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COLLECTIVE MISTRUST OF ALARMS

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Recently, alarm systems have become more sensitive and ubiquitous. Unfortunately, sensitive alarm systems may produce greater numbers of false alarms, lowering an operator's level of trust and degrading task performance. In the past, researchers have considered only situations where individuals react to alarms. Because of the frequency and variability of teamed alarm reaction scenarios, we investigated the reactions of independent and dependent teams to marginally reliable alarms. Based on prior literature, we expected dependent teams to show slower but more appropriate alarm reactions and poorer ongoing task performances. One hundred four general psychology students (52 two-person teams) independently or dependently performed a psychomotor task while reacting to alarms that were 30%, 50%, or 70% reliable. Participants responded more frequently to alarms of higher reliability, and less appropriately to those of medium reliability. Generally, dependent teams made more appropriate alarm reactions. Our results suggest that designers and trainers should promote team interdependence when operators are faced with marginally reliable signals.

Since the early 1980s researchers have studied alarm mistrust during a variety of tasks. In most cases, participants who encountered marginally reliable alarm systems have shown degraded task performance. They respond slower, less frequently, and less appropriately to the alarms. In some cases, their ongoing task performance also suffers. These results support Breznitz (1983), who noted that alarm mistrust produced fluctuations in physiological responses such as heart rate.

In a recent investigation of the Aviation Safety Reporting System, Bliss, et al. (1999) found that most alarm related incidents in aviation occurred during high workload periods such as aircraft takeoff and landing. During these times, members of the flight crew usually work together to communicate with air traffic control and interpret flight instruments (Wiener & Nagel, 1988).

Teamed alarm responding is also common in other complex task environments. Welch (1999) noted that alarms in critical care settings are often heard by a number of staff members who share the responsibility for reacting. In other environments like nuclear power plants, surgical theatres, and air traffic control centers, task operators frequently share the responsibility for reacting to emergency signals, collectively troubleshooting systems, deciding about signal priority, or allocating responsibility for system response functions.

Although flight crews often work interdependently to accomplish many tasks, the degree to which they collaborate varies with the task and the environment (Thompson, 1967). In commercial aviation, resource-intensive activities such as flight planning, takeoff, and landing typically require the flight crew to coordinate. In cruise flight, however, it is not uncommon for members to operate independently.

Researchers have studied the impact of task interdependence for many years (Thompson, 1967). Previous research suggests that requiring team members to work together promotes discussion about the task, confidence about members' abilities to perform the task, and generally superior task performance (Campion et al., 1993). The improvements in performance for interdependent tasks are typically explained by Field Theory (Mathieu & Hamel, 1989), which suggests that interdependence increases aspects of team cohesiveness, such as a shared sense of responsibility for accomplishments and increased organizational commitment. However, much of the research regarding task interdependence has taken place in industrial settings, and has considered traditional team-oriented tasks such as operation of complex mechanical systems. Researchers have not considered situations where teams must react cooperatively to alarm signals.

Goal and Hypotheses

The goal of the current research was to investigate the effectiveness of dependent and independent teams of operators as they reacted to alarm signals of various reliability levels. In this experiment, individuals (working dependently or independently) reacted to true and false alarms while performing a complex ongoing task. Our goal was to investigate whether team interdependence would affect reactions to alarm signals of differing reliability levels.

Based on prior research concerning task interdependence (Johnson & Johnson, 1989), we hypothesized that dependent teams would react more appropriately to alarms, responding to true alarms and canceling false alarms. However, because of the increased communication and participation that task interdependence requires (Campion et al., 1993), we expected dependent teams to react more slowly and to exhibit poorer ongoing tracking and gauge monitoring performance. Based on prior research by Bliss (1993), we expected teams to perform the worst for alarms of 50% reliability, because of greater task ambiguity.

METHOD

Design

Alarm task interdependence and alarm reliability were manipulated using a 2 X 3 mixed design. Interdependence was manipulated between two groups. Independent team members required no interaction to react appropriately to the alarms. Dependent team members, however, required interaction to react appropriately. Alarm system reliability (30%, 50%, and 70% true alarms within each session) was manipulated within groups. Teams experienced all reliability levels over three sequential task sessions.

Ongoing task measures included gauge monitoring accuracy and dual-axis tracking accuracy. Alarm reaction measures included speed to react (in seconds), appropriateness of reactions (responding to true alarms and canceling false alarms were appropriate reactions), and response frequency (the percentage of alarms to which participants responded within each experimental session).

Participants

One hundred four students (52 two-person teams) from General Psychology courses at The University of Alabama in Huntsville participated in this study for course credit. The ages of the participants ranged from 19 to 40 years. There were 13 same-sex, dependent teams (5 male, 8 female), 15 same-sex, independent teams (2 male, 13 female), 13 different-sex, dependent teams and 11 different-sex, independent teams. A ten-dollar performance bonus was promised to the team with the highest score on the primary and alarm tasks.

Materials

The Multi-Attribute Task (MAT) battery (Comstock & Arnegard, 1992, see Figure 1) was used as the ongoing experimental task. The MAT battery is a microcomputer-based task designed to simulate the demands required by piloting aircraft. It measures cognitive and spatial abilities through dual-axis compensatory tracking, gauge monitoring, and resource management tasks. The continuous compensatory tracking task is particularly suitable for measuring operator attention shifts in multiple-task situations.

In the resource management task, participants manipulated eight pumps to control fluid transfer among six holding tanks. The goal of this task was to ensure that the fluid levels in tanks A and B stayed at 2500 gallons (see Figure 1).

While tracking and managing resources, participants monitored four gauges at the upper left corner of the screen. If a pointer shifted further than one mark from the center line, they were to press the corresponding function key on the keyboard to reset it (F1 for TEMP1, F2 for PRES1, F3 for TEMP2, and F4 for PRES2).

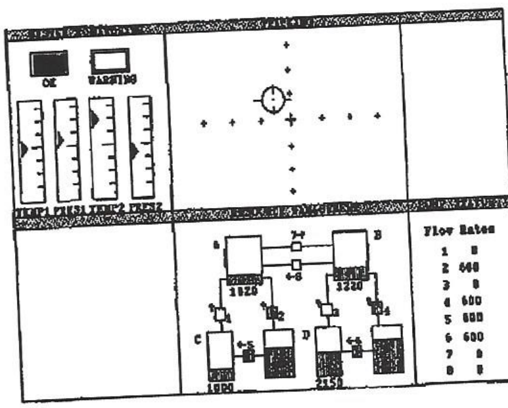

Figure 1. The MAT Battery.

The MAT battery was independently presented to both team members on IBM compatible 486 computers, using 14" color VGA monitors. The participants used the mice and keyboards to make responses.

Participants performed the MAT tasks back-to-back while auditory and visual alarms were presented using a Macintosh Quadra 610 and a 14" VGA monitor. The alarm stimulus was the fire bell digitized from a Boeing 757/767 simulator. The Macintosh was positioned ninety degrees to the side, relative to the primary task computers. When an alarm activated, participants determined whether the MAT gauges TEMP1 and TEMP2 were out of tolerance. If both TEMP1 and TEMP2 were out of tolerance, the alarm was true and required participants to hit the Macintosh F12 key (marked "R" for "RESPOND") and to reset the alarm (in that order). If none or only one of the TEMP1 and TEMP2 gauges were out of tolerance, the alarm was false and required participants to hit the Macintosh F9 key (marked "C" for "CANCEL") and resume the primary tracking task.

Interdependent team members were required to communicate to determine alarm validity, because one team member monitored TEMP1 and the other monitored TEMP2. Independent team members monitored both gauges, and so were not required to communicate to react appropriately. The alarm stimuli were presented at 60 dB(A) (ambient sound level was 45 dB(A)).

Procedure

Participants completed an Informed Consent Form prior to participating. Then the experimenters carefully presented detailed experimental instructions to the participants. Independent team members were told that they had all of the necessary information on their primary task (MAT) screens to make responses to the alarms and did not necessarily have to communicate with each other. Dependent team members were told to communicate with their teammates to determine the validity of each alarm.

After the initial instructions, participants received familiarization on each element of the primary task (MAT). They practiced tracking, monitoring, and managing resources during two 120-second sessions. Participants also received familiarization on the alarms, as well as instructions about how to respond to them. Following primary and alarm task familiarization, participants completed a joint 200-second practice session, during which they completed the MAT task while responding to alarms.

After the practice sessions, participants began the first of three experimental sessions, separated by 5-minute breaks. Ten alarms were presented during each session. The reliability, or true alarm rate, of alarms during each session was 30%, 50%, or 70% (randomly counterbalanced). The reliability of the alarms was told to the participants before they began each session. The appropriateness of reactions was reflected by a team score, present at all times on the Macintosh screen. Appropriate alarm reactions increased the score and inappropriate reactions decreased the score. After completing three experimental sessions, participants were debriefed and dismissed.

RESULTS

We calculated several 2 X 3 mixed ANOVAs to test our hypotheses. There was no interaction between team interdependence and alarm reliability level for alarm response frequency; and no main effect of interdependence (see Figure 2). However, there was a reliability main effect, $F(2,100)=88.685$, $p<.001$. Trend analyses indicated that response frequency increased with alarm reliability in a linear fashion, $F(1,50)=174.06$, $p<.001$.

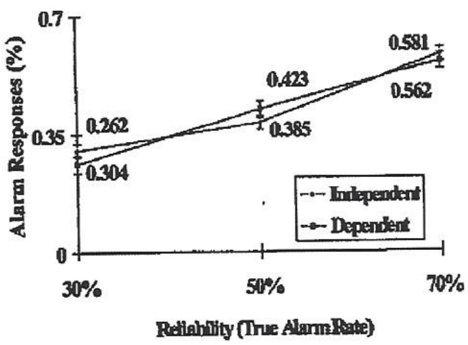

Figure 2. Alarm Response Frequency as a Function of Team Interdependence and Alarm Reliability.

Although there was no significant interaction between interdependence and reliability for alarm reaction appropriateness (see Figure 3), there was a main effect for interdependence, suggesting that dependent teams made more appropriate reactions to alarms, $F(1, 50)= 4.906$, $p=.031$. The main effect for reliability was also significant, $F(2,100)= 4.903$, $p=.009$. Further tests indicated a quadratic trend, with participants showing less appropriate reactions to alarms that were 50% reliable, $F(1,50)=10.359$, $p=.002$.

Figure 4 shows that although there was no significant interaction or interdependence main effect for alarm reaction time, there was a main effect for reliability, $F(2,100)= 3.015$, $p=.05$. The data followed a quadratic trend, with participants reacting to 50% reliable alarms more slowly than the others, $F(1,50)=4.505$, $p=.039$.

For the MAT, there was no interaction of reliability and interdependence for frequency of monitor resetting; however, independent team members reset their monitors more frequently than dependent team members did, $F(1,50)= 23.185$, $p<.001$. Also, teams reset their monitors more frequently when there were more true alarms, $F(2,100)= 95.491$, $p<.001$. Further contrasts indicated that the data followed linear ($F(1,50)=138.082$, $p<.001$) and quadratic ($F(1,50)=7.723$, $p=.008$) trends (see Figure 5).

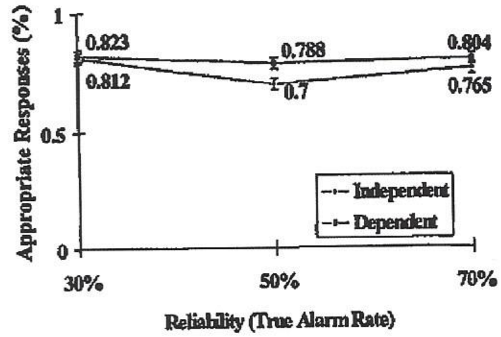

Figure 3. Alarm Reaction Appropriateness as a Function of Team Interdependence and Alarm Reliability.

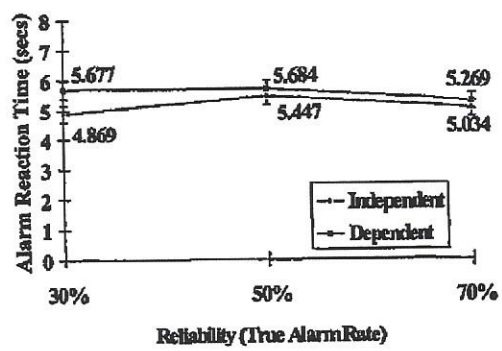

Figure 4. Alarm Reaction Time (secs) as a Function of Team Interdependence and Alarm Reliability.

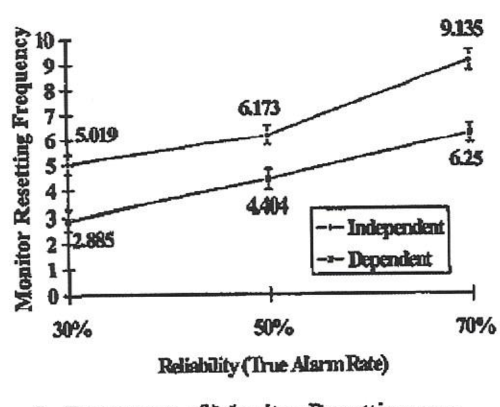

Figure 5. Frequency of Monitor Resetting as a Function of Team Interdependence and Alarm Reliability.

An examination of pump activation frequency revealed no interaction or reliability main effect; however, dependent team members activated pumps to regulate liquid flow more often than independent team members, $F(1,50) = 3.959$, $p = .05$ (see Figure 6).

We found no significant interaction or main effects for MAT task tracking accuracy, $p > .05$.

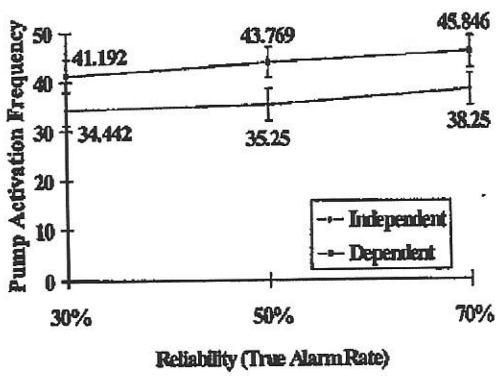

Figure 6. Pump Activation Frequency as a Function of Team Interdependence and Alarm Reliability.

DISCUSSION

In general, our results confirmed our hypotheses. The fact that dependent teams reacted more appropriately to alarms suggests that they realized the benefits of task interdependence. The opportunity to share information before reacting to alarms was instrumental for teams, and ensured that their reactions were appropriate. However, interdependent teams took longer to react to alarms, presumably because of the added time required to communicate before reacting. Together, these results support the convictions of Campion et al. (1993) and other researchers.

Furthermore, as predicted, participants exhibited the worst performance for alarms that were 50% reliable. Bliss et al. (2000) found similar results, and attributed them to the uncertainty surrounding this particular reliability level.

With regard to alarm responsiveness, the current findings echo those of prior work (Bliss, 1993), showing that operators generally match their response rates to the alarm reliability levels in a linear fashion. Yet, in this research participants responded less frequently than the reliability levels might have suggested. Perhaps the workload inherent in the primary task may have lowered overall response rates (see Bliss et al., 2000).

These results suggest that alarm designers strive to distribute reaction responsibility among multiple individuals, provided that reaction time is not a crucial issue. It is likely that status or low-level alarms may be good candidates for shared reaction. Our findings also highlight the importance of operator training, so that marginal alarm reliability conditions may be handled quickly and effectively.

REFERENCES

Bliss, J.P. (1993). The cry-wolf phenomenon and its effect on operator responses. Unpublished doctoral dissertation, University of Central Florida, Orlando.

Bliss, J.P., & Dunn, M.C. (2000). Behavioural implications of alarm mistrust as a function of task workload. Ergonomics, 43(9), 1283-1300.

Bliss, J.P., Freeland, M., & Millard, J. (1999). Alarm related incidents in aviation: A survey of the Aviation Safety Reporting System database. Proceedings of the 43rd Annual Meeting of the Human Factors and Ergonomics Society. September 27-October 1: Houston, TX.

Breznitz, S. (1983). Cry wolf: The psychology of false alarms. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Campion, M.A., Medsker, G.A., & Higgs, C.A. (1993). Relations between work group characteristics and effectiveness: Implications for designing effective work groups. Personnel Psychology, 46, 823-850.

Comstock, J.R., & Arnegard, R.J. (1992). The multi-attribute task battery for human operator workload and strategic behavior research. (Technical Memorandum No. 104174). Hampton, VA: National Aeronautics and Space Administration.

Johnson, D.W., & Johnson, R.T. (1989). Cooperation and competition: Theory and research. Edina, MN: Interaction Book Company.

Mathieu, J.E., & Hamel, K. (1989). A causal model of the antecedents of organizational commitment among professionals and nonprofessionals. Journal of Vocational Behavior, 34, 299-317.

Stanton, N. (1994). A human factors approach. In N. Stanton (ed.), Human factors in alarm design. London: Taylor & Francis.

Thompson, J.D. (1967). Organizations in action. New York: McGraw-Hill.

Welch, J. (1999). Auditory alarms in intensive care. In N.A. Stanton & J. Edworthy, Human Factors in Auditory Warnings (pp. 319-344). London: Ashgate.

Wiener, E. & Nagel, (1988). Human factors in aviation. New York: Academic Press.