribed and coded using the Group Development Observation System (GDOS; Wheelan, Verdi & McKeage, 1994b), which categorizes utterances into seven team behaviors associated with the different stages of group development: Work (task-focused statements), Dependency (seeking direction/permission), Counter-dependency (asserting autonomy/challenge), Fight (confrontational statements), Flight (task avoidance/topic shift), Pairing (affiliative support), and Counter-pairing (keeping distance). The coded data was structured into time-ordered categorical sequences by task, team, and utterance timing. Reflecting real-world performance criteria, performance metrics were task completion time and accuracy of the final meta-task. Based on team performance ranking, we selected the four highest scoring (named team 1-4) and the four lowest-scoring teams (named team 27-30). Out of the ten total tasks in the simulation two tasks were selected to represent early (task 2) and later (task 8) stage behavior. These were selected to enable comparisons within-team of interactional dynamics over time, as well as between-team across performance levels. To ensure comparability for within- and between-team analyses, data from an Early and Later Task for each team were truncated to a fixed length of 420 seconds.

To describe verbal behavior, GDOS category frequencies were computed, providing the total percentage of time spent on each behavior for all teams. These values were summarized using means and standard deviations to provide a baseline understanding of interaction patterns of team behaviors. To explore interactional dynamics, RQA on time-based categorical series for the Early and Later tasks in each team were computed. We calculated key metrics for each team and phase, including recurrence rate (RR) as an index of recurrence density, determinism (DET) as the proportion of recurrent points forming diagonals (predictable structure), laminarity (LAM) and trapping time (TT) as the persistence of states (vertical structure), and categorical entropy (catH) as distributional complexity.

Results

Work occupied a larger share of time for high compared to low performance teams at both phases (Early: M = 78.1% vs. 76.4%; Later: M = 61.7% vs. 56.3%; see **Figure 1A**). Flight was lower for high performance teams (Early: M = 0.1% vs. 0.5%; Later: M = 1.7% vs. 8.3%). Dependency was slightly lower for high performance teams in both phases (Early: M = 4.2% vs. 4.8%; Later: M = 13.9% vs. 14.3%). Work was observed to decrease from Early to Later tasks in all low performance teams and increase in one out of four high performance teams (in three out of four high performing teams Work decreased). Dependency increased from Early to Later low performance teams but also increased in all high performance teams. Flight increased from Early to Later in three out of four low performance teams and was unchanged in one team, whereas among high performance teams Flight increased slightly in three teams and was unchanged in one (though absolute levels remained low).

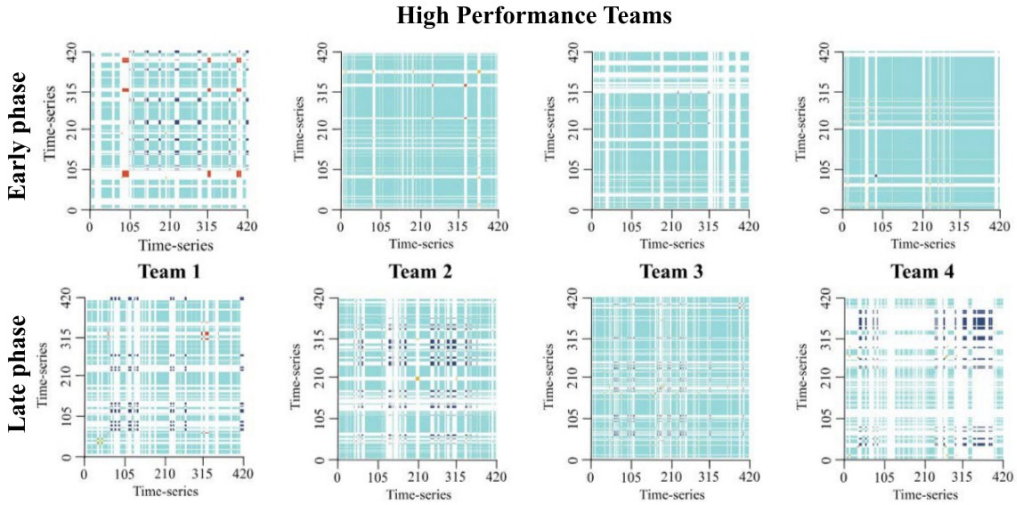
Figure 1. (A) Overview of distributions of GDOS categories averaged across high and low performance teams, **(B)** cRPs for high performance teams, and **(C)** cRPs for low performance teams.

(A)

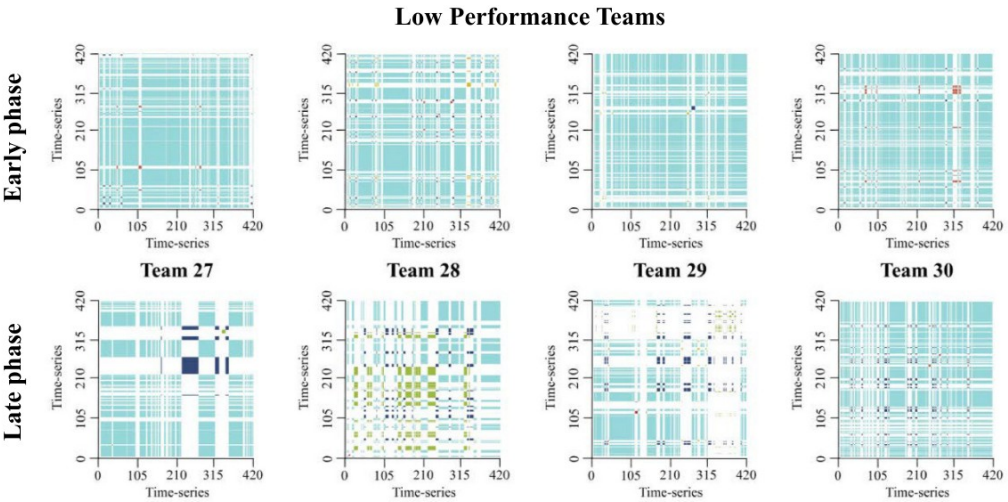
	High Performance Teams				Low Performance Teams			
	Early Phase (%)		Later Phase (%)		Early Phase (%)		Later Phase (%)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Work	78.1	11.3	**61.7**	15.5	**76.4**	2.8	**56.3**	12.0
Dependency	4.2	5.6	**13.9**	3.7	4.8	2.2	**14.3**	1.3
Counterdependency	2.9	4.3	1.8	1.7	3.3	2.6	.5	–
Fight	0.1	0.1	0	0	0.2	0.4	1.0	0.8
Flight	0.1	0.2	1.7	1.2	0.5	1.1	**8.3**	11.0
Pairing	2.7	2.2	2.6	1.0	2.6	2.9	1.1	1.5
Counterpairing	0	0	0	0	0	0	0	0
Silence	11.5	8.0	**17.9**	13.7	12.0	2.6	**17.9**	5.8
Unscorable	0.4	0.8	0.4	0.7	0.1	0.2	0.7	1.3

Note: Values are mean percentages of time in each GDOS category, calculated within 420-second windows for each phase, averaged across performance group (High, n = 4; Low, n = 4). Categories unobserved for a team-phase were set to 0% before averaging; totals may not equal 100% due to rounding

(B)



(C)



Color key: Work = light; blue; Dependency = dark blue; Flight = green; Counterdependency = orange; Fight = dark red; Pairing = yellow; Silence = white.

DET and LAM were uniformly high across teams and phases (*DET* range: 89.82–98.98%; *LAM* range: 95.40–99.87%). This pattern indicates that utterances tended to occur in structured sequences (diagonals) and sustained states (vertical structure), consistent with extended stretches of a single GDOS-code (most often Work) across teams (see **Figures B** and **C**). RR varied more widely (29.12–76.55%), indicating between-team differences in how densely the sequences revisited prior states. Later plots for teams 2 and 4 displayed fragmentations of diagonal structure (shorter, more broken diagonals) relative to Early, consistent with lower L and TT. Team 28 exhibited clusters of Flight that interrupted Work sequences, whereas team 30 showed larger continuous Work patches Later with fewer interruptions. High performance teams showed heterogeneous shifts across phases. While team 4 decreased on recurrence density and order (RR_{Early} = 76.55%; RR_{Later} = 33.64; DET_{Early} = 98.98%; DET_{Later} = 89.82%), with pronounced shortening of repeating sequences (TT_{Early} = 21.22; TT_{Later} = 5.25), team 3 remained comparatively stable on density and order (RR_{Early} = 62.04%; RR_{Later} = 62.76%; DET_{Early} = 98.01%; DET_{Later} = 97.25%) and exhibited high Later laminarity (LAM_{Later} = 99.87%), consistent with large, coherent Work fields in the CRP. Among low performance teams, team 28 displayed a later disruption of structure (RR_{Early} = 54.79%; RR_{Later} = 29.12%; DET_{Early} = 97.52%; DET_{Later} = 93.22%; LAM_{Early} = 99.62%; LAM_{Later} = 97.45%). Its Later CRP shows clustered Flight segments interrupting Work (visible olive patches puncturing teal fields). In contrast, Team 30 exhibited Later consolidation on several metrics (DET_{Early} = 91.77%; DET_{Later} = 95.56%; LAM_{Early} = 95.40%; LAM_{Later} = 99.18%) with a modest change in RR (RR_{Early} = 59.60%; RR_{Later} = 52.71%).

Discussion

Our study shows how interactional dynamics of team behaviors vary across high and low performance teams, and early compared to later phase tasks. The patterns discovered here converge with Wheelan's longitudinal evidence that higher performance teams make more task-focused and supportive contributions and fewer off-task or conflictual turns, and that maturity co-varies with performance over time. However, two expectations were not clearly supported: First, Work decreased from Early to Later tasks not only among low performance teams but also in three of four high performance teams; second, Dependency increased in all eight teams rather than remaining stable/decreasing among high performance teams. Exploratory analyses suggest that while temporal dynamics of team behavior varied within and between teams and tasks, they did not consistently relate to performance. This study encourages further research by investigating how interactional dynamics in newly formed teams may align with, challenge, or expand upon the assumptions inherent in sequential models of group development, particularly concerning team performance.

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