INSTANT MESSAGING AND TEAM PERFORMANCE IN A SIMULATED COMMAND AND CONTROL ENVIRONMENT
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Gregory J. Funke
General Dynamics
Dayton, Ohio, USA

Scott M. Galster
W. Todd Nelson
Allen W. Dukes
Air Force Research Laboratory
WPAFB, OH

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Collaboration Technologies and Command and Control (C2)

- **Recent military acquisitions emphasize introducing collaboration technologies into C2 environments (Kaufman, 2005)**
- **Personnel are expected to rapidly coalesce into functioning teams (Boiney, 2005)**
- **Performance may be facilitated through emerging collaborative technologies (i.e., email, IM, virtual whiteboards, videoconferencing, etc.) (e.g., Alberts & Hayes, 2003)**

Potential Problems with Collaboration Technologies

- Bordia (1997): Literature synthesis
- Baltes et al. (2002): Meta-analysis
- Concluded that teams restricted to text-based collaboration technologies:
  - Made poorer decisions
  - Took more time to reach a decision
  - Experienced less satisfaction with team processes
  - Pattern of results was observed across different experimental tasks
  - Bordia (1997): Restricted communication impairs team comprehension

Task Type and Collaboration Technologies

- **Using McGrath's (1984) circumplex model, team experiments can be categorized by *task type***
- **Studies reviewed by Bordia (1997) & Baltes et al. (2002) are primarily *choosing* tasks**
  - **Require problem solving in situations with and without correct answers**
  - **Generally, task is completed when the team achieves a consensus**

Task Type and Collaboration Technologies

- **C2 tasks are better described as *execution* tasks (McGrath, 1984)**
  - **Involve competition (both inter- and intra-team) or performance measured against a standard of excellence**
  - **Team performance dependent upon in-team performance and opposing-team performance**
  - **Generally, task completion criterion are different**

Goals and Hypotheses

- **Goal for the study was to evaluate the potential utility of instant messaging (IM) and to examine its effects on team performance in an *execution* task (RoboFlag)**
- **Hypotheses:**
  - **Communication restricted to IM would result in lower mission success rates, longer mission completion times, and less coordinated team strategies**
  - **Restricted communication would result in higher workload and lower situational awareness**
  - **Teams restricted to IM would send more instant messages than teams whose communication was unrestricted**

Method

- **Participants**
  - **36 paid participants (28 men, 8 women)**
  - **Participants completed experiment in groups of four, yielding a total of nine experimental groups**

- **Experimental design**
  - **2 × 3 within-subjects design**
  - **Control environment (remote, co-located)**
  - **Level of abstraction (manual, automated, mixed)***

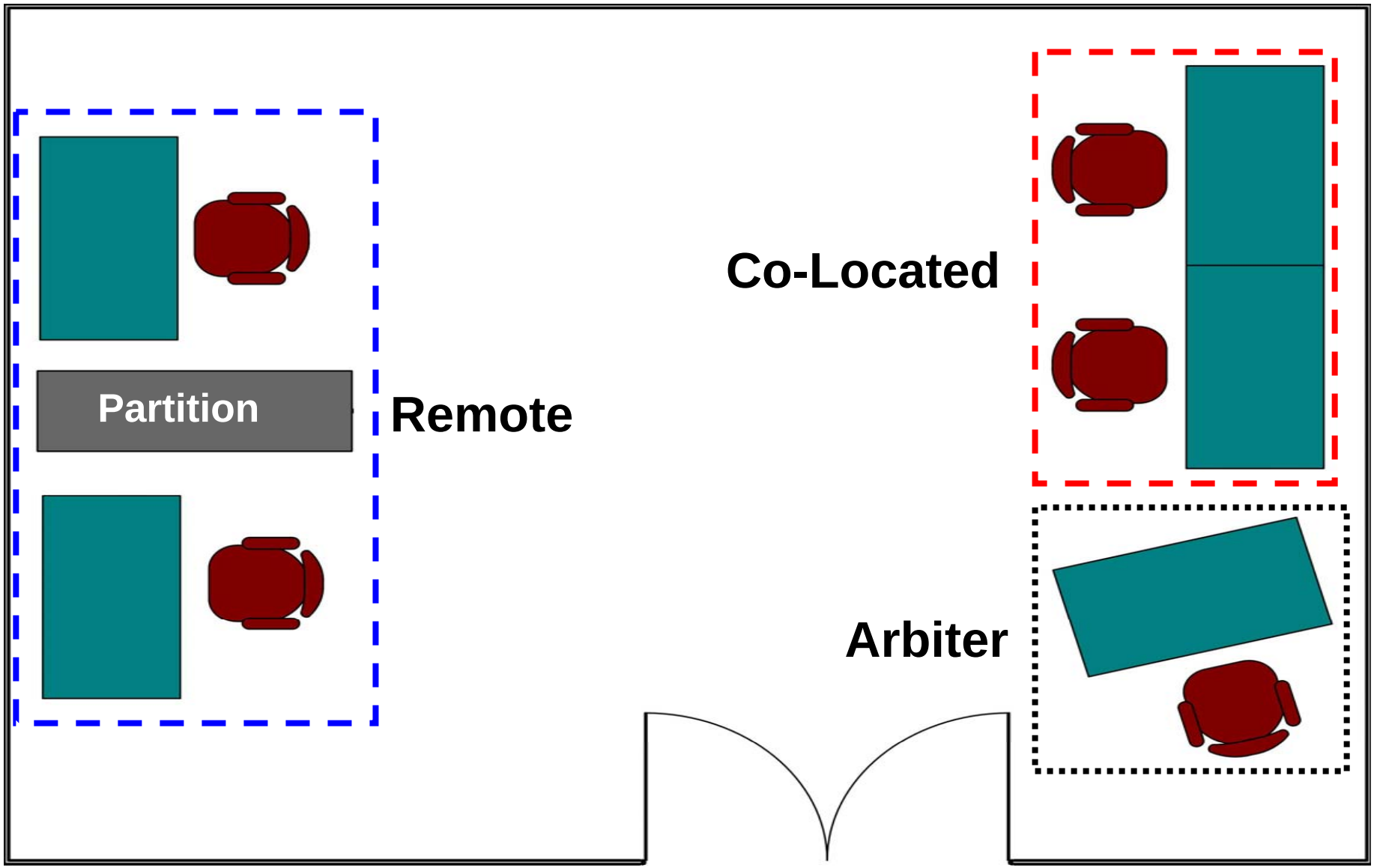
Method

- **Participants completed six mission trials in each condition (36 trials total).**

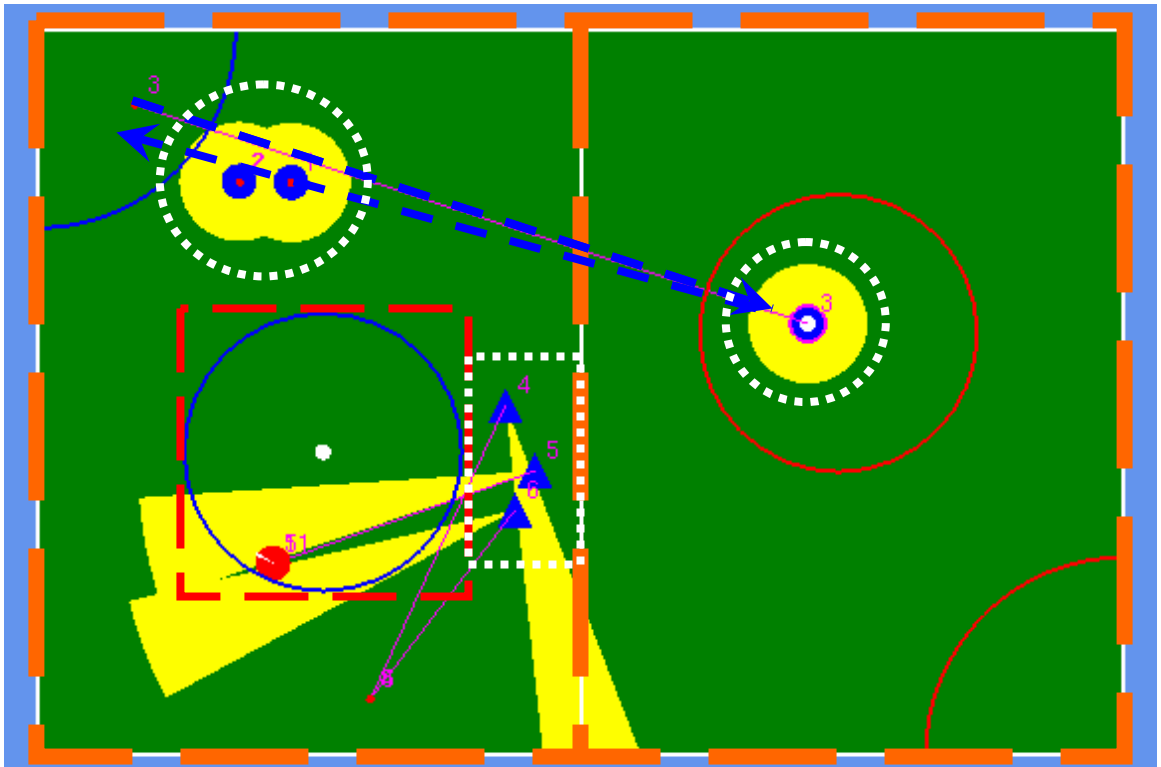
- **Control environment was a block factor (12 trials per block), and level of abstraction was randomized within each block.**

- **Participants filled out the NASA-TLX and one item from the 3-D SART following each mission trial.**

Control Environment



RoboFlag Simulated Environment



ROBOT ID	STATE	TYPE	PLAY	FUEL
Robot 1	ACTIVE	CIRCLE	Destination	20.2
Robot 2	ACTIVE	CIRCLE	Destination	20.4
Robot 3	FLAGGED	CIRCLE	Circle Offense	25.9
Robot 4	ACTIVE	TRIANGLE	Guard Position	3.8
Robot 5	ACTIVE	TRIANGLE	Guard Position	5.8
Robot 6	ACTIVE	TRIANGLE	Guard Position	15.9

Method

- Participants given written and verbal instructions on the capabilities of circles & triangles
- Participants told that experiment involved a game similar to ‘capture the flag’
  - Each team was in direct competition with the other
- Any single trial continued until one team successfully captured the other team’s flag

Method

- Participants allowed to practice for five minutes
  - Option of additional practice time if needed
- Prior to the start of each mission trial, participants were allotted 30 seconds for communication (30 second “huddle”)

Results

- **RoboFlag software recorded which team successfully captured the flag (the winner) and the time elapsed during each mission trial.**
  - **Also recorded the number of vehicle position changes initiated by each participant**
- **Analysis strategy: Follow the Winner**

Results

- **Data for each factor tested for statistical significance by means of a 2 (control environment) × 3 (level of abstraction) repeated measures analysis of variance (ANOVA)**
- **For the frequency of wins, mission length, and number of vehicle position changes no statistically significant differences were detected between the two conditions (F [1, 8] = 0.22, 0.49, 0.45 respectively, p > .05).**

Results

- **One possible explanation for the results was that one team consistently won all mission trials (i.e., teams were unevenly matched – team 1 vs. team 2 distinction).**
- **The number of mission trials each team won was counted and compared by means of a two-sample *t*-test.**
- **Result indicated that there was not a significant difference for number of wins, $t(16) = 0.73$, $p > .05$.**

Results

- **Data were also examined to identify patterns of wins that were not due to the experimentally manipulated factors.**
  - **Defined a win 'streak' as three or more serial wins by the same team**
  - **A total of 38 win streaks were identified in the data**
    - **Mean number of win streaks per experimental session per team was 2.11 (*SE* = 0.32)**
    - **Mean number of trials in a streak was 4.05 (*SE* = 0.45)**
      - **Neither was statistically significantly different**

Results

- **Tested the effects of the experimental conditions on participants' workload and situational awareness ratings by means of a 2 (control environment) × 3 (level of abstraction) repeated measures ANOVA.**
- **For workload and situational awareness, no statistically significant differences were detected between the remote and co-located conditions (F [1, 35] = 0.30, 0.00 respectively, $p > .05$).**

Results

- From IM logs, total number of communications per experimental session was calculated.
- Messages were divided into three categories, depending on when they were sent:
  - Pre-game messages
  - In-game messages
  - Post-game messages

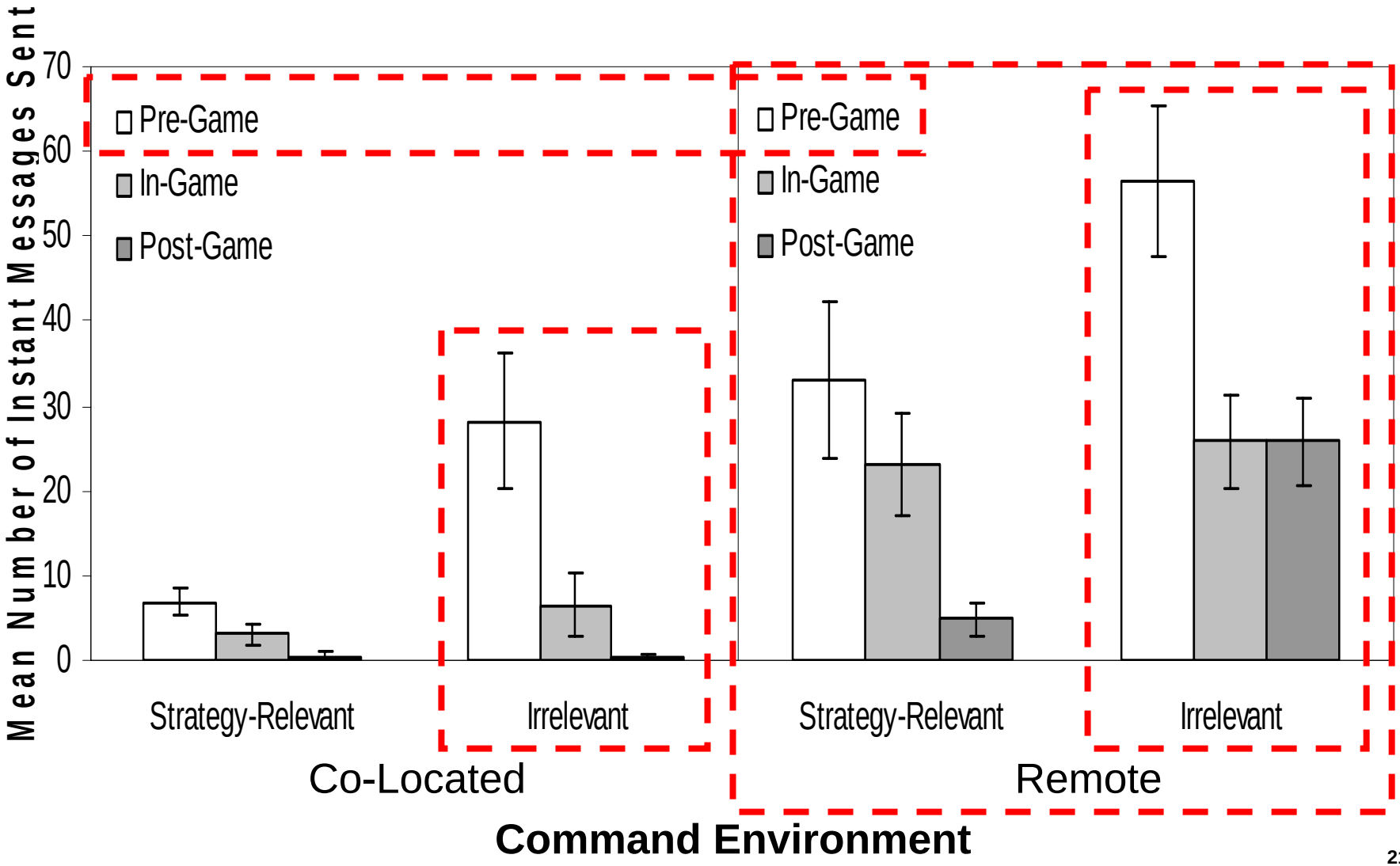
Results

- **IM's sent between teammates were analyzed to determine content.**
- **Messages were coded as either 'irrelevant' (e.g., "I'm hungry," "I like this game") or 'strategy-relevant' (e.g., "go straight for their flag," "use more robots next time").**
- **Two coders separately classified each instant message into one of the two categories.**
  - **Inter-coder reliability was good (*Kappa* = 0.92).**

Results

- **Mean number of strategy-relevant and irrelevant instant messages sent during each messaging period for both command environments were compared using a 2 (type of message) × 3 (messaging period) × 2 (command environment) repeated measures ANOVA.**

Results


Mean Number of Instant Messages Sent
70
60
50
40
30
20
10
0
Pre-Game
In-Game
Post-Game
Pre-Game
In-Game
Post-Game
Strategy-Relevant
Irrelevant
Strategy-Relevant
Irrelevant
Co-Located
Remote
Command Environment

Discussion

- Previously hypothesized that:
  - ~~Communication restricted to IM would result in lower mission success rates, longer mission completion times, and less coordinated team strategies~~
  - ~~Restricted communication would result in higher workload and lower situational awareness~~
  - Teams restricted to IM would send more instant messages than teams whose communication was unrestricted

Discussion

- Overall, IM did not affect team performance.
- Contrasts the effects of collaboration technologies reported by Bordia (1997) and Baltes et al. (2002)
- Dynamic, adversarial nature of execution tasks may favor:
  - Succinct messages between teammates
  - Weak or generalized strategies
  - Feedback may engender dynamic strategy evolution
    - Supported by infrequent win streaks
    - May explain high ratio of irrelevant to strategy-relevant messages

Discussion

- **IM also did not negatively impact workload and situational awareness**
  - **Temporal demands favor short communications and focused attention**
  - **Also, competition and game-related nature of the RoboFlag environment may motivate participation (Matthews & Westerman, 1994)**

Discussion

- **Participants *were* using IM for collaboration**
- **However, participants largely used IM for socialization purposes, rather than using it exclusively for strategy development and coordination.**
- **May be some concern on longer tasks, particularly if they require less active involvement**
  - **Potential for personnel to engage in off-task conversations more frequently, resulting in distraction, decreased situational awareness, and ultimately poor team performance.**

Discussion

- Current experiment offers limited support for future successful integration of collaboration technologies into command and control environments
- Team performance unchanged under both command environments, indicating that **IM was at least as effective as face-to-face collaboration**
- Results underscore need for continued research into team performance and collaboration technologies in tasks from the executing quadrant of McGrath's (1984) circumplex model

Discussion

- **Potential foci for future research:**
  - **Track strategy development, implementation, and execution**
  - **Factors that mediate the use and performance consequences of collaborative tools (i.e., task workload, time on task, etc.)**

Questions?