Article Title Page

Structured Abstract:

Purpose – Incidents requiring command and control require all personnel from firefighters to the incident commander to make continuous decisions often with limited information and under acute time pressure. Therefore, the purpose of this paper is to explore the stress reactivity of specific roles during the command and control of an immersive, computer based incident.

Design/methodology/approach – Experienced firefighting personnel undergoing incident command training participated in this study. Participants completed measures of state anxiety and stress immediately before and after taking part in a computer based simulation of a large scale incident run in real time. During the simulation personnel assumed one of four roles: incident commander, sector commander, entry control officer, and command support officer. Following the simulation personnel then completed measures of perceived workload.

Findings – No significant changes in state anxiety were observed, but levels of stress and perceived workload were related to task roles. Specifically, incident commanders reported the greatest levels of mental and temporal demands and stress when compared with entry control officers.

Research limitations/implications – Limitations include the lack of environmental factors (such as rain, darkness, and noise), a relatively small sample size and the use of self-reported questionnaires.

Practical implications –The application of immersive training environments as a method of developing firefighters' experience of incident command roles and skills pertinent to high-acuity, low-frequency events.

Originality/value –This research represents one of the first attempts to identify the self-reported anxiety, stress and perceived workload of specific role demands during the command and control of simulated incidents

Keywords: Fire service, firefighters, stress, demand, incident command.

Article Classification: Research Paper

INTRODUCTION

One of the key aspects of fire and rescue service incident command and control is the ability of commanders and decision makers to think in a flexible manner, be able to critique a situation in order to identify any potential problems in the way the incident has been handled, and generate a set of alternative actions that anticipate novel or unusual events (Joung et al., 2006). However, incident commanders are not the only personnel involved in this process. Firefighters, depending on their function and position during the emergency response within delegated roles, also assume organisational and monitoring responsibility of other firefighters (Sommer & Nja, 2011). As a result, command tasks are carried out by personnel at a variety of levels and in a variety of roles, and therefore personnel need to combine the ability to rapidly evaluate the situation and make a decision with the ability to think and behave as though the unexpected will happen (Joung et al. 2006). Firefighters have limited opportunities to gain experience, knowledge and training of these types of tasks either in real life or in training, and the infrequent nature of large-scale disasters during a firefighter's career often means that personnel will have limited experience of the demands of real-life incidents. This reduction in the collective experience of emergency personnel is also attributed to a lack of available practice opportunities to experience the chaos of large incidents, make mistakes, have the mistakes identified, and then go through the scenario again (Danielson & Ohlsson, 1999).

One of the traditional methods of undertaking large scale incident command and control training is through large scale activities run in real-time. However, realism and fidelity are usually difficult to achieve in these tasks, and within these scenarios, there will often be limited opportunities for any repetitive skill rehearsal for an individual, or for other personnel to take charge due to being on a different shift, sick leave, or due to undertaking different duties during the task (Wilkerson et al., 2008). Large-scale exercises are typically expensive, often costing hundreds of thousands of pounds, and require the attendance of gold / strategic or silver / tactical commanders as well as other agencies and as a result, personnel in command and control roles may be unwilling to make mistakes or try alternative methods in the optimal environment, thus limiting the effectiveness and benefits of training.

On a smaller scale, the use of 'tabletop' exercises is common practice in emergency services. In these tasks, participants discuss desired responses to a pre-determined scenario controlled by a moderator. Such exercises provide a useful alternative to large scale real-time activities due to their lower cost and increased frequency and standardisation of the scene. However, again there is a problem with realism and with the skill of the moderator, and such exercises can be limited by factors such as resource allocation that includes unrealistic response times and equipment and personnel availability. Post incident evaluations of tabletop exercises are also often heavily dependent upon the evaluator's ability to accurately capture the events of the exercise through observation (McGrarth & McCarthy, 2008).

One of the benefits of command and control training is exposing individuals to stress that may be present at real life incidents, with expert performance under stressful conditions considered to exist following experience at previous incidents. Opportunities for personnel to be exposed to stress can be considered important as firefighters may be operating under high stress conditions when engaging in incident command and control tasks, yet require skills that are considered to be less developed due to limited experiences from which to draw from (Danielson & Ohlsson, 1999). Regehr et al. (2008) considered the question of whether stress affects performance in emergency personnel engaged in acute high stress situations and suggested that stress can lead to performance deficits, although it is unclear as to the impact of this stress upon the work of emergency workers performing critical functions. However, it is acknowledged that firefighters on the emergency scene who take additional time to find an optimal solution to an operational demand stressor run the risk of stalling their decision making which may be considered a negative trait during high time pressure and environment where early decision making and intervention may prevent the escalation of the incident. Therefore the aim by personnel on the emergency scene is to find a satisfactory, workable course of action in response to the incident-related stressors (Flin, 2008).

To allow personnel to experience the demands and stressors of incidents, advancements in immersive computer-based learning systems now provide simulations of large scale exercises that allow individuals or teams to undertake command and control tasks in real time. Webb et al. (2010) have suggested that the use of computer scenarios has become more prevalent in fire training as they allow for the manipulation of predictability and require fire and rescue personnel to respond to challenges similar to those presented at a fire scene, but in an environment that poses less physical risk. Immersive training methods are also commonplace in military training sectors, with all U.S. military flight training incorporating simulator training into its syllabus to some extent (Koonce & Bramble, 1998).

Due to the difficulties of collecting data of command and control roles at real-life incidents, such as the variances in the incidents attended and ethical issues associated with researcher interference with firefighting tasks during time-critical tasks, knowledge regarding the specific stress and demand placed on personnel within these environments remains limited. The use of immersive computer based systems allows the demands of real-life incidents to be explored in greater detail, and allow for the collection of data applicable to command and control to be replicated with a greater number of participants. Therefore using the computer based system the current study aimed to identify the demands of specific command and control roles, and assess changes in subjective measures of stress that occur as a result of participation in an immersive computer-based exercise.

METHOD

Participants

The sample comprised 80 full time, male firefighting personnel from one fire and rescue service. All were currently active in either a firefighter (FF) (n = 60), crew manager (CM) (n= 14), or watch manager (WM) (n= 6) role. Participants were aged between 29 and 48 years (mean = 39.0 years) with years' of service in their current role ranging from 10 months to 26 years (mean = 21.1 years). Roles during the task were identified through the use of tabards, which were representative of those carried on a fire appliance for use at operational incidents.

Apparatus

All testing took place at an incident command suite (ICS), a purpose built complex featuring a large lecture room, a control room, and four separate rooms along a single corridor designated as 'sectors' denoted by colour (red, blue, green, or yellow). Each sector was fitted with a large monitor displaying real time images of the side of the building that must be attended to, and two video cameras were linked to the control room to observe the crews undertaking the task. A one way microphone was set up in each room to allow the control room to listen to the conversations and decisions taking place. Other equipment in these rooms / sectors was representative of the equipment that would be available at a real life operational incident of this nature, including identification tabards, breathing apparatus entry control board, sector command board, white board, and radios to allow communication during the exercise. A central control room within the ICS allowed a team of facilitators to observe all four sectors of the incident, and to listen in to conversations between the participants, as well as listening in on all radio traffic on the different channels used.

Materials

In order to capture as much information as possible in a limited time period, a paper based questionnaire booklet was used for data collection. This included copies of the National Aeronautics and Space Administration Task-Load index (NASA-TLX) (Hart & Staveland, 1988), and visual analogue scales for the measurement of anxiety and self-reported stress.

Perceived workload. The NASA-TLX was included to measure the participants' perception of the task demands. This questionnaire consists of six workload facets: mental demand, physical demand, temporal demand, effort, performance, and frustration. These facets were measured using a 100 mm visual analogue scale anchored from 'low' to 'high'. Responses related to the subjects' experience of the test that they had just completed with a higher score indicating greater levels of that facet during the task.

State Anxiety. State anxiety is described as the anxiety related to present circumstances (Storch & Panzarella, 1996), and is considered to be the most commonly used assessment of stress manipulations (Regehr et al., 2008) as well as being sensitive to acute stress manipulations (Spielberger, 1983) in emergency workers during simulated exercises (LeBlanc et al., 2005). A short form version of the Speilberger State-Trait Anxiety Inventory (STAI; Speilberger, 1983) consisting of six items by Marteau and Bekker (STAI-SF; 1992) was incorporated and modified into a 100 mm visual analogue scale to ensure consistency with the other state measurements. Participants were asked to read each statement and mark how they felt at that exact moment, to give a score from 0-100, anchored by 'not at all' and 'very much'. Facets considered to be beneficial (calm, relaxed, and content) were negatively scored, and the scores of all six items added to give an overall score of between 0 and 600, where a higher score indicated higher levels of state anxiety.

Self-reported stress measures. Levels of self-reported stress and happiness were recorded using 100mm visual analogue scales anchored with 'not at all' and 'very much'. Higher scores for each scale indicated greater levels of self-reported stress and happiness accordingly.

Procedure and task

Upon arrival at the site participants were greeted, given an overview of the procedures to be followed, and given the opportunity to ask any questions. If they were willing to take part, a consent form was read and signed. All participants were then provided with a thorough exercise brief by the specialist incident command staff, before completing the first part of the booklet in the lecture room consisting of the demographic information (age, length of service, and current role) and the anxiety, stress and happiness measures.

To replicate the structure and 'real-life' validity of operational incidents, a number of roles were integrated into the task. In total there were four primary roles allocated: incident commander (IC); sector commander (SC); entry control officer (ECO); and command support officer (CSO). Roles were allocated by the manager of the attending watch at the start of the exercise prior to the task briefing and were not subject to any intervention by either the research team or ICS personnel. Each session consisted of eight personnel at any one time, and comprised one dedicated incident commander, three sector commanders, three entry control officers, and one command support officer. Personnel took part in the activity once.

Participants were 'turned out' to the incident from the upstairs lecture room. This was done using a protocol that was indicative of a real incident using a computer printout representative of a regular dispatch. No information was provided until arrival at the scene and participants were turned out in teams of four to represent a fire appliance. The scenario was of a large industrial unit well alight with an unknown number of persons reported to be trapped inside. On arrival crews would be faced with a visual display on each of the monitors of the outside of the building with smoke billowing out, as well as a member of ICS staff playing the role of the fire warden of the building who could provide information if asked. This information included floor plans, building construction, and persons believed to be inside the building. During the exercise, all participants were free to move between the different rooms / sectors as required by the incident commander.

Considerations for participants included the method of entry into the structure, number of firefighters committed to search for persons believed to be trapped inside, search pattern and the location of their entry, additional resources required and method of attack on the fire (offensive or defensive). Additional resources such as specialist fire appliances or external agencies (such as police or paramedics) could be requested but would be provided in token only (i.e. no additional personnel would appear at the incident), although such requests would be noted by ICS staff for use at the post task debrief.

The task was undertaken until the 'fire' was extinguished and objectives completed as dictated by a member of the ICS staff in the control room who displayed this via the TV screens in each sector screens. Upon immediate completion of the task participants returned to the lecture room and completed the remaining part of the question booklet that included the self-reported measures of perceived workload, anxiety and stress. Participants were also required to state at the front of the booklet their primary role during the task, and were given the opportunity to ask any questions or voice any concerns about the data collection process. Finally, participants were thanked and provided with a participant debrief before taking part in a task and performance related debrief provided by ICS staff.

Treatment of data

In order to assess the effect of role on perceived workload scores, a series of one way ANOVAs were utilised. Mixed model ANOVAs considering time (pre-post) and role (incident commander, sector commander, entry control officer, and command support officer) were used to assess pre-post changes in anxiety, stress and happiness. F and P values, and effect sizes are reported throughout and post-hoc analyses were conducted when appropriate. An alpha level of .05 was employed to determine the significance of all statistical tests.

RESULTS

Task demands

Means and standard deviation scores of the six facets of perceived workload by the four task roles are displayed in table 1. Analysis found that there was a statistically significant effect of role during task on mental demand ($F(3, 76) = 3.069$, $p = 0.03$) and on temporal demand ($F(3, 76) = 4.306$, $p = 0.007$). No significant effects were observed for the facets of physical demand ($p = 0.912$), effort ($p = 0.132$), performance ($p = 0.774$), or frustration ($p = 0.862$). Post-hoc analyses demonstrated significant differences between incident commanders and entry control officers in levels of mental demand ($p = 0.03$) and temporal demand ($p < 0.01$)

[INSERT TABLE 1 ABOUT HERE]

Psychological stress

The means and standard deviations for the three self-reported measures of the mood and stress measures are displayed in table 2.

[INSERT TABLE 2 ABOUT HERE]

Anxiety. There were no significant effects of time on the levels of anxiety ($F (1, 76)$, $= 0.946$, $p = 0.334$, partial $n^2 = 0.012$), of task role ($F (3, 76)$, $= 1.263$, $p = 0.293$, partial $n^2 = 0.047$) or a significant interaction between anxiety scores and task role ($F (3, 76)$, $= 2.30$, $p = 0.084$, partial $n^2 = 0.083$).

Stress. There was no significant main effect of task on pre-post changes in stress levels ($F (1, 76)$, $= 0.898$, $p = 0.346$, partial $n^2 = 0.012$), although there was found to be a significant effect of task role ($F (3, 76)$, $= 2.808$ $p = 0.045$, partial $n^2 = 0.100$), and a significant interaction between pre-post levels of stress and role during the task ($F (3, 76)$, $= 2.871$, $p = 0.042$, partial $n^2 = 0.102$). Post hoc analysis demonstrated that there was a significant difference in levels of stress between the incident commander and entry control officer ($p = 0.042$).

Happiness. There was no significant effect of time upon levels of happiness ($F (1, 76)$, $= 0.105$, $p = 0.747$, partial $n^2 = 0.001$), and no significant effect of task role ($F (3, 76 = 1.817$, $p = 0.151$, partial $n^2 = 0.067$) despite a significant interaction between pre-post changes in happiness and role during task ($F (3, 76)$, $= 3.139$, $p = 0.030$, partial $n^2 = 0.110$). Post hoc analysis did not find any significant differences between any task roles; however, the mean values demonstrate the greatest discrepancy between the incident commanders and entry control officers who demonstrated a post-task reduction in happiness, and command support who demonstrated an increase.

DISCUSSION

The study demonstrated that the role playing in an immersive computer based environment is associated with high levels of perceived workload characterised by levels of mental and temporal demand. Results were comparable with Webb et al. (2011) who found average NASA-TLX workload levels of 68.75 when participants were faced with a computerised fire suppression simulation. Mental demands and temporal task demands reported by the personnel allocated as incident commanders in this study were found to be significantly greater than entry control officers, with the incident commanders also self-reporting the highest levels of each of the facets of mental demand, temporal demand, effort and performance. The simulated task was not found to lead to an overall significant change in self-reported levels of state anxiety, or any significant difference in levels of state anxiety between the four roles.

The current results demonstrated that of the four roles, incident commanders experience the greatest levels of state anxiety both before and after the task although these levels could be considered relatively low levels (below 200, out of a potential maximum score of 300). An increase in post task state anxiety was also found in the entry control officers, whilst sector commander scores remained stable pre and post task, and the command support officers demonstrated a decrease in mean state anxiety score post task.

Similar findings were also found in the measure of stress, whereby overall mean stress levels reported by participants in the four roles were comparatively low both pre and post task. Of the four roles, again the incident commanders reported the greatest levels of stress both pre and post task, with post task levels found to increase significantly more than those of the entry control officers. Command support was the only role to decrease in stress levels post task, whilst the sector commander stress levels were found to remain relatively stable. Finally, the measure of happiness demonstrated post task decreases for both the incident commanders and entry control officers, a rise in mean scores by the command support officers, and again relatively stable scores pre and post task by personnel in sector commanders.

State anxiety and stress levels were lower than expected. One potential explanation is due to personnel knowing that they are not at a real incident, and is consistent with Sommer and Nja (2011) who describe how firefighters may be in ‘training mode’ due to the training taking place in familiar settings. Similarly, Lieberman et al. (2006) have stated how although military simulations are able to replicate environmental conditions, there is still a lack of factors that may cause a psychological response such as genuine risk to life, or pressure from bystanders to act.

Results suggest that the most demanding role undertaken at a large scale incident is that of the incident commander. This would be expected due to the responsibility of this role as one of overall command and control of the incident, a role which becomes even more complex with increased scale and duration. The incident commander is often likely to be the most senior person at the incident, and although they receive training specific to the role that may help to alleviate stress, they are likely to be primarily concerned with the tactics and operational tasks in the initial stages of the scene of operations when there is limited information of the environment involved. This would include requesting further personnel and resources, evaluating the scene to assess the risk to firefighters, and the likely development of the internal and external conditions. Langerman (2007) suggests that a major task for those in the incident commander leadership role is to see and manage the most significant aspects of the whole incident, including the identification of 'critical aspects' which, if properly controlled will result in a positive outcome. This will also include keeping sight of the 'big-picture', regardless of the size of the incident, and avoiding micro-managing by not focusing upon single issues or sectors and by allowing staff to do their jobs. This is in contrast to the other three roles within the task, who are delegated a specific set of objectives to complete that contribute to the overall management of the task. Staff within these supporting roles only oversee a relatively small segment of the incident and do not have to consider the cumulative effect of their objectives upon other tasks.

In particular, command support officers are primarily involved in a supporting role and as a result, this role involves receiving large quantities of information from all of the sector commanders and ensuring that this information is correctly disseminated during the early stages of the incident. Stress is unlikely to exist towards the end of the task since all duties have been undertaken and the command support officer is not required to make any major tactical or operational decisions. Due to recording of information and updates in each sector, the command support officer is provided with an overview and running commentary of exactly what is happening at each sector of the incident and will therefore be aware of the outcome of the incident without having to directly intervene.

The use of simulation is considered an acceptable tool to assess incident command and control (Joung et al., 2006). However, one of the limitations related to the use of simulated tasks is the issue of ecological validity. For example, when considering the differences in laboratory versus field based stressor testing in the military, Lieberman et al. (2006) suggest that in most real world situations humans are exposed to a complex combination of stressors, including fear of death and injury, confusion, and uncertainty. Whilst the incident command suite does provide a stressor based environment, all participants will be aware that there are no actual threats to the well-being of themselves or their colleagues, and that the simulation cannot be as demanding as an actual fire scene. Participants in this study reported minimal physical demand from the task, as well as lower than expected state anxiety and stress, yet this is unlikely to be the case at a real incident. Rooms representing sides of the structure were set up next door to each other, facilitating ICS staff to observe all actions easily, yet this meant that incident commanders could easily manoeuvre between the three or four sectors incorporated into this task, instead of hundreds of metres that would be involved at a real incident. For example, the sectorisation of a large building often utilised by commanders may require the incident commander to repeatedly move around a large area in full firefighting personal protective equipment including firefighting boots, tunic, overtrousers, helmet, and gloves.

In addition, there were a number of environmental factors that were missing from the simulated task including inclement weather, such as wind or rain, pressure from bystanders to act unsafely to rescue lives, and any risk of structural collapse. The environmental demands of this operational scene will provide a significant challenge to the individual's physical, cognitive and affective resources that may not be experienced through simulation. Similarly, if the incident occurred during the night, there would have been an increased need for decision making to occur with limited vision and missing visual cues due to darkness, in addition to potential sleep deprivation. Finally, due to the time constraints of the exercise, and in order to minimise participant burden and encourage participation, measurement tools were chosen in on the basis that they could be completed as quickly and honestly as possible in a situation with limited resources such as a place to sit or write. As a result, the measure of state anxiety featured only six questions along a 100mm visual analogue scale, unlike the 20 questions and four-level scoring scales of alternative measures employed in studies of state anxiety, such as the state-trait anxiety inventory (STAI; Spielberger, 1983). Similarly, both stress and happiness were only a single-item, self-reported visual analogue scale and if further assumptions are to be made regarding stress reactivity, more thorough and validated measures may be more appropriate.

This research has given some further insight into the stress and demands faced by firefighters, and although the task was representative of a large scale incident, the introduction of additional stressors into this environment is recommended to further increase ecological validity, including additional personnel arriving on scene, role rotation and the introduction of supporting agencies. However, the extent of stressors must be a compromise with the training aspects of incident command training, with Friedman and Keinan (1992) describing how the introduction of stress training can often result in counterproductive results. These factors have been stated to include high levels of anxiety in personnel that may inhibit both training and post-training performance, and increase in levels of stress that may interfere with the acquisition of the skills and knowledge that the training is designed to promote.

There is also the recommendation to consider the application of other agencies involved in emergency first-responding. As all participants of this study were members of the fire service, further research may wish to consider the inclusion of other emergency agencies during the task to establish practical experience of inter-agency working to improve on scene performance and cohesion between groups that may not often get the opportunity to train together. The benefit of this cohesion includes a collective focus, consensual sharing of meaning (Bass, 1985) and acting as a catalyst in eliciting higher levels of performance and commitment, especially given the need for firefighters and other emergency service workers to work closely as coordinated teams in the face of high environmental and personal dangers (Pillai & Williams, 2003).

CONCLUSION

Expert performance under stress in the fire service is considered to exist as a result of extensive exposure and experience at previous incidents. This is considered to equip the individual with the ability to make the appropriate decisions. These skills are considered to be less developed in inexperienced firefighters who do not have the experiences to draw from when assuming a command role (Danielson & Ohlsson, 1999), yet may be experienced through the use of computer based simulated environments. The results of this study demonstrate that exposure to a simulated exercise was found to produce a series of changes in levels of state anxiety, stress and happiness in the four roles typically required at an 'operational' level response to such incidents, particularly in incident commanders. Although stress and anxiety levels were lower than expected, command support was the only role to decrease in stress levels and anxiety post task and to increase in happiness. There were also a number of factors considered demanding, namely the mental demands and temporal demands, with effects most profound in incident commanders.

The findings of this study may be useful in increasing the knowledge of the potential impact of workload and stress of personnel engaged in command and control roles at real-life large scale incidents, and it is recommended that further research should continue to utilise the immersive simulated environment due to practicality and cost.

REFERENCES

Bass, B. M. (1985), *Leadership and Performance beyond Expectations*, Free Press, New York, NY.

Danielson, M., & Ohlsson, K. (1999), "Decision making in emergency management: A survey study", *International Journal of Cognitive Ergonomics*, Vol. 3, pp. 91–99.

Flin, R. (2008), "The Psychology of Command", in *Fire Service Manual Vol. 2. Fire Service Operations: Incident Command* (3rd Edition), Her Majesty's Stationary Office, Edinburgh, pp.107-118.

Freidman, A., & Keinan, G. (1992), "Training effective performance in stressful situations: three approaches and implications for combat training", *Military Psychology*, Vol. 4 No. 3, pp.157-174.

Hart, S. & Staveland, L. (1988), "Development of NASA-TLX (Task Load Index). Results of empirical and theoretical research". In P. A Hancock and M. Meshkati (Eds) *Human Mental Workload*, North Holland Press, Amsterdam, pp. 239-250.

Joung, W., Hesketh, B., & Neal, A. (2006),"Using 'war stories' to train for adaptive performance: Is it better to learn from error or success?", *Applied Psychology: An International Review*, Vol. 55 No. 2, pp. 282-302.

Koonce, J. M., & Bramble, W. J. (1998), "Personal Computer-Based Flight Training Devices", *The International Journal of Aviation Psychology*, Vol. 8 No. 3, pp. 277-292.

Langerman, N. (2007), "You need a leader". *Journal of Chemical Health and Safety*, September/October 2007, pp. 5-7.

LeBlanc, V. R., MacDonald, R. D., McArthur, B., King, K., & Lepine, T. (2005), "Paramedic performance in calculating drug dosages following stressful scenarios in a human patient simulator", *Prehospital Emergency Care,* Vol. 9, pp. 439–444.

Lieberman, H. R., Niro, P., Tharion, W. J., Nindl, B. C., Castellani, J. W., & Montain, S. J. (2006), "Cognition during sustained operations: Comparison of a laboratory simulation to field studies", *Aviation, Space and Environmental Medicine*, Vol. 77 No. 9, pp. 929-935.

Marteau, T. M., & Bekker, H. (1992), "The development of a six-item short-form of the Spielberger State-Trait Anxiety Inventory (STAI)", *British Journal of Clinical Psychology*, Vol. 31, pp. 301-306.

McGrath, D., & McCarthy, M. R. (2008), "Computer simulation of incident command exercises" available at:http://www.policechiefmagazine.org/magazine/index.cfm?fuseaction=display_arch&article_id=1653&issue_id=102008
(Accessed October 20 2011)

Pillai, R., & Williams, E. A. (2003), "Transformational leadership, self-efficacy, group cohesiveness, commitment, and performance", *Journal of Occupational Change Management*, Vol. 17 No. 2, pp.144-159.

Regehr, C., LeBlanc, V. Jelley, R. B., & Barath, I. (2008), "Acute stress and performance in police recruits", *Stress and Health*, Vol. 24, pp. 295-303.

Sommer, M., & Nja, O. (2011), "Learning amongst Norwegian fire-fighters", *Journal of Workplace Learning*, Vol. 23 No.7, pp. 435-455.

Spielberger, C. D. (1983). *Manual for the State Trait Anxiety Inventory (STAI),* Consulting Psychologists Press, Palo Alto, CA.

Storch, J. E., & Panzarella, R. (1996), "Police stress: State-trait anxiety in relation to occupational and personal stressors", *Journal of Criminal Justice*, Vol. 24 No. 2, pp. 99-107.

Webb, H. E., Garten, R. S., McMinn, D. R., Beckman, J. L., Kamimori, G. H., & Acevedo, E. O. (2011), "Stress hormones and vascular function in Firefighters during concurrent challenges", *Biological Psychology*, Vol. 87, 152-160.

Webb, H. E., McMinn, D. R., Garten, R. S., Beckman, J. L., Kamimori, G. H., & Acevedo, E. O. (2010), "Cardiorespiratory responses of firefighters to a computerized fire strategies and tactics drill during physical activity", *Applied Ergonomics*, Vol. 41, pp. 376-381.

Wilkerson, W., Avstreih, D., Gruppen, L., Beier, K-P., & Woolliscroft, J. (2008), "Using Immersive Simulation for Training First Responders for Mass Casualty Incidents", *Academic Emergency Medicine*, Vol. 15 No. 11, pp. 1152-1159.

TABLES

Table 1: Participant self-reported perceived workload means (and standard deviations) of each of the four task roles following completion of the incident command exercise (n = 80).

	Mental Demand	Physical Demand	Temporal Demand	Effort	Perceived Performance	Frustration
Incident commander (IC)	86 (8.2)	18 (10)	78 (11)	77 (11)	67 (14)	37 (23)
Sector commander (SC)	65 (20)	21 (20)	57 (21)	58 (21)	64 (25)	37 (25)
Entry control officer (ECO)	63 (22)	17 (25)	46 (29)	56 (27)	64 (24)	37 (27)
Command support officer (CSO)	61 (31)	21 (21)	52 (29)	60 (28)	72 (14)	29 (31)

Table 2: Means (and standard deviations) of task induced changes in the four participant roles as measured by state anxiety, and self-reported measures of stress, anxiety, and happiness following completion of a simulated incident command task

	Happiness		Stress		Anxiety	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
Incident commander (IC)	68 (12)	60 (12)	34 (16)	40 (24)	168 (81)	199 (101)
Sector commander (SC)	75 (19)	79 (18)	17 (20)	22 (19)	142 (93)	143 (86)
Entry control officer (ECO)	74 (18)	64 (33)	12 (24)	26 (34)	127 (73)	186 (141)
Command support officer (CSO)	64 (25)	81 (8.3)	28 (24)	15 (8.9)	135 (103)	100 (58)

For internal production use only

Running Heads:

Article Title Page

TABLES

Table 1: Participant self-reported perceived workload means (and standard deviations) of each of the four task roles following completion of the incident command exercise (n = 80).

	Mental Demand	Physical Demand	Temporal Demand	Effort	Perceived Performance	Frustration
Incident commander (IC)	86 (8.2)	18 (10)	78 (11)	77 (11)	67 (14)	37 (23)
Sector commander (SC)	65 (20)	21 (20)	57 (21)	58 (21)	64 (25)	37 (25)
Entry control officer (ECO)	63 (22)	17 (25)	46 (29)	56 (27)	64 (24)	37 (27)
Command support officer (CSO)	61 (31)	21 (21)	52 (29)	60 (28)	72 (14)	29 (31)

Table 2: Means (and standard deviations) of task induced changes in the four participant roles as measured by state anxiety, and self-reported measures of stress, anxiety, and happiness following completion of a simulated incident command task

	Happiness		Stress		Anxiety	
	Pre	Post	Pre	Post	Pre	Post
Incident commander (IC)	68 (12)	60 (12)	34 (16)	40 (24)	168 (81)	199 (101)
Sector commander (SC)	75 (19)	79 (18)	17 (20)	22 (19)	142 (93)	143 (86)
Entry control officer (ECO)	74 (18)	64 (33)	12 (24)	26 (34)	127 (73)	186 (141)
Command support officer (CSO)	64 (25)	81 (8.3)	28 (24)	15 (8.9)	135 (103)	100 (58)

For internal production use only

Running Heads: