Team Composition: Linking Individual and Team Characteristics to Team Decision-Making and Performance

13th ICCRTS
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Reiner K. Huber, Petra M. Eggenhofer, Jens Römer & Sebastian Schäfer
reiner.huber@unibw.de * petra.eggenhofer@unibw.de * jens.roemer@unibw.de

Institute of Technologies of Intelligent Systems (ITIS)
at the Universität der Bundeswehr München (UniBw),
Munich, Germany
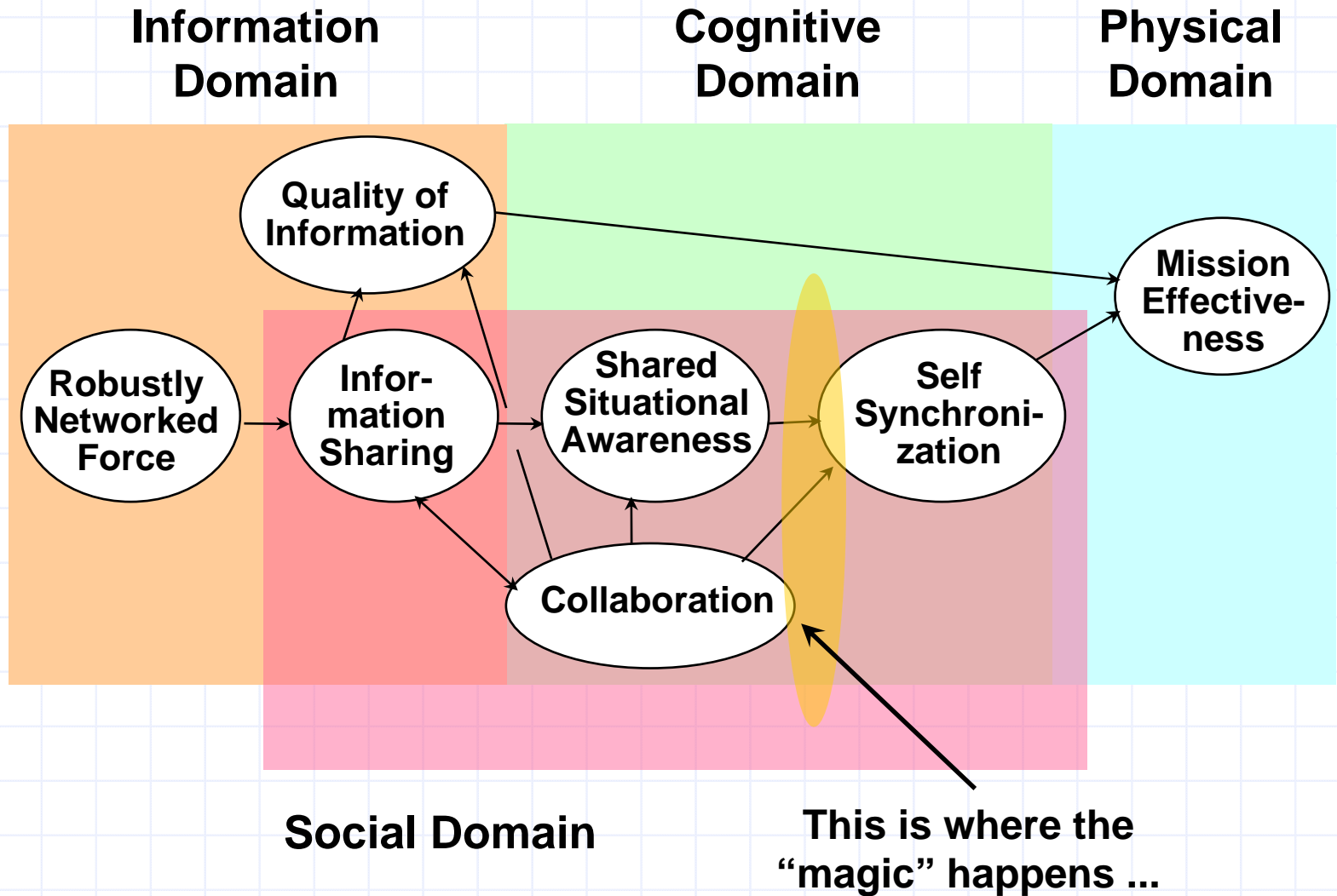
Motivation and Rationale

Complex endeavors build increasingly on network-enabled collaboration.

The focus of R&D efforts is gradually shifting from techno-logical sophistication and quality of infra-structure to human factors.

To date little is known about which human factors contribute to a networked team's effective-ness, and how.

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NCW Tenets

Information Domain **Cognitive Domain** **Physical Domain**

Quality of Information

Robustly Networked Force

Infor-mation Sharing

Shared Situational Awareness

Self Synchroni-zation

Mission Effective-ness

Collaboration

Social Domain

This is where the "magic" happens ...

Research Question and Variables

- What team composition in regard to psychological factors supports the quality of collective decision-making and performance in a networked team? – What are the effects of specified individual and team characteristics on team performance?

- **Input (independent) variables**
  - ▶ **Individual characteristics**
    - ▶▶ Extraversion – Introversion
    - ▶▶ Sensing – Intuition
    - ▶▶ Thinking – Feeling
    - ▶▶ Judging – Perceiving
    - ▶▶ Locus of Control
    - ▶▶ Ambiguity Tolerance

  - ▶ **Team-specific characteristics**
    - ▶▶ Task Cohesion
    - ▶▶ Social Cohesion

- **Output (dependent) variables**
  - ▶ Team performance
    - ▶▶ Team effectiveness
    - ▶▶ Team efficiency
    - ▶▶ Shared Situational Awareness

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Individual Characteristics – MBTI®

Extraversion	Introversion
■ Communicate actively ■ Decide and act fast ■ Tendency for impulsivity	■ Appear reserved and passive ■ Strive to deeply analyze things ■ Reflect things long before acting
Sensing	**Intuition**
■ Interested in details, facts, figures ■ Realistic, pragmatic, benefit-oriented ■ Favor approved strategies	■ See the „big picture" ■ Creative, future-oriented ■ Favor unconventional solutions
Thinking	**Feeling**
■ Think in terms of „cause and effect" ■ Try to decide rationally, act logically ■ Performance-oriented	■ Judgements based on beliefs ■ May appear irrational in decisions ■ Oriented toward others' needs
Judging	**Perceiving**
■ Value unambiguousness ■ Planful, value orderly procedures ■ Dislike time pressure ■ Tend to be inflexible, change resistant	■ Preserve alternatives ■ Tendency for tardiness ■ Deal with time pressure easily ■ Value spontaneity and flexibility

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Other Individual/Team Characteristics

Locus of Control: Internal	Locus of Control: External
▪ Believe to be in control over one's own life ▪ Attribute success and failures to one's own acting (ability, effort) ▪ High achievement motivation	▪ Believe that one's life is controlled by fortuity or influential others ▪ Attribute success and failures to (bad) luck or influential others ▪ Lower achievement motivation
Ambiguity Tolerance: High	**Ambiguity Tolerance: Low**
▪ Positive attitude toward ambiguous information and uncertainty ▪ Perceive ambiguity as challenging ▪ Willingness to take risks in the face of incomplete or ambiguous info	▪ Negative attitude toward ambiguous information and uncertainty ▪ Perceive ambiguity as stressful ▪ Tendency to avoid risks in the face of incomplete or ambiguous info
Task cohesion	**Social cohesion**
▪ Shared commitment to group goals ▪ Subordinate personal goals to group ▪ Willingness to cooperate to achieve group goals ▪ Performance-stimulating interactions	▪ Perceived team member similarity ▪ Sympathy for fellow team members ▪ Perceived integration into the team ▪ Willingness to work with fellow team members on future tasks

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Hypotheses

<u>Main effects:</u> Hypotheses 1a – 6a (Individual characteristics):

Team-level (1a) Extraversion, (2a) Sensing, (3a) Thinking, (4a) Judgement, (5a) Internality is positively related to team performance.

(6a) Team-level Ambiguity Tolerance is related to team performance in an inverted-U-shaped way.

Hypothesis 7 – 8 (Team characteristics):

(7) Social cohesion, (8) Task cohesion is positively related to team performance.

<u>Moderator effects:</u> Hypotheses 1b – 6b:

The higher team heterogeneity in
(1b) Extraversion, (2b) Sensing, (3b) Thinking, (4b) Judgment,
(5b) Internality, and (6b) Ambiguity Tolerance is,
the lower is the correlation between the respective team-level variable and team performance.

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Research Design

Step 1: Theory-based development of hypotheses on relationships

Input variables → Team performance

Step 2: Data Collection

2a: Measurement of in-dividual-level variables (Questionnaires)

2b: Collaboration experiments (Simulation game)

2c: Measurement of team-specific variables (Questionnaires)

Step 3: Data Analysis

3a: Quantitative analyses: Output measures, Test of hypotheses

(3b: Qualitative analyses: Process description and interpretation)

Step 4: Discussion of results and implications

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Collaboration Experiments

CAFFEINE: „_C_ollaborative G_a_me _f_or _F_irst _E_xperiences _i_n a _N_etworked _E_nvironment" (Schäfer, 2005)

Caffeine

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Setting

- 130 teams of four spatially distributed participants (German Air Force officer cadets) connected through local computer networks

- Two experimental conditions: Common Result Picture (CRP), Individual Result Picture (IRP)

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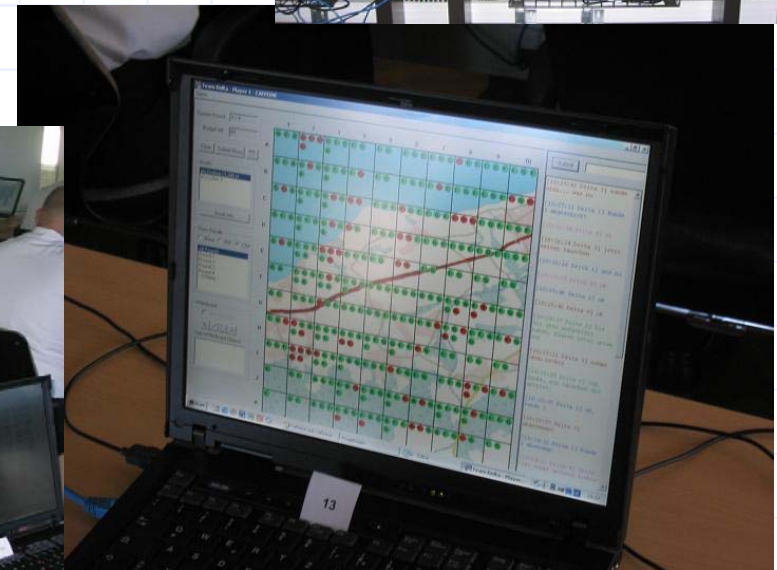
Task assignment

Find the 7 hidden targets!

Game sequence:

4 recce runs,

1 „strike" run
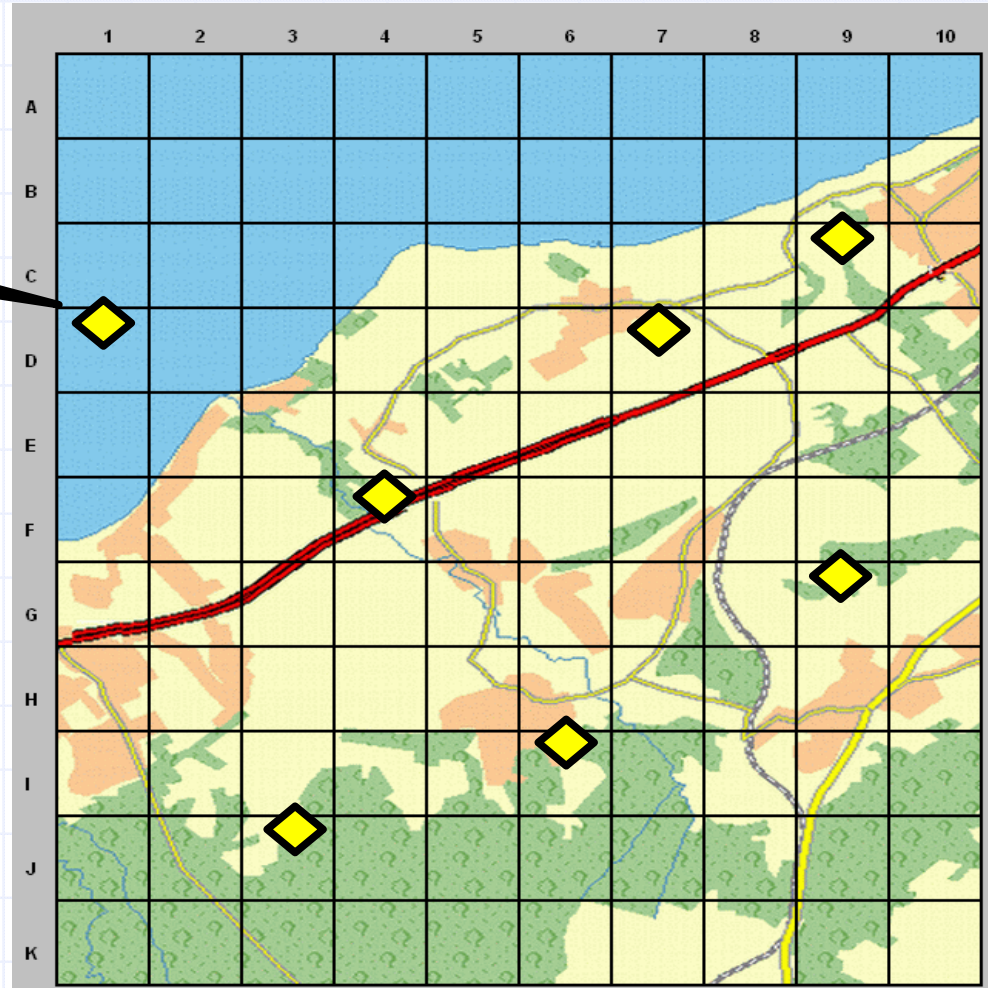
Recce runs and tools

Sensor example:

- Specified budget and (set of) sensors available per player and run

- Sensors of different
  - price per deployment, ──────▶
  - coverage, ──────▶
  - reliability. ──────▶

Asset Info ✕

Tornado Recce

Price per Deployment: 20

Coverage: 2 horizontal * 2 vertical

Risk of Non-Detection: 10%
Risk of False Alarm: 5%

Deployment Area: UNLIMITED

Close

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Displayed Recce Result Picture

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„Strike" run

- Each player may execute up to 9 „strikes" at the 7 hidden targets

- Conflicting tactics: Utilize all 9 strikes versus risk as few errors as possible

- Players may strike independently or (partly) coordinated with fellow team members

- Team top score (Maximum effectiveness): Each player has hit all targets, no errors

- Shared awareness (SA): Maximum overlap among the targets stroke by the team members. High SA is a necessary but non-sufficient prerequisite for high effectiveness.

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Displayed Final Results Picture
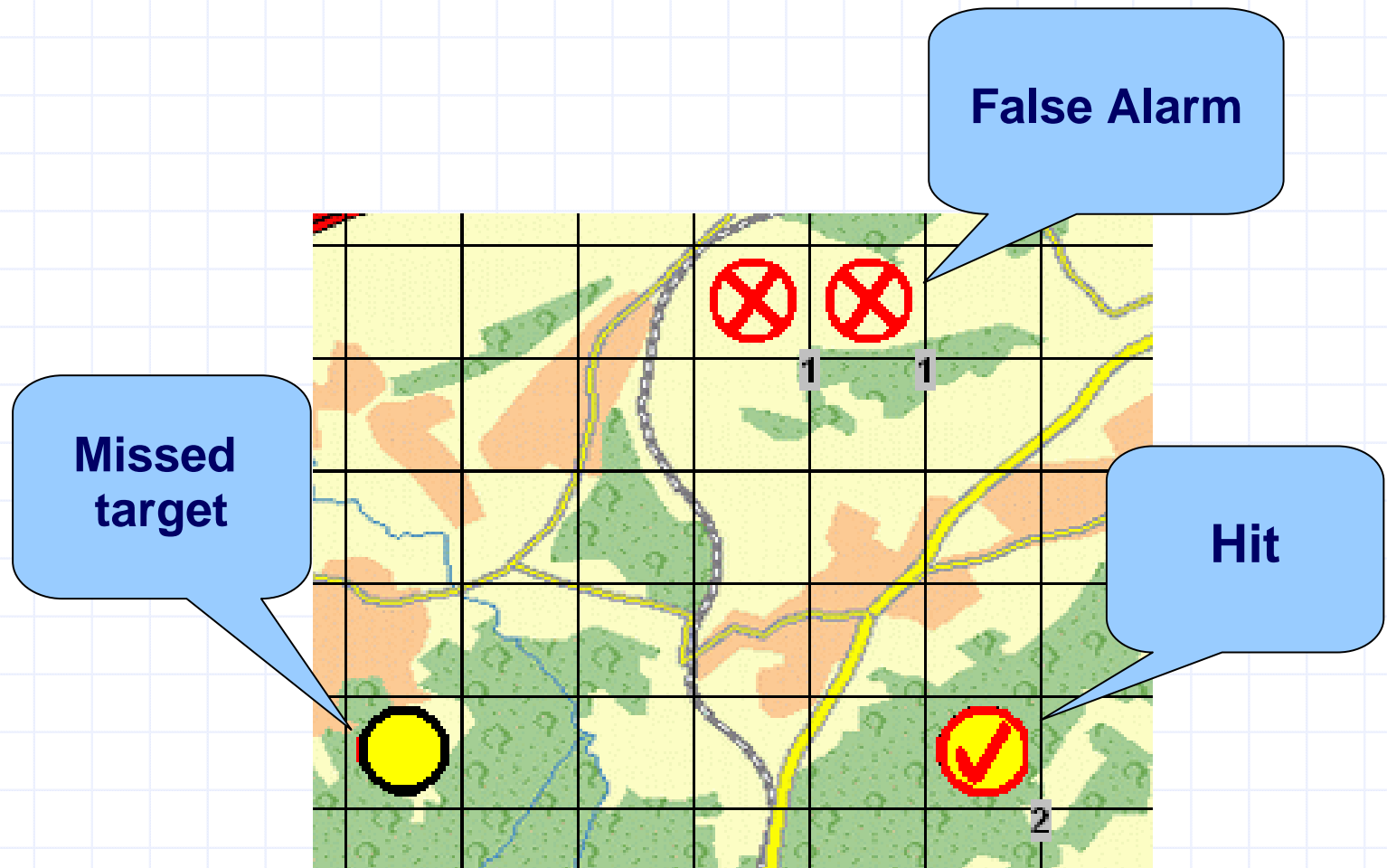
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CAFFEINE Overview

Current run/ current budget

Submit move

Display final results

Submit Message

Select sensor

Information on sensors

Display results of single runs

Chat

Round 2 / 3

Budget left 20

Clear | Submit Move

Assets
(E) Tornado Recce
(F) Breguet Atl.

Asset Info

Show Results
○ None ● IRP ○ CRP

All Rounds
Round 1
Round 2
Round 3
* STRIKE *

Whiteboard
☐ View
Your White Board

Submit

[09:04:37 Alpha 1] Hole B4-B9

Alpha 2] Habe C4-C8

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Final Results Table

Number of messages sent

Game Over -- Team Results

PLAYER	HIT	FAIL	START	END	TOTAL	CHAT	WB	SCORE
Alpha 1	5	3	21:01:50	21:04:52	03:02	0	0	61
Alpha 2	4	4	21:00:01	21:05:13	05:12	0	0	25
Alpha 3	4	3	20:58:29	21:05:29	07:00	0	0	29
TEAM	13	10	20:58:29	21:05:29	07:00	0	0	139

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Total number of hits

Total number of errors

Duration of game

Total team score

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Comparing CRP and IRP

	Minimum		Maximum		Average		s. d.		T[a]
	CRP	IRP	CRP	IRP	CRP	IRP	CRP	IRP	
Hits	12	9	20	20	24.3	21.1	3.4	4.2	- 8.52**
Errors	0	0	14	20	4.5	7.4	3.3	4.5	7.60**
Time (sec.)	135	158	1053	1599	452	643	177	258	9.45**
Chat Msgs	0	0	65	156	17.6	28.4	12.8	19.0	9.18**
Budget left	0	0	485	385	165	125	96.0	86.0	- 5.26**
Performance	0.5	0.0	17.8	11.7	5.4	2.6	3.4	2.2	-10.13**
Shared Aw.	1.46	1.38	4.00	4.00	3.21	2.69	0.58	0.69	- 7.44**

[a] T-Tests for paired samples; ** $p < .01$

Frequencies of achieved performance scores

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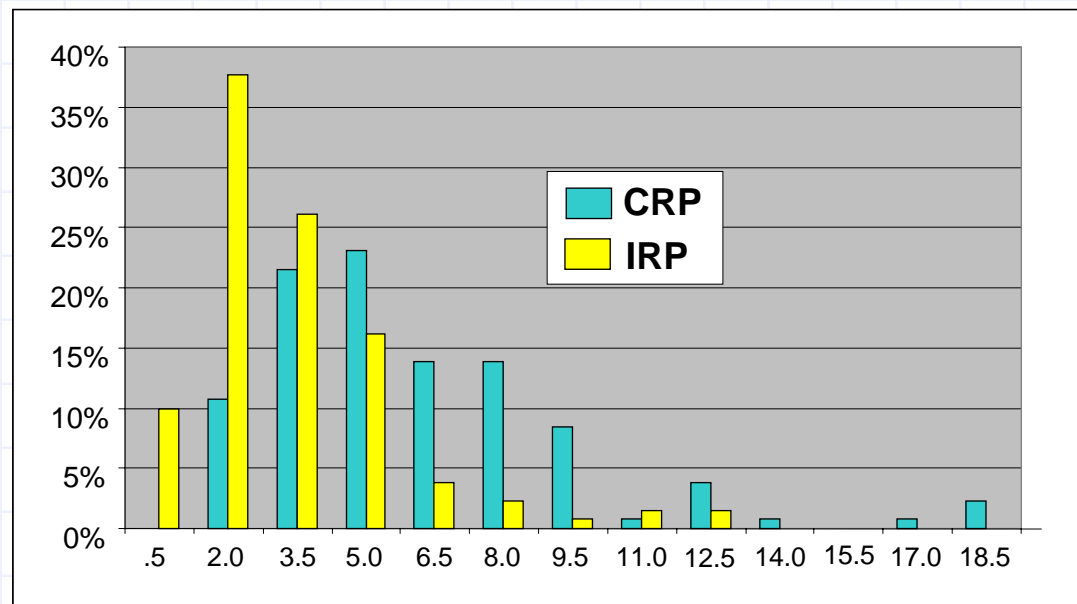
Regression Results

Independent and *Control* Variables	Task effectiveness			Task efficiency			Shared Awareness		
	R²	βᵃ	T	R²	βᵃ	T	R²	βᵃ	T
(Absolute term)			.18			.01			-.24
Extraversion – Introversion		.15	1.44		**.30**	**3.07****		.04	.40
Sensing – Intuition		-.02	-.20		.03	.26		.05	.46
Thinking – Feeling		-.01	-.13		-.01	-.12		.01	.09
Judging – Perceiving		**.26**	**2.74****		**.22**	**2.38***		**.16**	**1.67⁺**
Locus of Control internal	.10	**.18**	**1.88⁺**	.16	**.17**	**1.81⁺**	.08	.13	1.35
Ambiguity Tolerance		.02	.22		-.03	-.38		.08	.85
Control variables:									
Intellectual ability numeral		*-.02*	*-.23*		*.07*	*.78*		*.09*	*.89*
Intellectual ability figural		*.03*	*.28*		*-.04*	*-.44*		*.02*	*.17*
Age		*-.11*	*-1.10*		*-.16*	*-1.69⁺*		*-.09*	*-.91*
Number of females		*-.01*	*-.12*		*-.03*	*-.28*		*-.14*	*-1.48*

ᵃ Standardized Beta (regression weights);
Significance levels: + $p < 0.10$; * $p < .05$; ** $p < .01$

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Results

Main effects: Team efficiency is positively related to team-level

(1a) Extraversion: **significant in opposite direction**

(2a) Sensing: **not supported**

(3a) Thinking: **not supported**

(4a) Judgment: **significant in opposite direction**

(5a) Internality: **supported**

Team efficiency is related to (6a) Ambiguity Tolerance

in an inverted-U-shaped way: **not supported**

Team performance is positively related to

(7) social cohesion: **supported**

(8) task cohesion: **supported**

Moderator effects: The correlation between team-level variable and team efficiency is the stronger, the lower team heterogeneity in this variable is.

(1b) Extraversion: **supported**

(2b)-(6b): **not supported**

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Practical implications (1)

Locus of Control

To manage complex endeavors, agile organizations decentralize and delegate decision rights to self-organized teams. These should be able to recognize their abilities to exert control over outcomes of their decisions.

Leadership and training should provide ample performance feedback and nurture self-efficacy and achievement motivation.

Judging – Perceiving

In complex and dynamic environments, cognitive flexibility and the willingness to adapt to changes meet the requirements of network-enabled operations better than (too) early decision-making and acting.

Complex endeavors require cultural change and new strategies for personnel selection and training toward cognitive complexity and adaptability.

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Practical implications (2)

Extraversion – Introversion

Strong extraversion may negatively influence team performance – if text chat is the only available communication medium.

Utilizing specified communication media requires adjustment of team composition and training (communication skills).

Task cohesion

Commitment to team goals and the superordinate purpose promote team performance substantially.

To promote delegation of decision rights and responsibilities, training efforts should support teams in developing shared understanding of the endeavor's significance and purpose.

Social cohesion

Social cohesion promotes performance even in "ad hoc" teams. It is a valuable resource for teams from the very beginning of an endeavor.

Social cohesion should be nurtured carefully, while being aware of the risks of unfavorable group dynamics.

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Qualitative analyses

What factors of emergent human (communication) behavior contribute to a networked team's effectiveness?

Main areas:

▸ Task-knowledge coordination:
What are the key factors in task-knowledge coordination that distinguish effective from ineffective networked teams?

▸ Decision-making processes:
In what terms do processes differ between effective and ineffective networked teams?

▸ Communication patterns:
In what terms do observed communication patterns differ between effective and ineffective networked teams?

▸ Emergent team roles:
In what terms do emergent team roles and emergent (shared) leadership differ between effective and ineffective networked teams?

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Selected Results (1)

Task-knowledge coord.	Effective teams (N=12) / Ineffective teams (N=12)
Locate expertise	Communicate who has which sensors: Yes / No
Divide task	„Filter strategy" / „Quadrant strategy"
Integrate subtasks	Evaluate recce results / Report pre-evaluated results Develop target list / No shared target list
Coordinate decisions and actions	Target list jointly developed / No agreement on targets Concerted actions / Autonomous (pre-mature) actions

Decision process	Effective teams (N=12) / Ineffective teams (N=12)
Plan info collection	Comprehensive and shared / At best short notice
Collect information	Follows joint planning / Overlaps with previous phase
Integrate information	Integrate jointly / Report unsystematically, no feedback
Assess options	Evaluate options carefully / Pre-evaluate, little agreement
Strike targets	Follows joint decision / Overlaps with option evaluation

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Selected Results (2)

Communication patterns	Effective (N= 12)	Ineffective (N=12)	T
Strategy (suggest strategy)	4.1	1.5	-2.30*
Guidance (influence attempts)	11.7	9.0	-2.10*
Coordination (assess status, coordinate)	12.9	7.0	-2.44*

Absolute number of sent messages; T = T-Test statistic; * p < .05; ** p < .01

Emergent roles	Effective teams (N=12)	Ineffective teams (N=12)
Emergent leadership	Leadership attempts accepted / neglected	
	Whole process / only at beginning or toward end	
	Efforts made by emergent leader to integrate results and promote joint evaluation process: high / low	
	Emergent leaders make sure that all members participate / do not care about participation	
Proactive followership	Member engagement in proactive followership: high / low	

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Qualitative Study: Practical Implications

Task-knowledge coordination:
Sufficiently exchange information on available resources (expertise location, available methods/ tools, etc.) at the very beginning

Decision-making process:
Improve "maturity" of collaborative capability through true resource sharing and sophisticated coordination

Communication patterns:
Focus on task-related communication (procedural/ coordination matters), constructive conflict communication

Emergent team roles:
Train and develop various leadership roles and behaviors; nurture proactive followership, promote shifting leadership

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Limitations and Suggestions for Future Research

- **Sample characteristics:**
  - Homogeneity in participants' personality characteristics
  - Sample size in qualitative study: (12 + 12 teams)

- **Generalizability:**
  Moderate complexity of employed game as compared to endeavors in the "real world"

- **Future research**
  - Role of increased task complexity
  - Impact of intercultural differences on collaboration in multinational teams and between teams of different nations
  - Role of tailored training and/or field experience of team members

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Thank you