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Psychophysiological responses in experienced firefighters undertaking repeated novel self-contained breathing apparatus tasks

Abstract: In order to safely and effectively extinguish fires and rescue life, firefighters are required to routinely wear self-contained breathing apparatus (SCBA), yet little is known about the specific physiological and psychological demands associated with repeated exposure to novel tasks whilst wearing SCBA. Twelve experienced firefighters took part in a series of commonly encountered SCBA activities: free search, guideline search and live firefighting tasks under ambient and extreme heat conditions to assess changes in heart rate, blood pressure, mood, perceived workload and air usage. Findings from the current study indicated high cardiovascular demand regardless of the presence of heat. No significant impact of task upon mood and no significant differences between the perceived demands of guideline, free search and live firefighting exercises were found.

Keywords: firefighters; demand; mood; breathing apparatus

Practitioner summary: This study considered the physiological and psychological responses of UK firefighters when undertaking three commonly encountered self-contained breathing apparatus (SCBA) exercises. This study has shown high cardiovascular demand regardless of environmental temperatures; no significant changes in mood constructs, and no differences in self-reported measures of demands between the tasks.

1. Introduction

The use of self-contained breathing apparatus (SCBA) by firefighters at incidents provides an essential component of safety by allowing the individual to operate in fire, heat, and irrespirable atmospheres. However, SCBA use can act as a significant barrier to performance due to the weight of the component parts. Typical SCBA equipment weighs between 10 and 12 kg, with the majority of this mass localised on the back (Cheung et al., 2010). Marshall (2003) estimated the total weight of personal protective equipment and SCBA to be almost 23 kilograms per person, or carrying a load equivalent of up to 41% of own body mass when also carrying supplementary firefighting equipment (Rayson et al. 2005).

Psychologically, SCBA can limit the normal sensory awareness abilities of a firefighter, including scent, hearing and sight, and clear verbal communications are made more difficult. The compressed air cylinder attached to a SCBA set varies and the actual 'working' duration of a cylinder is subject to a number of factors. For example, better cardiovascular condition of the user can extend the duration, whilst poor emotional control during use, such as panic or anxiety, can reduce the duration of the cylinder due to increased breathing and respiration rate (Sendelbach, 2001).

Whilst the environments encountered by firefighters vary considerably on a daily basis, the type of search technique utilised at incidents can be classified into three main types: free search, guideline search and firefighting operations. During a 'free search' of a structure the breathing apparatus team leader maintains physical contact with the wall of the structure bulkhead. The other team members maintain contact with the team leader and each other through physical contact. Where structures may involve large open areas, environments with a complex layout or extremely limited means of access and egress, free search may be an ineffective technique and 'guideline search' may be initiated instead. In a guideline search a 60 metre rope carried by the SCBA team leader is tied to points in the structure (such as door handles or internal piping) and can be used to indicate a route between an entry control point and the scene of operations. Finally, 'live' firefighting operations, are used when the degree of light emitted from a fire is high and there is a reduced need for a 'free search' pattern. On these occasions firefighters will utilise the hose to extinguish the fire as a means of egress from the fire to a safe environment, reducing the need for guidelines to be laid.

Studies examining the effects of SCBA in firefighters have typically considered physiological demands in extreme heat utilising a single SCBA wear, but little research has explored any differences that may arise during whilst wearing SCBA during different search techniques. At present, only a limited number of studies have attempted to address the issue of operational redeployment or multiple breathing apparatus wears during the same time period either in training or real work. For example Elgin and Tipton (2003) observed that firefighter instructors are capable of successfully carrying out a rescue task immediately following a 10-minute live-fire training task; however in more severe situations, a rescue may not be possible because firefighters are too close to their physiological limits. Sustained and multiple firefighting is also associated with changes in physiological functioning, for example, three hours of intermittent firefighting activities have been found to produce alterations in left ventricular function consistent with 'cardiac fatigue' previously found in endurance athletes (Fernhall et al., 2012). Further research by Carter et al. (2008), estimates that on average, under live fire conditions after an initial deployment of 26 minutes, 50 minutes of recovery would be required to safely perform a further redeployment of 24 minutes. This suggests that issues of redeployment and repeated SCBA wearing may pose a hazard for the firefighter at an incident if insufficient rest periods are available between SCBA wears.

The specific responses of each of these three SCBA tasks have yet to be investigated, despite the impact that further understanding of physiological and psychological demands of particular types of task have upon the duration of the air cylinder and the available 'safe air' for firefighters at incidents requiring SCBA. Therefore, this study aims to consider the physiological demands and psychological responses that occur when carrying out specific search techniques during repeated novel SCBA activities.

2. Methods

2.2 Participants

Twelve experienced UK fire and rescue service personnel were recruited, with ages ranging from 28.0 to 50.0 years of age (mean age 39.7 years). Mean length of service was 14.7 years although years of operational service ranged from 2.1 to 28.1 years. Eight of the participants were firefighters (FF), three were crew managers (CM) and one individual was a watch manager (WMB) and all were full-time fire and rescue personnel.

2.3 Apparatus

Tasks took place inside a purpose built three storey breathing apparatus training centre (BATC) featuring different points of entry to prevent any familiarity. Internal walls inside the structure were also moved to ensure the task represented a novel environment, and realistic sound effects were played through the building via internal speakers to replicate noises and create the experience of hearing degradation that would replicate that encountered at real incidents.

During live fire conditions firesets were lit on the ground floor around one hour prior to subjects beginning their live fire training to provide a preheated and relatively stable temperature of 180-200^{o} Celsius as measured by internal thermocouples. Throughout the exercise, experienced stokers and fireground technicians monitored conditions at a number of points in the structure and added materials to increase the heat or ventilate the roof to decrease heat to maintain target conditions. Scenarios under ambient temperatures involved the use of obscuration masks over the breathing apparatus mask to simulate heavy smoke filled conditions inside the structure.

Personal protective equipment worn during the tasks included personal issue fire tunic, overtrousers, fire boots, fire gloves and helmet, and also included the use of a flash hood to protect the neck and ears. Participants used the current Draeger PSS 7000 breathing apparatus set (Draeger, UK), including the use of a 300 bar cylinder providing up to 49 minutes of compressed air.

2.4 Materials

2.4.1 Psychological measurement

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 Bond-Lader Inventory (Bond & Lader, 1974). Each item required participants to identify the point on a 100mm visual analogue scale which represented how they felt at that particular time. These scales ensured that data could be collected on-scene in an efficient manner, using minimal equipment (pencils and paper) in a time-limited environment, and with limited instructions or supervision required.

2.4.1.1 Perceived workload. The National Aeronautics and Space Administration Task-Load index (NASA-TLX) (Hart & Staveland, 1988) was incorporated to measure the participants' perceived workload of each SCBA exercise completed. Consisting of six workload facets (mental demand, physical demand, temporal demand, effort, performance and frustration), participants were required to state their subjective experience of the task they had just completed along a visual analogue scale labelled from 'low' to 'high'. Reported as having high internal consistency with a Chronbach's alpha of more than 0.80 (Xiao et al., 2005), measurement of this scale is from 0-100, with a higher score indicating greater effort for that facet.

2.4.1.2 Mood State. In order to assess stressor-induced changes in mood, the Bond-Lader Inventory (Bond & Lader, 1974) was incorporated before and after the completion of each breathing apparatus task. The inventory consists of 100 mm visual analogue scale anchored with antonyms and combined to produce mood factors of alertness, calmness, and contentedness, with each of the scales showing high internal validity (Chronbach's alphas = 0.77 - 0.93) (Bond & Lader, 1974). Each line is scored as millimetres to the mark from the negative antonym, with each factor capable of a maximum of 100 mm.

2.4.2 Physiological measurement

Heart rate and blood pressure measurements were taken using an upper arm inflatable cuff (Omron M2, Omron Worldwide, UK). Ratings of perceived exertion (RPE) were measured using a 15 point version of the Borg Scale (Borg, 1970). The Borg Scale was completed immediately post task, with participants required to state self-perceived ratings by identifying the number that most closely applied to them between 6 (20% 'light effort') and 20 ('exhaustion').

Air usage of the SCBA wearers was collected through the use of a Draeger Merlin Telemetry Board (Draeger, UK). The SCBA wearer removed a plastic tally with their identification details on from the SCBA set and placed it into a dedicated board (an entry control board) outside the structure. This allowed the entry control board to wirelessly 'read' the information of the wearer's SCBA set, including a live feed of air left in the cylinder as measured by bars pressure, and the time until all air in the cylinder was exhausted. Air usage was measured at the participant's point of entry and upon immediate exit, and was taken to include bars of pressure used.

2.5 Procedure

All procedures were approved by the institutional ethics board and fire service. Upon arrival at the BATC, participants were greeted, given an overview of the forthcoming procedures and asked to read an 'information for participants' booklet. Participants were given the opportunity to ask any questions and were also provided with an explanation of the information that they would gain as a result of their participation in the study. Written consent was then obtained before the commencement of data collection.

Prior to beginning any task, an exercise brief was delivered to all participants in the classroom of the breathing apparatus training centre. Experienced training officers randomly selected the teams of two, three, or four persons that would be taking part in each activity, and described the task that was to be completed in each exercise. Standard Operating Procedures (SOP) were adhered to and safety officers wearing SCBA were to in attendance at all times

The scenarios were identical for each of the teams and are described below. To ensure consistency, for each of the three tasks, the dummies were placed in the precisely the same location within the structure by SCBA instructors prior to the next team entering the testing environment.

Free search - The scenario involved a team entering a structure set out as a single storey flat via a third storey door. The team then had to search all of the compartments within the premises for persons known to be trapped inside and rescue the occupiers (a 90kg dummy and a 5kg baby dummy placed side by side).

Guideline search - The structure was set up as a single storey, large industrial unit post fire. Crews were required to make entry on the ground floor, traverse a pre-laid guideline, use correct search technique to locate persons known to be missing (in this scenario a single 55kg dummy), and remove them to a place of safety.

Live firefighting search – Participants were required to enter the property (set up as two-storey residential premises) on the ground floor through a double door, locate the seat of the fire, extinguish the fire, and rescue any persons inside the building (in this scenario a single 90kg dummy).

Upon completion of the safety briefs, all participants completed the Bond-Lader mood scale, and had their heart rate and blood pressure taken by the researchers in the classroom. All participants were then given time to service their breathing apparatus sets, which took approximately 10 minutes, and given time to change into their personal protective clothing (PPE) of tunic, overtrousers and fireboots, flash hood, gloves and helmet. Entry was made via one of three entry points and at this point the researcher would collect the air pressure in the BA set and note the time on entry into the structure.

Immediately following withdrawal from the BA training structure the air pressure in the SCBA set and observed the time of exit from the training structure were recorded by the researcher. Participants in that team turned off and removed their SCBA set and were then asked to verbally report their highest perceived rate of exertion (PRE) during the task using the Borg Scale (Borg, 1970). Participants then completed the Bond-Lader mood scale and NASA-TLX. Following this the researcher a recorded blood pressure and heart rate, and participants received a formal exercise debrief from the fire service training officers.

2.6 Treatment of data

Repeated measures ANOVA's considering time (pre-task, post-task), task (guidelines, live firefighting, and search and rescue), and task x pre-post interaction were employed, and post-hoc analyses were conducted utilising Bonferroni tests when appropriate. An alpha level of .05 was used throughout.

3. Results

3.1 Physiological measurements

The mean time taken to complete the tasks was 17 minutes for free search, 14 minutes for guidelines, and 19 minutes for the live firefighting task. Guidelines required greatest air consumption at 7.6 bar/min, followed by free search (7.2 bar/min) and live firefighting (5.5 bar/min). Descriptive characteristics of the physiological measurements are provided in table 1.

[INSERT TABLE 1 ABOUT HERE]

3.1.1 Heart rate.

There was no significant main effect of the type of task on heart rate ($F (2, 18) = 1.733$, $p = 0.205$, partial $n^2 = 0.16$). There was, however, a significant main effect of time ($F (1, 18) = 120.298$, $p < 0.01$, partial $n^2 = 0.930$), and also a significant interaction between the type of task and pre-post changes in heart rate ($F (2, 18) = 3.690$, $p = .045$, partial $n^2 = 0.291$). All three tasks completed by participants led to significant increases in heart rate. Subsequent post hoc analysis revealed that the three conditions all produced significant increases in heart rate during live firefighting ($p < 0.0001$), guideline ($p = 0.001$) and free search ($p = 0.005$) tasks.

3.1.2 Blood pressure.

There was a significant main effect of task upon systolic blood pressure ($F (2, 18) = 0.291$, $p = 0.751$, partial $n^2 = 0.31$). The main effect of time was significant ($F (1, 9) = 9.203$, $p = 0.014$, partial $n^2 = 0.506$), although there was no significant interaction found between the type of task and pre-post changes in systolic blood pressure ($F (2, 18) = 1.265$, $p = 0.306$, partial $n^2 = 0.123$). There was no significant main effect of the type of task upon changes in diastolic blood pressure ($F (2, 18) = 0.1.735$, $p = 0.205$, partial $n^2 = 0.162$). However, there was a significant main effect of time ($F (1, 9) = 8.671$, $p = 0.016$, partial $n^2 = 0.491$) and a significant interaction between the type of task and pre-post changes in diastolic blood pressure ($F (2, 18) = 4.795$, $p = 0.021$, partial $n^2 = 0.348$). Pre-post changes in diastolic blood pressure were characterised by significant increases following guideline ($p = 0.002$) and free search ($p = 0.014$) tasks, but no significant changes following the live firefighting task ($p = 0.868$).

3.2 Psychological measurements

Means and standard deviations for the three self-reported facets of mood are displayed in table 2, and for the six strands of perceived workload and perceived exertion in table 3.

[INSERT TABLE 2 ABOUT HERE]

3.2.1 Mood

Statistical analysis found no significant main effect of type of task ($F (2, 18) = 0.171$, $p = 0.844$, partial $n^2 = 0.19$) or time ($F (1, 9) = 1.036$, $p = 0.335$, partial $n^2 = 0.103$) upon participants' self-rated levels of alertness. There was no significant interaction between the type of task and pre-post changes in alertness ($F(2, 18) = 0.355$, $p = 0.706$, partial $n^2 = 0.038$).

There were no significant main effects of the type of task ($F(2, 18) = 0.196$, $p = 0.824$, partial $n^2 = 0.21$) in levels of calmness. Although pre-post changes in calmness were found to be significant ($F(1, 9) = 17.154$, $p < 0.01$, partial $n^2 = 0.656$), no significant interaction was produced between the type of task and pre-post changes ($F(2, 18) = 1.674$, $p = 0.215$, partial $n^2 = 0.157$).

Finally, there was no significant main effect of type of task ($F(2, 18) = 0.113$, $p = 0.894$, partial $n^2 = 0.12$) on levels of contentedness. Although there was a significant main effect of pre-post changes ($F(1, 9) = 6.533$, $p = 0.031$, partial $n^2 = 0.421$), there was no significant interaction between the type of task and pre-post levels ($F(2, 18) = 0.063$, $p = 0.215$, partial $n^2 = 0.007$).

[INSERT TABLE 3 ABOUT HERE]

3.2.2 Perceived workload and perceived effort

Statistical analysis revealed no significant main effect of task for self-perceived levels of mental demand ($p = 0.911$), physical demand ($p = 0.51$), temporal demand ($p = 0.293$), effort ($p = 0.136$), performance ($p = 0.192$), or frustration ($p = 0.924$). The main effect of task on perceived physical effort (as measured by the Borg Scale) approached significance ($F(2, 22) = 4.545$, $p = 0.055$, partial $n^2 = 0.292$). However, post hoc analysis found that live firefighting tasks were perceived to be significantly more physically demanding than free search tasks ($p = 0.031$), although no significant differences were found between guidelines and live firefighting ($p = 0.089$), or free search, and guideline tasks ($p = 1.000$).

4. Discussion

This study sought to investigate the effects of SCBA on mood and physiological responses during three firefighter activities. The tasks led to significant increases in heart rate, with firefighters working at approximately 58% of their maximum heart rate during free search and guideline tasks, and 54% during the live firefighting task. The greatest increases in mean heart rate in this study were observed following live firefighting. An increase in heart rate in all three tasks is consistent with previous research by Fernhall et al. (2012) who observed similar increases during multiple repeated SCBA wears. There are a number of factors that may have contributed to the increase in heart rate observed. For example the rapid adjustment from stationary / light activity during classroom based lectures and checking of SCBA sets to the active task based scenarios may have led to increased sympathetic nervous system activation. In addition factors such as heat, humidity, decreased oxygen, increased carbon dioxide and emotional factors not directly attributable to high physiological stress have previously been shown to increase heart rate in firefighters (Lemon & Hermiston, 1977) and may have contributed here.

Mean heart rates measured following completion of all three tasks are, however, lower than those reported in previous studies. Previous observations include 150 +/- 13 beats per minute during a six floor rescue of hospital patients (Von Heimburg et al., 2006); 182 +/- 20 bpm during a simulated rescue task after a 40 minute live fire training exercise (Elgin & Tipton, 2003); 182 bpm after live fire drills in a training environment (Smith et al., 1996) and 177 +/- 23 bpm during a large fire simulation structure, where 7 of the 49 firefighters taking part exceeded their age predicted maximum (Angerer et al., 2008). However, the generalisation of findings of SCBA studies have been acknowledged as being highly task dependent and as such great care is needed to transfer observations from one study to another (Rayson, 2005). In the UK , as there are currently no standardised protocol or exercise briefs for SCBA training exercises, tasks will also vary according to the geographical locations of the participating fire and rescue services utilised in previous studies.

The absence of a control group undertaking the same tasks but under live fire or ambient conditions make it difficult to determine whether heart rate increases are caused by changes in increased environmental conditions, or by, the different task demands of the activity. Due to the individual differences between firefighters, including shift duration, exposure to fires at real life incidents, and the duration of previous SCBA tasks, measuring and identifying the specific changes in cardiovascular reactivity is difficult (Rayson et al., 2005). It remains unknown if increases in heart rate were a result of the physiological demands of the heat, the psychological stress associated with the task (such as fear or anxiety), or a combination of both. Even experienced firefighters may suffer from increases in heart rate attributable to psychological factors. For example, Matthews et al. (2000) describe how previous experience of physical stressors may lead to an increase in the individual's psychological stressor of fear as they know what to expect from the task, particularly if it is likely to be extremely demanding.

Participants did not demonstrate any significant changes in systolic blood pressure, although significant post-task increases in diastolic blood pressure (DBP) after guideline and free search tasks were observed. Findings are consistent with those of Webb et al. (2011) who suggested that increased cardiac output and the associated increased blood pressure occur to allow the body to be prepared to meet the increased exertion required during firefighting. However, these blood pressures changes were in contrast to previous studies of simulated firefighting. For example, Smith et al. (2008), observed that brachial blood pressure levels in 10% of their firefighter sample could be classified as hypertensive, and a further 65% of participants were considered pre-hypertensive after 18 minutes exposure to the firefighting task. No participants in the current study were considered to be hypertensive.

With regard to a potential stable blood pressure, Fahs et al. (2009) examined the impact of acute exercise resistance, and observed a decrease in arterial compliance without changes in blood pressure 30 minutes after a bout of exercise resistance. Since many of the activities involved in fire suppression can be considered to mimic resistance training, this is not entirely surprising, although the reasons for unaltered blood pressure in the current study remain unclear. Due to the potential factors that influence blood pressure, further research into the blood pressure reactivity of firefighters in real life settings is recommended to support the observations from training environments.

4.1 Psychological measures

Firefighters started each of the three tasks with a high level of self-reported alertness of approximately 75% of their maximum level. This level was maintained following completion of each of the tasks. Firefighters reported high levels of calmness both pre and post task in each of the conditions. The Bond-Lader mood inventory scores showed post task decreases in calmness in free search and live firefighting and a slight increase in calmness following the guideline task. This suggests that anticipation of being exposed to novel training environments and being assessed had little impact upon experienced firefighters. However, post task decreases may be caused in part by frustration at having to adapt their technique used at incidents for assessment purposes (Sommer & Nja, 2011). Increases in calmness following the guideline task may be attributed to the feelings of relief associated with completing a task involving complex fine motor skills such as knot tying whilst wearing thick fire gloves in darkness. However, the observed effects of increased calmness should not be taken as representative of firefighters' levels of calmness at operational incidents. The nature of the course undertaken by the participants required that they were informed in advance of what to expect on each day. As such, the degree of uncertainty is less than what would be expected at an operational incident, where a firefighter may be told the type of SCBA actions required by the officer in charge only seconds before they are deployed into the building. As a result it is possible that levels of calmness under these conditions would be reduced at operational incidents.

There were no significant effects of task type upon levels of contentedness in the sample. Mean scores demonstrated that all three tasks were associated with high levels of contentedness. This may be expected with firefighters who are used to the training environment, who will analyse their techniques and firefighting methods more so than at an operational incident. For example, the firefighters may be content at having had reached the required standard and completed the tasks, whilst the introduction of positive or structured feedback of their performance by observing officers that would not be practical at real life incidents provides empowerment and advice upon how to improve their future performance.

Measure's of perceived workload revealed that, with the exception of frustration during the guideline based task, live firefighting produced the greatest levels of self-perceived mental demand, physical demand, temporal demand, effort, and performance, although no significant main effect of task was found. Although there were relatively low levels of frustration created by the tasks, the finding that greatest levels of frustration were observed following the guideline task was expected. This is due to the required application of fine motor skills such as tying knots and clipping a belt-attached karabiner on and off a thin rope whilst wearing thick fire gloves and under obscuration. Such fine motor skill tasks are rarely required in other breathing apparatus tasks.

4.2 Methodological considerations

Although the current sample is consistent with previous firefighter research (i.e. Smith et al., 2001; Carter et al., 2007), the relatively small sample size should be acknowledged. Previous researchers such as Smith et al. (2001), state that the differences reported by different firefighter research studies are likely attributable to differences in the intensity of the task and radiant heat load. In addition, variables could not be manipulated to ascertain causal effects. This study had to be conducted as passive observation that included a lack of random assignment of participants to any conditions by researchers. However, the passive observation approach used in this study did maintain the validity of the training exercise undertaken by participants and allowed for the identification of potentially naturally occurring key variables that may play a role in a causal relationship.

One of the main limitations of this study concerns the use of controlled training environments as representative of real-life situations (Williams-Bell et al., 2010), and the firefighters' subjective perceptions of the tasks undertaken. Firefighters considered to be in 'training mode' are usually fully aware that exercises are not real incidents and response. A tendency observed by Sommer and Nja (2011) in their study of Norwegian firefighters was that training exercises do not seem to present a sufficient challenge for the more experienced firefighters. Such explanations have also been suggested in relation to cardiovascular responses in military training environments (Lieberman et al., 2006), whereby, whilst physical challenges such as environmental conditions were representative of real life situations, there was a lack of factors that may cause a psychological response such as genuine risk to life, task uncertainty, and pressure from bystanders to act.

Measures of heart rate and blood pressure were carried out through use of an automated oscillometric device involving an inflatable cuff placed over the upper arm. This involved the participants removing their SCBA set and then firefighting tunic before measurement could take place and this potentially increased the duration of the post task recovery interval. In addition, this technique only provides a single assessment of HR and BP at each sample point and does not allow for continuous recording during the tasks. Similarly, when measuring BP levels through the use of oscillometric methods, accidental movement of the limb may impair measurement and very low pressures may not be measured accurately (Ward & Langton, 2007).

5. Conclusion

This research considered the demands of wearing SCBA during training exercises utilising a range of psychological and physiological measures and demonstrated little to no differences observed between the demands of guideline, free search and live firefighting exercises. Wherever possible, training officers should consider the use of a range of physiological measures and self-reported psychological measures to validate the effectiveness of training activities. Further research is required to identify the components of successful firefighting performance that exist in all three tasks.

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Table 1. Pre and post means (and standard deviations) of physiological measures pre and post task (n = 12) when undertaking guideline, free search, and live firefighting tasks.

	Guideline		Free search		Live firefighting	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
Heart rate (bpm)	84 (11)	104 (19)*	91 (21)	104 (18)*	70 (8)	98 (12)*
Systolic blood pressure (mmHg)	141 (14)	154 (17)	136 (15)	156 (12)	138 (16)	143 (23)
Diastolic blood pressure (mmHg)	78 (16)	96 (12)*	87 (10)	96 (11)*	80 (10)	79 (19)
Air pressure (bars)	287	181	291	169	292	187
Time in task (mins)	n/a	13.9	n/a	17.0	n/a	19.0
Air consumption per minute (bar/min)	n/a	7.6	n/a	7.2	n/a	5.5

*= $p < 0.05$

Table 2. Means (and standard deviations) of task induced changes in mood following completion of guideline, free search, and live firefighting tasks (n=12)

	Guideline		Free search		Live firefighting	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
Alertness	76 (13)	75 (15)	75 (16)	73 (16)	80 (13)	74 (12)
Calmness	67 (16)	68 (17)	69 (19)	57 (13)	71 (16)	55 (19)
Contentedness	74 (15)	72 (16)	76 (18)	72 (14)	78 (16	75 (13)

Table 3. Means and (standard deviations) of post task, self-perceived facets of workload (as measured by the NASA-TLX) and effort (as measured by the Borg Scale) (n = 12) in guideline, free search, and live firefighting tasks

	Guideline	Free search	Live firefighting
Mental demand	72 (11)	74 (22)	75 (19)
Physical demand	66 (18)	61 (20)	77 (15)
Temporal demand	61 (15)	60 (14)	67 (15)
Effort	71 (17)	68 (19)	78 (13)
Performance	73 (20)	74 (13)	83 (7)
Frustration	40 (21)	36 (20)	38 (22)
Borg Scale	13 (1.9)	13 (1.7)	15 (2.1)*

*= $p < 0.05$