
Macro cognition in Command and Control:

Understanding and assessing verbal and non-verbal communications during complex collaborative problem solving

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Macro cognition in Teams

Working definitions...

- Macro cognition is the internalized and externalized high-level mental processes (i.e., combining, visualizing, and aggregating information)
- Resolve ambiguity in support of discovery of new knowledge and relationships
- Employed by teams during complex, one-of-a-kind, problem solving



Macrocognition in Teams

- Team Cognition and Macrocognition
 - Both involve individual and team level cognitive processing
 - However, team cognition research has tended to focus on behavioral coordination, and macrocognitive research uniquely emphasizes the knowledge work done by a team
- Explored through skill-rule-knowledge framework of human performance
 - **Rule-based performance**
 - Composing a sequence of actions that are previously known and carrying them out in a familiar environment
 - *For example, involves selecting from repertoire of performance strategies; e.g., aviation crew training where responses to emergencies are proceduralized and prepared for ahead of time*
 - **Knowledge-based performance**
 - Involves unfamiliar situations where there are no a priori rules to guide performance
 - *For example, NEO scenario where situation parameters are characterized by ambiguity and uncertainty*
- *There are good theories and methods of measurement for understanding and capturing team cognition (rule-based performance), but more is needed for macrocognition (knowledge-based performance).*

Goals of the current effort

Help fill the theory and measurement gap with an unexplored area of group research

- **Review and integrate relevant theory and methods from Group Communication Theory**
- **This is a mature and important research area that has direct bearing on:**
 - **Understanding how macrocognition can be measured through communication**
 - **Understanding team problem solving**

Relevant Theorizing from Group Communication Theory

- **Functional Perspective**
 - Gouran, D. & Hirokawa, R. (1983). The Role of Communication in Decision-Making Groups: A Functional Perspective, In M. Mander (Ed.), *Communications in Transition* (pp. 168-185). New York: Praeger.
 - **Decision-Emergence Theory**
 - Fisher, B. A. & Hawes, L. C. (1971). An interact system model: Generating a grounded theory of small groups. *Quarterly Journal of Speech*, 42, 444-453.
 - **Multiple Sequence Models of Group Decision Making**
 - Poole, M. S. (1981). Decision development in small groups I: A comparison of two models. *Communication Monographs*, 48, 1-24.
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Relevant Theorizing from Group Communication Theory

■ **Functional Perspective**

- **All decision making groups must fulfill a basic set of functions in order to perform effectively**
 - **Decision making effectiveness is a product of the amount and quality of group interaction processes focused on:**
 - **problem analysis**
 - **establishment of evaluation criteria**
 - **generation of solution alternatives**
 - **evaluation of positive/negative consequences of solutions**
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Relevant Theorizing from Group Communication Theory

- **Functional Perspective**

- **Support**

- **Recent meta-analysis of functional perspective found**

- **Process of evaluating negative consequences of solutions paramount**

- **Strongest predictors of group decision-making effectiveness**

- **Task moderators explain variability in previous findings**

- **Evaluation of negative consequences better predictor of performance when requirements for evaluation are high**
 - ***Supports importance of ‘critical evaluators’ within a group***
 - ***This need grows with complexity of the problem***
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Relevant Theorizing from Group Communication Theory

Functional Perspective

- Relevance to macrocognitive framework
 - *Functional perspective contributes idea that amount and quality of interaction processes focused on specific group functions are key to understanding and predicting group outcomes*
 - Can this facilitate adaptation within a group's process?
 - Focus or refocus on most critical group functions
 - Most predictive was analysis of negative consequences of decision alternatives.
 - *Develop better understanding of and methods for prompting group to consider negative consequences of decision alternatives*
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Relevant Theorizing from Group Communication Theory

■ **Decision-Emergence Theory**

- **Explanation of complex communicative process problem-solving groups go through in reaching consensus**
 - **Decisions are not 'made,' they emerge from group interactions**
 - **Decision proposal is focus of analysis**
 - **Each group member's communication *acts* on the decision proposal in one of the following ways:**
 - **expressing an opinion about decision proposal (favorable, unfavorable, ambiguous)**
 - **modifying or clarifying decision proposal**
 - **providing evidence to support an opinion**
 - **agreeing or disagreeing with another group member's stated opinion**
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Relevant Theorizing from Group Communication Theory

Decision-Emergence Theory

- Four general phases of activity
 - **Orientation**
 - Characterized by expressions of ambiguity towards decision proposals
 - Unsure of direction the group will take
 - Attempt to avoid committing themselves to a particular solution alternative
 - **Conflict**
 - Characterized by one group member expressing a favorable attitude about a decision proposal followed by another member expressing an unfavorable attitude about that proposal
 - Opinions become polarized and conflict inevitable.
 - **Emergence**
 - Opposition from sub-group of members voicing unfavorable opinions wanes
 - Members previously voicing opposition back away by expressing ambiguity
 - **Reinforcement**
 - Virtually all dissent to the consensus proposal vanishes
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Relevant Theorizing from Group Communication Theory

- **Decision-Emergence Theory**
 - **Relevance to macrocognitive framework**
 - **Monitor sequence of communication acts**
 - **Can help us understand how groups converge more generally on building and sharing knowledge**
 - **Potentially applicable through all stages of the problem solving process**
 - **Can enrich analysis of consensus process**
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Relevant Theorizing from Group Communication Theory

Multiple Sequence Models of Group Decision Making

- Challenges the notion that Group Decision Making goes through the same phases in the same order
- Groups will follow different sets of phases depending on nature of the decision task and existing structures within the group
- Three fundamental types of group threads have been defined:
 - 1) task process activities (focused on how group structures its activity)
 - 2) relational character (focused on relationships between members)
 - 3) topical focus (focused on substantive issues group is dealing with).
 - *Changes in patterns of interaction on these three threads defines a group's trajectory.*
 - *Trajectories* can further be characterized by breakpoints
 - Points in flow of communication where one pattern of interaction is replaced by another
 - A group's development can be characterized into one of three paths
 - Unitary path (e.g., decision emergence)
 - Complex decision paths (characterized by cycles of problem analysis and solution generation),
 - Solution-oriented paths (characterized by a focus on confirming a solution and little group effort is expended on problem analysis).

Relevant Theorizing from Group Communication Theory

Multiple Sequence Models of Group Decision Making

- **Relevant to overall macrocognitive framework**
 - Macrocognitive phases are said to be nonsequential and recursive
 - Consistent with central propositions of multiple paths model
 - Can we similarly identify trajectories or courses of development towards decision solution?
 - Groups thought to pass through different phases of interaction in different orders
 - Finite set of possible paths groups will take
 - Are these paths predictable from (or diagnostic of) certain features of the group or task being addressed
 - Can a different trajectory indicate different levels of outcomes
 - Highlights the importance of breakpoints and routing statements.
 - **If group exhibiting interaction patterns characteristic of a trajectory associated with poor task outcomes, interventions can be developed that will change the trajectory of the group**
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Integrating Group Communication Theory and Macrocognition in Teams

- **Communication plays a functional role in macrocognition in teams**
 - A limited set of functions must be fulfilled for group effectiveness
 - These functions can be fulfilled by any number of processes
 - **Measurement must capture not only the group processes, but the functions these processes are fulfilling**
- **Communication acts on information**
 - Communicative acts of team members alter shared information, or create new shared information
 - **Communication should be measured relative to the decision proposal (i.e., pieces of information)**
- **Communication patterns define developmental trajectories**
 - Communication patterns can be interpreted as paths the team has taken to solve a problem
 - Different types of paths are more or less effective, and the effectiveness of a path can depend on features of the problem or team
 - **Measurement that captures developmental trajectories can be used to infer the effectiveness of the team's problem solving**