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With a unique high fidelity simulation lab, participants completed 3 hour work shifts to a run a simulated regional airline. The experimental design consisted of three teams randomly assigned to either a minimal, moderate, or maximum level of difficulty. Increases in workload and stress were implemented with various triggers and the participants had to quickly develop solutions to mitigate the problems. After the simulation, the participants completed the CATME (Comprehensive Assessment of Team Member Effectiveness) online survey for evaluations of their performance for five variables. (Ohland et al., 2012). Based on one-way analysis of variance (ANOVA), the results suggest only two components of teamwork were affected by workload and stress, expectation of quality and having relevant KSA's. This leads to the conclusion that generally a team will perform based on their level of team cognition and efficient group behaviors, not necessarily based on the demands of workload and stress.

Multi-team, safety critical professions such as the aviation industry, military operations, and the medical field utilize realistic Simulation-Based Training (SBT) to allow people to refine their technical and nontechnical skills in a non-consequential environment (Lazzara et al., 2010; Shapiro et al., 2008). Effective teamwork is vital for any organization to meet their performance goals, yet communication and coordination within teams rarely comes easy for people. To help improve team performance, people are often placed into various simulated settings to practice improving their teamwork skills so those skills can transfer into the workforce. Simulation can be an effective measurement tool as it allows for people to make mistakes without actual consequences. While it is important to be able to complete technical tasks, such as flying an aircraft or operating in a surgery room, there are also "non-technical" skills that must be perfected to obtain the necessary knowledge, skills, and abilities (KSA's) for high performing teams (Alinier, Hunt, Gordon, & Hardwood, 2006; Beaubien & Baker, 2004; Lazzara et al., 2010; Shapiro et al., 2008). Taking into account varying workload demands and stresses are inevitable throughout one's career, examining how these factors affect teamwork during simulations can help broaden the knowledge on group dynamics and team cognition research. Without a doubt, simulation training has the ability to revolutionize team psychological research.

Like a well-harmonized symphony, it takes effort and dedication from all team members for a team to operate efficiently. The negative effects of poor team performance can be catastrophic if operating in a high-risk field in which people's lives depend on the team communicating and coordinating as one unit. With increasing technology and teams co-located in different places across the globe, it has become even more important for psychology to continue to examine teamwork in various settings and to integrate simulation as an evaluative tool. Not only does teamwork research increase understanding of human interactions in team settings, but also the results from such studies can be used to improve training in educational and professional environments.

Review of Team Literature

The guiding foundations for the design and implementation of this study were the merits of two psychological theories: group dynamics and team cognition. The synthesis of these two theories

created a single, complete theory in which to objectively describe the often subjective concept of effective teamwork. On one hand, teamwork can be simply defined as the workings of a team; on the other hand, the teamwork construct can become complex when trying to objectively measure team performance. Many areas of research and safety-critical industries use simulation as a catalyst for examining the dynamics of group behavior and thinking and improving team effectiveness. While there are some potential negative uses of simulation that need to be avoided, Simulation-Based Training (SBT) is a highly effective tool to practice the technical and non-technical skills that must be mastered for high performing teams.

Synthesis of Group Dynamics and Team Cognition

In order to acccurately address and measure teamwork, the evolution of a single, cohesive theory surfaced from an exploration of group dynamics and team cognition theories. To simplify the complexities of team theories, team cognition explains the relevant aspects of cognitive functioning within a team and group dynamics addresses the behaviors. Together, the manner in which a team thinks and behaves determines the level of team effectiveness. The only way to truly determine if a team performs well is to examine the internal and external factors surrounding the dynamics of a team. The unification of both team theories is evident considering most research that measures teamwork includes some component of cognitive and group dynamics (Burtscher et al.,2011; Ellis & Pearsall, 2011; Waller, Gupta, & Giambatista, 2004). For example, Waller, Gupta, and Giambatista (2004) combined principles from both theories by examining adaptive behaviors and shared mental models to explain team performance. Interestingly, few differences were found to exist in team adaptability between low and high performing teams. The greatest impact on team performance was the way in which information was collected and processed, along with the accuracy of the shared mental models.

Part of the focus in group dynamics and team cognition research is to provide effective training to individuals that work in dynamic, technological environments. Often times, individuals must be flexible and be able to adapt to an ever-changing team environment (Resick et al., 2010). An excellent example of the necessity of adaptability is evident with the professional pilot career. On a weekly basis, there are changes in the times a pilot must report to duty, their route of flights, type of airplane, and the flight crewmembers they fly with in the cockpit. Regardless of the composition of a flight crew, pilots must be able to fly the aircraft and adapt to unforeseen weather conditions, system malfunctions, passenger issues and more. This requires effective communication, good decision-making, the use of all available resources, and, above all, working together as a team, all which are key components of Crew Resource Management (CRM) training (FAA, 2004).

Mandatory for airline pilots, aircraft dispatchers, flight attendants, and many other positions within airline operations, the purpose of CRM training is to reduce human error and improve performance. While it is impossible to completely eliminate human error, CRM training focuses on the continued education of vital aspects of effective teamwork so as to reduce the number of mistakes that occur from poor communication and coordination. By holistically viewing teamwork from the internal and external dyamics of a team, it fosters the ability to develop effective training modules that addresses how a team can operate in an efficient and safe manner.

Usefulness of Simulation-Based Training (SBT)

A growing body of literature supports the validity and reliability of using simulations to help improve the technical and non-technical aspects of effective team performance (Arora et al., 2010; Gettman et al., 2009). When the design of a study includes simulation training and suitable measures, this can be an excellent evaluative tool for team performance. The merits of simulation to improve team performance are evident in the ability to measure and evaluate the knowledge, skills, and abilities (KSA's) of individuals interacting in a team environment (Alinier, Hunt, Gordon, & Harwood, 2006; Beaubien & Baker, 2004; Lazzara et al., 2010; Shapiro et al., 2008). The ultimate goal of integrating

simulation is to foster a learning environment which affords the unique opportunity to practice skills and develop strategies for effective teamwork (Arora et al., 2010; Bond et al., 2007). Errors made during a simulation should be viewed as an opportunity to learn how to improve one's level of knowledge and capabilities so as to not make the same mistakes when performing in real-world teams.

Methodology

The purpose of this study was to gain a better understanding of the effects of the difficulty of high fidelity simulation on teamwork. Understanding the role of simulation difficulty is important so as to avoid the misuse of simulation which could lead to negative learning of how to effectively communicate and coordinate in a team environment (Bond et al., 2007; Salas, Bowers, & Rhodenizer, 1998). The simulation lab closely mirrors a regional airline operations center with various positions that must interact and coordinate with one another to run the airline.. The research design followed a quantitative, experimental approach with 3 experimental groups. The degree of difficulty in simulation was the independent variable (IV) that was manipulated in the experiment and was divided into minimal, moderate, and maximum levels of difficulty. The dependent variable was teamwork based on 5 dependent team effectiveness variables. The 5 team effectiveness variables were based on the Comprehensive Assessment of Team Member Effectiveness (CATME) online self and peer evaluation tool. Those categories were contributing to teamwork, interacting with the team, keeping the team on track, expecting quality, and having the needed knowledge, skills, and abilities. The emphasis was to determine how the difficulty of a simulation affects the team and their performance.

The sample type was senior-level undergraduate aviation students at a large southeastern university from their capstone course. It was important that the participants had a strong foundation of knowledge, skills, and abilities (KSA's) in order to understand and contribute during the simulation exercises; therefore, the participants were selected from a senior capstone course in which all concentrations were required to take this course their last semester. Within the capstone course, the students were randomly assigned into teams and then based on their concentration assigned to positions in the lab. Once the participants were selected and placed into teams, the teams were randomly assigned into one of the experimental groups (minimal, moderate, and maximum level of difficulty).

As the three teams were part of a larger class, the entire class received an onboarding training session which included the purpose of the simulation lab, the various functions and roles within the lab, basic operational information of the simulated airline, and the informed consent forms were handed out. After the completion of the initial training, the teams participated in the simulation exercise and were given scenarios that mimicked real-world problems and disruptions that required quick resolutions with minimal impact to the airline operations. The subject matter experts (SME's) implemented various "triggers" to the team and observe how they react to solve the issues. They are called triggers because they have the potential to cause compounding downstream impacts if not handled correctly. The level of simulation difficulty was based on the implementation of various triggers and the potential for disruption of normal operations.

Upon completion of the simulation, the participants completed the CATME (Comprehensive Assessment of Team Member Effectiveness) web-based self and peer-evaluation survey in a computer lab. After a brief explanation of the survey, the participants completed the CATME online survey and the results were accessed with a faculty login account on the CATME website. The information was delineated so it was not possible to identify the data with participants.

Results

A one-way analysis of variance (ANOVA) was used to answer the following research question: What is the difference in teamwork between groups with minimal, moderate, and maximum levels of simulation difficulty? As teamwork was measured on five categorires, there were five alternative and null hypothesis. Results from ANOVA analysis found there were significant differences in two of the five teamwork categories between the minimal, moderate, and maximum levels of simulation difficulty. As illustrated in Table 1, there were differences amongst the groups in for having relevant knowledge, skills, and abilities (KSA's), F (2, 27) = 5.765, p= .008, $p < .05$, and the expectation of quality, F (2, 27) = 6.13, $p = .006$, $p < .05$. These two null hypotheses were rejected. Specifically, the differences in means for KSA's were between the minimal and maximum level of simulation difficulty and the minimal and moderate levels. There were not significant differences in KSA's between the moderate and maximum groups. For the expectation of quality, the post hoc results showed the differences existed between the minimal and maximum groups only.

Regarding the other three teamwork variables, results from the one-way ANOVA found the differences in teamwork amongst the experimental groups not to be significant at the $p < .05$ level. Significant differences were not found in regards to the contribution to the team (F (2, 27) = .326, p= .725), interaction with the team (F (2, 27) = .147, p= .864), and keeping the team on track (F (2, 27) = .150, p= .861). As a result, he null hypotheses relating to the aforementioned teamwork variables were not rejected.

Table 1**.**
Results From the One-Way ANOVA

		Sum of Squares	Df	Mean Square	F	Sig.
Contribution to Team	Between Groups	.061	2	.030	.326	.725
	Within Groups	2.513	27	.093		
	Total	2.574	29			
Interaction with Team	Between Groups	.013	2	.006	.147	.864
	Within Groups	1.161	27	.043		
	Total	1.174	29			
Keeping on Track	Between Groups	.035	2	.017	.150	.861
	Within Groups	3.120	27	.116		
	Total	3.155	29			
Expecting Quality	Between Groups	.893	2	.446	6.130	.006
	Within Groups	1.966	27	.073		
	Total	2.859	29			
Having KSAs	Between Groups	1.173	2	.586	5.765	.008
	Within Groups	2.746	27	.102		
	Total	3.919	29			

Pair-wise comparisons between the three experimental groups of simulation difficulty and the teamwork categories were made using the Scheffe's test. Based on this test (using $\alpha = .05$), it was found that differences in expectation of quality were present between the minimal and maximum groups. The means from the Scheffe's test revealed the maximum level of group had a higher

expectation of quality (M = 4.25) from themselves and their team members as compared to the minimal level of group (M = 3.83). In regards to for having KSA's, there was not a significant difference in having KSA's between the moderate and maximum level of difficulty. On the other hand, there was a significant difference between the minimal versus moderate and the minimal versus maximum groups. For the KSA's mean scores, the minimal group had the lowest scores, M = 3.83, followed by the maximum group, M = 4.21, and the moderate group scored slightly higher than the other groups (M = 4.28). Overall, for the areas in which significant differences in teamwork were found, the minimal level of difficulty group produced the lowest scores for having relevant knowledge, skills, and abilities (KSA's) and their expectation of quality.

Discussion of Findings

With two teamwork variables being significantly different between the experimental groups, this translates to the idea that some components of teamwork are affected by the design of the simulation while others are not as susceptible to its effects. The ANOVA calculations yielded results that suggest the degree of relevant knowledge, skills, and abilities of a team and the expectation of quality are affected by the difficulty of the simulation. From the overall group perspective, the degree of simulation significantly effected having KSA's between the minimal and moderate groups, as well as the minimal and maximum group. There were not significant differences between the maximum and moderate group and this may be because there is not as great of a leap from moderate to maximum simulation as from the lowest level of minimal difficulty to a higher level. For the expecting quality variable, only the minimal versus maximum group yielded significant differences due to the level of simulation difficulty.

Taking into consideration only two out of the five teamwork variables were significantly different due to differences in workload and stress, this leads to the conclusion that generally a team will perform based on their level of team cognition and efficient group behaviors, not necessarily based on the degree of difficulty presented during a simulation. While the decrease or increase of workload and stress integrated into simulation-based training (SBT) may play a role in team performance, it is not a primary determinant in how well a team coordinates and communicates.

Recommendations for Future Research

I have three recommendations for improvements in future research. First, use a larger sample size to ensure the assumptions of sphericity and equal variances are met. This in turn leads to stronger results, improved research design, and ability to generalize from the sample to a larger representative population. Secondly, I recommend combining the self and peer CATME tool with ratings from subject matter experts that observe individual and group performance in the experimental groups. Pairing the CATME results with SME observer ratings will open the opportunity to compare the two ratings to determine if the participants are performing at similar levels rated by the experts. The third and final suggestion is to give the CATME survey to participants after a debriefing session as opposed to after completion of the simulation. The debriefing sessions would provide immediate feedback as to their positive and negative outcomes and ensure the particpants know how their team performed. Without this debriefing session, particpants lack the feedback from the SME's and are basing their performance soley on their perceptions.

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