Leadership Networks in Space Crews

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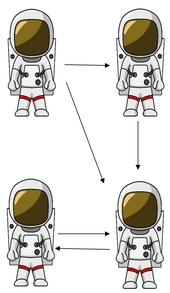
Introduction

"It is becoming ever more difficult for any one person to be an expert on all aspects of the work that needs to be done" (Pearce & Manz, 2005). A collective leadership approach could benefit long-duration space exploration teams (Mulhearn et al., 2016).

Shared Leadership is a dynamic, interactive influence process among individuals for which the objective is to lead one another to the achievement of team or organizational goals (Pearce & Conger, 2003)

Motivator Leadership Network



Who motivated your crew?

As part of the CREWS NASA grant, we are looking to develop metrics that measure the *functioning* and *performance* of teams.

Research Question 1: To what extent is leadership distributed or shared among analog space crews?

Research Question 2: To what extent does leadership shift across tasks and over time?

Research Question 3: Which forms of shared leadership best predict team cohesion and team performance?

Method

Sample

Four, 4-member crews participating in the HERA analog. Each crew was isolated and confined for 30 days.

Procedure

Crews completed three team task batteries of three task types (problem solving, ethical decision making, and creativity). Upon completion of task battery, each crew member was given a survey in which they assessed individual contributions and team dynamics.

1. Problem Solving Task: survival scenario in which crew must rank order top 15 most important items from a give list
   - Sample Item: A compass while stranded in the dessert
2. Ethical Decision Making: scenario in which crew must come to agreement about morally ambiguous decision
   - Sample Scenario: How to allocate life boats on a sinking shipping lacking boats for all passengers
3. Creativity Task: crew is presented with an object and must come up with as many uses for that object
   - Sample Item: a rubber band

Measures

Leadership Roles:

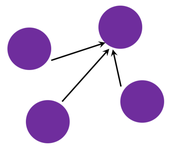
1. Deviant (made task difficult to complete)
2. Ideator (ideas were integral to task completion)
3. Performer (instrumental in completing task)
4. Motivator (kept team motivated during task)

Shared Leadership (Contractor et al., 2012):

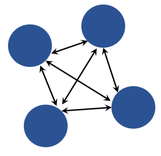
1. Member concentration: Diverse set of individuals are leaders
2. Role multiplexity: Diverse set of individuals enacting different roles
3. Temporal stability: Diverse set of individuals are enacting leadership roles at different points in time

Leadership Centralization

Measure of the concentration of links



Low (de)Centralization "Vertical Leadership"



High (de)Centralization "Shared Leadership"

Cohesion:

Individuals were asked to rate crew cohesion for each task on a 6 item scale (α = .91)
Sample item: *"Our crew members enjoyed working together during the task"*

Performance:

1. Team Problem Solving Total = Score of crew above optimal solution
2. Team Problem Solving Energy = Difference between crew score and best performing member
3. Creativity Task = The total number of ideas generated by team (Fluency)

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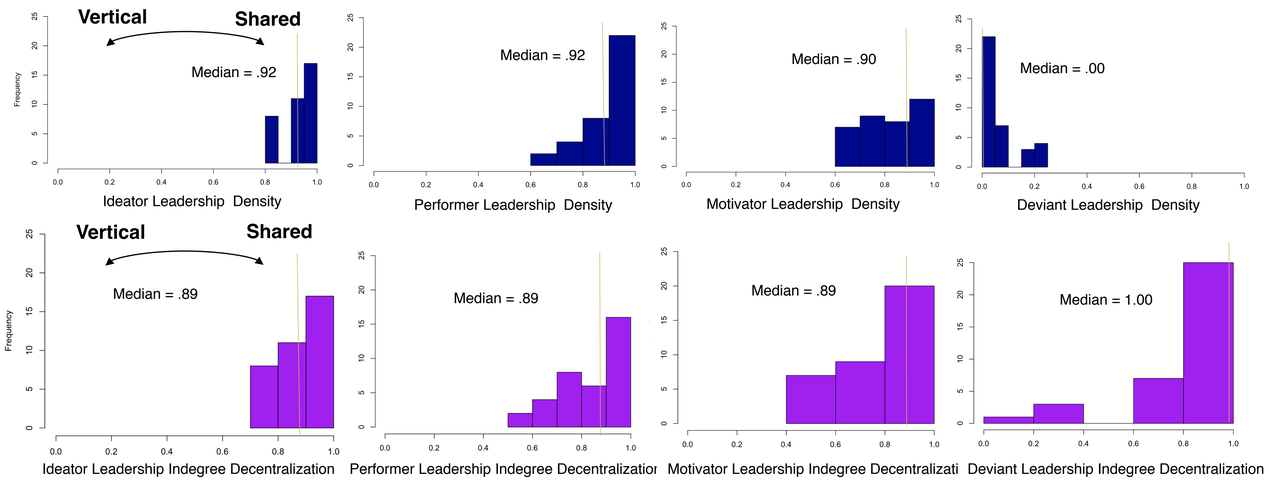
Results

Frequency of Role Sharing



RQ1: Role Multiplexity

	Ideator	Performer	Motivator	Deviant
Decentralization Mean (SD)	.92 (.09)	.87 (.14)	.82 (.19)	.84 (.25)
Density Mean (SD)	.94 (.07)	.90 (.11)	.87 (.14)	.06 (.09)
Coefficient of Variation Mean (SD)	.11 (.11)	.15 (.15)	.21 (.21)	.67 (.92)

RQ2: Member Concentration & Temporal Stability

Task	Time 1		Time 2		Time 3	
	Decentralization Mean (SD)	Density (SD)	Decentralization Mean (SD)	Density (SD)	Decentralization Mean (SD)	Density (SD)
Problem	.80 (.15)	.32 (.06)	.83 (.17)	.34 (.04)	.88 (.10)	.32 (.06)
Ethical	.86 (.02)	.29 (.04)	.74 (.20)	.37 (.05)	.79 (.12)	.32 (.06)
Creative	.97 (.04)	.27 (.03)	.94 (.01)	.28 (.03)	.96 (.04)	.28 (.03)

RQ3: Correlation Between Shared Leadership and Outcomes

Correlations with Density of Leadership

	1	2	3	4	5	6	7
1. Deviant Shared Leadership	(.30)						
2. Instrumental Shared Leadership	-.39	(.72)					
3. Ideator Shared Leadership	-.45	-.35	(.60)				
4. Motivator Shared Leadership	-.22	-.39	.05	(.79)			
5. Team Cohesion	-.51	56	.12	.30	(.91)		
6. Team Creativity	.59	-.20	-.10	.11	-.35	-	
7. Team Problem Solving Total	.69	-.24	-.37	.06	.00	-.38	-
8. Team Problem Solving Synergy	-.02	-.45	-.50	-.49	-.34	-.04	-.07

Correlations with (de)Centralization of Leadership

	1	2	3	4	5	6	7
1. Deviant Shared Leadership	(.78)						
2. Instrumental Shared Leadership	-.64	(.72)					
3. Ideator Shared Leadership	-.40	-.35	(.60)				
4. Motivator Shared Leadership	-.36	-.43	-.03	(.83)			
5. Team Cohesion	.67	.56	.12	.34	(.91)		
6. Team Creativity	-.59	-.20	-.10	.11	-.35	-	
7. Team Problem Solving Total	-.52	-.24	-.37	.04	.00	-.38	-
8. Team Problem Solving Synergy	-.37	-.45	-.50	-.47	-.34	-.04	-.07

Note. Correlations are Pearson's r. Shared leadership and Cohesion variables ($N = 36$), Performance variables ($N = 12$).
Average correlation between leadership role networks included across time points on the diagonal.

Discussion

- While completing task batteries, analog space crews demonstrate a highly shared leadership structure
- There appear to be fluctuations in shared leadership structures in relation to time and context
- Ideator leadership is the most shared leadership role, while deviant leadership is the least shared role
- With the exception of deviant leadership, shared leadership results in more cohesive crews
- With the exception of deviant leadership, shared leadership results in less problem solving synergy

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