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Exploring virtual mental practice in maintenance task training

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Abstract

Purpose—– This paper aims to contribute to a general understanding of mental practice by investigating the utility of and participant reaction to a virtual reality maintenance training among underground coal mine first responders.

Design/methodology/approach—– Researchers at the National Institute for Occupational Safety and Health's Office of Mine Safety and Health Research (OMSHR) developed software to provide opportunities for mine rescue team members to learn to inspect, assemble and test their closed-circuit breathing apparatus and to practice those skills. In total, 31 mine rescue team members utilized OMSHR's BG 4 Benching Trainer software and provided feedback to the development team. After training, participants completed a brief post-training questionnaire, which included demographics, perceived training climate and general training evaluation items.

Findings—– The results overall indicate a generally positive reaction to and high perceived utility of the BG 4 benching software. In addition, the perceived training climate appears to have an effect on the perceived utility of the mental practice virtual reality game, with benchmen from mines with more positive training climates reporting greater perceived efficacy in the training's ability to prepare trainees for real emergencies.

Originality/value—– This paper helps to broaden current applications of mental practice and is one of the few empirical investigations into a non-rehabilitation virtual reality extension of mental practice. This paper also contributes to the growing literature advocating for greater usage of accurate and well-informed mental practice techniques, tools and methodologies, especially for occupational populations with limitations on exposure to hands-on training.

Keywords

Computer based learning; Training evaluation; Training climate

Introduction

Mental practice can best be understood as a type of training or preparation in which participants engage in the cognitive rehearsal of a given task before, after or between opportunities for task performance. For example, athletes may spend time visualizing the sequential steps necessary for performance in their sport or musicians may mentally rehearse

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1. At the time of this publication, the BG 4 software is available for free download at: www.cdc.gov/niosh/mining/Works/coversheet1877.html

the bars and verses along with accompanying finger placements between lessons. Although several historical meta-analyses and literature reviews have established varied positive relationships between mental practice and task performance (Driskell *et al.*, 1994; Feltz and Landers, 1983), to the best of the authors' knowledge, few mental practice studies assess the influence of the organizational context on perceived training efficacy, and fewer still utilize interactive virtual reality as the mechanism for the manifestation of cognitive imagery, especially among first responder populations. The purpose of this applied study was primarily to determine the general utility of and participant reaction to a virtually displayed mental practice maintenance task via a preliminary training evaluation. In so doing, the authors also attempt to address two larger theory-based research questions using a specific first responder sample. Specifically, the study explores the degree to which virtual reality mental practice may be associated with perceived emergency response efficacy in a first responder sample and the kind of impact that training climate might have on the perceived usefulness or utility of this mental practice exercise.

To address these research questions, the applications of mental practice must be considered, including emerging applications of mental practice in a virtual reality context. Although training climate has a significant theoretical and empirical history (Tracey and Tews, 2005), the effects of training climate have largely not been addressed in mental practice training interventions. Therefore, a brief description of the theory followed by potential implications for mental practice is also needed.

In the sections below, the authors discuss the target population of this study – mine rescue team benchmen – including some of the shortcomings of the standard training procedures for this population. Next, the authors present a brief overview of relevant research regarding mental practice, including a brief discussion arguing why mental practice may be an ideal training intervention to use with mine rescue benchmen. This is followed by a discussion of the potential benefits of combining virtual reality and mental practice with this population. Finally, the authors highlight a potential moderator – training climate – in the mental practice and performance relationship.

Mine rescue teams

Underground coal mine rescue teams comprise highly trained and skilled miners who follow a prescribed regimen of classroom and hands-on training. They prepare themselves to enter an underground mine after an emergency event to perform rescue and recovery activities. Mine rescue teams generally comprise seven members. One team member remains at the "fresh air base". When a fresh air base is formed, it serves as a relatively safe established location for the base of operations for the team and is used to facilitate communication between the team and the command center, which is located outside the mine. Five of the team members methodically explore the mine by orders from the fresh air base. The seventh team member, "the benchman", inspects, assembles and tests the team's closed-circuit breathing apparatus prior to the team entering the mine.

The role of benchmen and benching training

As mentioned, a benchman is a member of a mine rescue team who properly maintains, or “benches”, the unit used for breathing underground during exploration. Using a procedural step-by-step method, the benchman visually inspects the parts of the breathing apparatus before they are reassembled into the housing. Once assembled, the benchman tests the reassembled device for leaks, positive air pressure and other functions before an apparatus is worn by a rescue team member. Although different closed-circuit breathing apparatuses are available and certified for commercial use, the most widely used unit for underground exploration is the Draeger BG 4 (MSHA, 2014).

Training benchmen and other mine rescue personnel to correctly check the working condition of the breathing apparatus ensures their safety and well-being when responding to an emergency. Federal regulations require each mine rescue team member, including the benchman, to complete an initial 20 h of instruction on the use and care of the breathing apparatus used by their team. After initial training, team members must wear their apparatus under oxygen for at least 2 h every two months. Federal law also requires a designated person be trained in the use and care of the breathing apparatus used by the mine rescue team. This person is to inspect and test the apparatus “at intervals not exceeding 30 days” (30 CFR 49.6b1).

Most benchmen are typically trained with one or more of three methods: hands-on, classroom presentations and competitions. Traditionally, hands-on training has been the chief method used to train team members to bench apparatus, with PowerPoint® presentations and training videos demonstrating the benching process supplementing this hands-on training. Teams also spend time training for apparatus benching competitions that are held as part of mine rescue contests to help reinforce skills. During competition benching, one or more flaws may be placed in the apparatus by the competition judges. A flaw can range from a tear in a breathing air bag to a missing seal ring. Much like military rifle disassembly and reassembly demonstrations, the benchman is timed while working on the unit and must find the flaws by visually inspecting the parts of the unit and/or testing it to determine what flaws may exist. They must replace any flawed components, assemble the unit and test it to confirm it is fully functional.

Skills maintenance

Benching a Draeger BG 4 requires motor skills for completing the task. Motor skills are those used by trainees to disassemble, manipulate and replace various BG 4 components. Regardless of the task, motor skills tend to degrade over time if not used regularly (Voelcker-Rehage, 2008). Mental practice has been shown to reinforce motor skill retention and lead to improved task performance. Research conducted by the US Bureau of Mines looked at using mental practice for helping miners remember the self-contained self-rescuer (SCSR) donning sequence. Trainees who regularly used a mental practice aid showing a “3 + 3” SCSR donning sequence performed more proficiently 90 days after initial training than did trainees who did not have the mental practice aid (Vaught *et al.*, 1993).

BG 4 benching also involves the use of cognitive skills. Cognitive skills, in part, involve processing information for the purposes of acquiring or applying some type of knowledge, such as inductive/deductive reasoning, selective attention, visualization and perception. In the case of the BG 4, cognitive skills are needed to identify apparatus components; understand how they function and interconnect; and perceive cues that indicate component performance. Cognitive skills also include procedural knowledge, that is, knowing how to do something and being able to demonstrate it (Driscoll, 2000). Knowing how and in what order the BG 4 components are installed into the case and how the breathing circuit is tested are examples of procedural knowledge. Utilizing both declarative and procedural knowledge, trainees practice the task of benching a BG 4. As they continue to practice, trainees' ability to bench the apparatus correctly continues to improve. With sufficient practice, trainees potentially can seamlessly and autonomously bench the apparatus.

Problems with traditional mine rescue benchmen training

Although anecdotal evidence suggests that many mines and mining contractors provide high-quality training sessions, some logistical and structural issues can make it difficult for benchmen to receive adequate training. BG 4 apparatuses are relatively expensive, so smaller mines or mine rescue teams with limited resources may go for longer periods with limited access to equipment available for hands-on practice. Turnover of mine rescue team members is common as a result of members retiring from the workforce, leaving the team to take another job at a mine or being unable to commit to the extensive training time requirements, thus resulting in a need for multiple introductory sessions over time. There are also a number of composite mine rescue teams that are made up of members who commonly work for different companies. Generally, these members must travel to a designated mine rescue station for regular training and will not have ready access to an apparatus for practicing benching when not at that location. Finally, consistency between training sessions may become an issue, as there is no set curriculum or standardized training materials available to trainers who may be concerned with covering the same information with each trainee. In spite of these obstacles, it is important that all rescue team members, in addition to the designated benchman, be adequately trained in benching their BG 4 apparatus.

Mental practice overview

One solution to overcome barriers to effective mine rescue team benchmen training may lie in mental practice methodologies. Mental practice, similar to many learning or psychosocial concepts, has a complex and nebulous past. Referred to by several names such as motor imagery, mental rehearsal, imaginary practice, covert rehearsal, conceptualization or mental imagery rehearsal (Rogers, 2006), the general thrust of the concept was allowing performers to train or practice tasks between formalized training sessions as a supplemental form of training, especially if training was infrequent or costly. Although historically the concept appears to have been used mostly in stroke rehabilitation (Braun *et al.*, 2006; Nilsen *et al.*, 2010), surgical technical skills (Arora *et al.*, 2011), athletic performance (Murphy, 1994) and musician rehearsal (Freymuth, 1994; Bernardi *et al.*, 2013), in recent years, the technique seems to have branched out to include diverse applications such as e-learning of pilot safety skills (Kearns, 2010) and Swedish solider military performance (Fjellman, 2010).

In addition, several meta-analyses on the subject have complemented the breadth of applications in which mental practice has been used with constraints and boundaries on its utility. For example, Driskell *et al.* (1994) consider the type of task (i.e. cognitive or physical), practice-performance time gap and length of mental practice durations in determining the effectiveness of mental practice in their meta-analysis. Results indicate that although overt physical practice is more effective, overall mental practice had a moderate effect on task performance with an effect size of 0.26, with stronger effects for cognitive tasks (0.33), more frequent refresher training periods (1- to 2-week schedule) and 20-min optimal mental practice session length, among experienced trainees (as compared to novices) (Driskell *et al.*, 1994). Previous meta-analyses corroborate these general findings, not only establishing links from mental practice to performance in a broad sense but also establishing stronger relationships between mental practice on cognitive tasks and performance (Feltz and Landers, 1983) and 10-20 min sessions seem to be ideal (Hinshaw, 1991).

Given the short-but-frequent ideal intervention structure as supported by the literature, as well as long-term cost-effectiveness, mental practice may provide a more effective supplemental training for mine rescue team benchmen. Indeed, as Driskell *et al.* (1994) conclude:

> Thus, for tasks that are dangerous to train for physically, for tasks in which there are seldom opportunities for physical practice, or as a means of supplementing normal training, mental practice should be considered as an effective training alternative.

Although hands-on training is the standard, mental practice could provide a benefit for this first responder population.

Virtual reality mental practice

The authors also suggest that virtual reality can serve as a tool to support mental practice. In fact, Hinshaw (1991) discusses this difference as mental practice with internal vs external imagery, and although a particular meta-analysis found a stronger link between internal imagery mental practice and performance, the author asserts that virtual reality provides interaction-based external imagery. Although imagery alone seems enough to produce an effect on performance, such images are static. For complex cognitive and psychomotor tasks, mental practice may need to involve an interaction component. Indeed, in a computer-assisted mental practice study in stroke rehabilitation, Gaggioli *et al.* (2006) suggest that in tasks that are cognitively demanding or where mentally projecting imagery may pose difficulty because of task complexity, virtual reality may serve as a mental practice tool. Rizzo *et al.* (1998) also argue that virtual reality provides imagery that is difficult to artificially represent in other neuropsychological assessments. From a logistical perspective, computer-based virtual reality may also serve as an optimal delivery format, given the prevalence of personal computing devices and remote location of mines and their rescue teams, and that computer programs can have a wide and immediate distribution mechanism (e.g. online downloads, CDs, thumb drives, email attachments, etc.).

Although the literature does not seem definitive on the topic of using mental practice methodologies among first responders, it would logically follow that mental practice could perhaps fill an emerging training gap among populations where actual practice can be a somewhat rarer event (especially in the case of volunteers or disaster response units). Thus, to address the first research question, the authors first explore the general perceptions of mine benchmen on a virtual reality mental practice exercise, including the training's effect on their own efficacy (or confidence) in their abilities to respond to a potential future emergency:

> *RQ1*. Is virtual reality mental practice associated with perceptions regarding emergency response efficacy in mine benchmen?

Training climate

Importantly, in the above discussions regarding the effectiveness of mental practice, the organizational context appears to be missing. One related noteworthy construct is training climate, which can be defined as trainee-perceived support from differing levels of the organization for formal and informal training and development activities (Tracey and Tews, 2005). Training climate can be conceptualized as a training-specific type of perceived organizational support (Rhoades and Eisenberger, 2002), especially given the established links between perceived organizational support and trainee perceptions of training quality (Russell *et al.*, 1985). Although more individual-centered constructs such as training motivation and intent to learn certainly have an effect on skill acquisition during training sessions, training climate encompasses a broader perspective by investigating the organizational context into which trainees are meant to transfer acquired knowledge, skills and/or abilities after training sessions. Indeed, although many variables certainly influence the effectiveness of training efforts, previous research has demonstrated that training climate is instrumental in preparing individuals for formal application of knowledge, skills, abilities and other characteristics (KSAOs) and in achieving learning objectives (Tracey *et al.*, 2001).

Within the context of mental practice is the consideration of whether organizations support mental practice activities and devote resources to trainees that allow them to mentally practice necessary KSAOs in the workplace. From a fiscal perspective, mental practice may appeal to managers, as mental imagery training interventions could certainly have lower training costs than formal standard training sessions, which may incur additional costs such as hiring external trainers. If mental practice can be considered a type of training when applied in an organizational context and training climate is one of many key variables in determining training effectiveness, then certainly organizational support of training in this context would seem salient. Because mental practice has been studied historically on an individual level, there appears to be a lack of consideration of training or social context in the empirical literature as far as mental practice is concerned. The argument made here is that especially in a workplace context and in a somewhat autonomous first responder population, the support offered by the organization regarding training (perhaps specifically unconventional training) could have a direct impact on trainee skill acquisition and retention. The second research question, then, considers the potential effect of the training climate of benchmen trainees on the perceived usefulness of the virtual reality mental practice exercise:

RQ2. What is the relationship between training climate and perceptions on the utility of mental practice training?

Method

Participants

Participants comprised 31 mine rescue team members across six different teams who participated in mine rescue training activities in the OMSHR virtual immersion and simulation lab (VISLab) located at the Bruceton Research Facility in Pittsburgh, PA. Teams and team members were recruited through trainers and mine managers who expressed interest in participating in virtual reality training and research activities. Participants provided reaction survey data to several mine rescue research activities, including the BG 4 Benching Trainer software. As a benefit to participating in the study, teams received no-cost training for mine rescue skills, including wayfinding and competition preparation. All participants were recruited and surveyed in accordance with an approved IRB protocol.

Participants ranged in age from 21 to 49 years with an average age of 33 years. Roughly half (n = 15) had no prior experience benching a BG 4 apparatus, and of the participants who had at least>0 years benching experience (n=16), average benching experience was 3.6 years. The majority of participants (n=21) reported that their teams were trained at least once every two weeks and half (n = 17) had not experienced a virtual environment before coming to the lab. All participants were males.

Procedure

Development of the BG 4 Benching Trainer software was done under the scrutiny of underground mine rescue and escape experts and Draeger subject matter experts. Once stable versions of the software were created, validation sessions took place. Utilizing these experts was a crucial step to ensure that the visual quality of the three-dimensional models and standard benching procedures presented within the training environment were realistic. At the conclusion of its development, an extensive validation took place to confirm the quality and accuracy of the simulation used for live training exercises.

As with live hands-on benching training and competition protocols, the BG 4 Benching Trainer software's scenario builder feature permits trainers to insert one or more flaws into the different parts of the apparatus. The software places the trainee in front of a virtual table where all of the BG 4 apparatus parts are shown. The trainee selects parts from the virtual table one at a time, with each part gliding into view for closer inspection. The trainee inspects each individual part for flaws with the inspection tools provided in the software. Most apparatus part flaws are visual and require an attention to detail to find, just as in the real-world benching competitions where judges introduce actual flaws in breathing apparatus parts for benchmen to find. In the software, apparatus part flaws range from a ripped breathing bag to missing O-rings. When trainees find a flaw, they can swap it for a replacement part as they normally would in a real-life mine rescue benching contest. Once fully assembled, the trainees can test the BG 4 for leaks using the virtual RZ tester. The software generates a score sheet for each trainee, which the trainer can use to review a trainee's performance and provide post-training feedback. Using the scenario builder, all trainees worked for the same training scenario in the software program as described below.

As part of a larger research effort evaluating the effectiveness of mine rescue teams, benchmen and other mine rescue team members were invited to engage with the mental practice software program in a large classroom environment in the OMSHR VISLab. The BG 4 Benching Trainer software was loaded onto four laptops, and team members decided amongst themselves which members to assign to which computer. Usually, team members elected to "pair up" trainees to laptops based on technology comfortability and benching knowledge/skill. All trainees were allowed time to become familiar with the mouse and keyboard and were put through a practice session of the simulation designed to give trainees an understanding of the various controls and features of the program. After all trainees completed this practice session and reported their ability and willingness to continue, a benching "problem" was then loaded onto the laptops for the trainees to work through at their respective laptop stations. Upon completion of the problem, trainees were given feedback regarding their performance, including proper identification of flaws, appropriate swapping and installation of parts and correct testing procedures. At the completion of training, all trainees were administered a one-page post-simulation training evaluation survey. The total procedure on average took approximately 45-60 min.

Measures

Unless otherwise stated, all items were measured on a five-point Likert scale, with higher scores indicating more agreement. Each of the three variables below was measured using one scale each:

(1) *Training climate (α=0.83)*. Participants responded to four items from the training subscale of the mine emergency preparedness climate measure (Bauerle and Mallett, 2013), which assesses trainee perceptions of the resources available to their mine rescue team from their respective mine organizations. An example item is "Our team has opportunities for constructive feedback from instructors".

(2) *Training evaluation (α=0.90)*. Ten training evaluation items were adapted from Ford and Noe's (1987) post-training self-assessment, which aims to capture participant's perceptions of training relevancy, comprehensiveness, intent to transfer and training efficacy. An example item is "Today's training helped prepare me to handle a real mine emergency".

(3) *NASA task load index (TLX) (α=0.82)*. The NASA TLX (Hart and Staveland, 1988) is a seven-item general indicator of task demand, often used in lab-based studies. Participants rate items on a scale from 1 to 10, with higher scores indicating higher task demands. An example item is "The mental demands of the simulation were [...] (Very Low/Very High)".

Results

Training evaluation

Central tendency measures for the training evaluation and NASA TLX scale scores are shown in Table I. Overall, participants seemed to react positively to the training and rated high perceived utility of the mental practice training session. Using a similar scoring procedure as outlined in Hart and Staveland (1988), NASA TLX items were weighted with regard to their respective factor loadings to yield an overall weighted measure of trainees' perceptions of task load. Scores on the weighted scale indicate a wide distribution of scores, with the median perceptions of trainees lying somewhere at the halfway point for task load (range = 35, median = 18.75), indicating a sufficiently challenging yet not overly difficult task. Additionally, according to the training evaluation items, more than 95 per cent of trainees either marked agree or strongly agree in response to statements that the BG4 software "covered knowledge and skills needed during a real emergency", "is a good supplement to other mine rescue training" and that they would "recommend the training to other mine rescue team benchmen".

Training climate

Participant data were dichotomized based on a median split of training climate, with approximately half ($n = 15$) of the participants grouped into a low training climate category and the rest ($n = 14$) grouped into a high training climate category. The student's t-test was conducted that compared the distribution of scores between these two groups on the training evaluation construct. An overall group difference was significant based on the training evaluation scale score ($t = -1.97$, $p < 0.05$). To probe for more specificity with regard to the training climate group differences in the training evaluation scale score, group differences were investigated on an item-by-item level in the training evaluation scale. Table II details the results of this exploratory, post-hoc investigation. Out of the ten total items which comprised the training evaluation scale score, five had significantly different group means per individually conducted t-tests. Of particular note is that all the items which showed a significant difference include the phrase "mine emergency" in the item text. Table III contains scale scores for the training evaluation variable split by "mine emergency" references in item text. Although the overall scale score and the scale score for the five emergency-specific items were significantly different on the t-test for group differences by low/high training climate, the scale score for the five non-emergency-specific items were not significantly different between the low/high training climate groups.

Discussion

The purpose of the present study was to perform training evaluation and investigate the role of training climate on perceived utility of a mental practice exercise utilizing virtual reality technology to teach mine rescue benchmen proper benching practices. Both research questions received moderate support, with overall findings generally supporting a mental practice framework for benchmen, and perceptions of and results from this mental practice may vary with respect to supportive workplace environments. Although these findings are quite preliminary and are not without limitations, the overall results indicate partial support for adapting mental practice methodologies for a wider audience using more sophisticated delivery mechanisms. Further, although perceived utility of the training was overall affirmative, training climate was shown to positively affect these perceptions with specific regard to the utilization of the skills instilled from the training in affecting performance in real emergencies. Such trends may be explained in part by the conservation of resources theory (Hobfall, 1989), which argues that stress – broadly defined – is a result of competing job demands and job resources, and, as such, the threat of loss to these resources has widespread implications for an individual (and by extension, the individual's performance). If supportive work environments can be thought of as an additional resource for workers and trainees according to this model, then perhaps this alleviates some of the translational demand between training and real-life contexts by enabling benchmen to more confidently draw connections between the virtual reality world of mental practicing benching and emergencies. Regardless, the current findings support continued trends in the larger training research literature regarding the importance of the psychosocial training context.

Limitations and directions for future research

Perhaps one of the more obvious limitations of the current study design is the lack of measured transfer performance. Indeed, a somewhat objective indicator of actual performance in the field would have yielded richer data and, therefore, a more thorough and rigorous training evaluation. However, training transfer for emergency-based KSAOs is a complicated subject area. In the words of Ford and Schmidt (2000):

> With emergency training [...] the assumption that the KSAs being trained will be used or applied immediately on the job does not hold. A key issue, then, is how to design training programs and how to develop on the job activities that help individuals not only maintain current knowledge and skill levels but also enhance their knowledge and skills given limited or nonexistent opportunity to perform trained tasks directly on the job.

Although assessing performance in a benching competition or hands-on benching capabilities would have also yielded high potential data, this was beyond the scope of the current project, which was limited to self-report post-training evaluation assessment. Future research could make bolder claims than the ones discussed in the present research by comparing the efficacy of various mental practice training methodologies, particularly among complex psychomotor/cognitive tasks such as BG4 benching, and further elaborate on the differences in training benefits between external and internal imagery.

Finally, several facets of the study design – such as a relatively small sample size, cross-sectional approach and the unique nature of the population – may affect the generalizability of the results. It is also critical to note that most mine rescue benchmen surveyed in the current study did so at the authors' main research facility, indicating not only an elevated level of training resources (e.g. travel budget and time off for training-related duties) but also a training management willing to use novel virtual reality interventions in place of traditional classroom training to fulfill monthly mine rescue team obligations. This could suggest a positive response bias or range restriction on certain survey items. It is the authors' hope that the current study can serve as preliminary or foundational work from which future research can explore the applications and limitations of virtual reality mental practice training sessions.

Conclusion and practical implications

The most apparent practical implication from the current study relates to the now-developed BG 4 software[1]. The BG 4 Benching Trainer software can be used by members of composite mine rescue teams between hands-on training sessions to help maintain their procedural skills. The module is also an ideal supplemental training tool that can be used to train benchmen and team members for new apparatus. The BG 4 Benching Trainer software supplements hands-on training in maintaining cognitive skills by giving trainees the opportunity to use procedural knowledge to assemble the apparatus and test it, along with declarative knowledge used in examining components for flaws. The BG 4 Benching Trainer software also helps trainees sharpen and maintain their motor skills by mentally practicing benching the apparatus.

From a research-practitioner standpoint, virtual reality applications of mental practice may introduce new and innovative ways to assess trainee KSAOs and evaluate training. For example, rather than needing a judge with a stopwatch observing a benching test, computer programs can be written to catalog and document time spent during certain phases of the benching task. Although the benefits of computer and virtual reality training have been known for some time, training managers and researchers interested in mental practice interventions may want to consider semi-digitizing some aspects of the training for these added benefits.

Generally speaking, the present research provides a basis for exploring the boundaries of mental practice applications in the technological age and advocates for further exploration into the high- and low-cost training solutions for routine tasks, especially in the emergency response fields.

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Table I

Correlation matrix

	Mean (SD)	Minimum	Maximum	1	2	3
Training evaluation	4.23 (0.49)	3.40	5.00	0.89		
Training climate	4.15 (0.44)	3.28	5.00	0.41**	0.80	
NASA TLX	4.57 (1.70)	1.57	8.57	0.34**	0.22*	0.82

Table II

Item-level analysis of training climate differences in training evaluation items

	Low training climate	High training climate	MΔ
Helped prepare me to handle a real mine emergency	3.53	4.43	0.90**
Covered knowledge and skills needed during a real mine emergency	4.07	4.50	0.43*
Made me more confident that I could correctly bench a BG4 during a real mine emergency	4.00	4.43	0.43*
Helped me learn something that could be helpful during a real mine emergency	4.00	4.43	0.43*
Gave me new ways to think about benching a BG4	4.13	4.50	0.37
Reinforced knowledge and skills I learned during previous mine rescue training	4.07	4.43	0.36
Motivated me to be generally more prepared for mine emergencies	4.07	4.43	0.36*
Included content relevant to mine rescue team members	4.33	4.43	0.10
Helped prepare me for a benching competition	3.93	4.00	0.07
Motivated me to learn more about benching a BG4	4.40	4.43	0.03
Overall scale score	4.05	4.40	0.35*

Table III

Analysis of training climate differences in training evaluation items based on emergency frames

	Low training climate	High training climate	MΔ
Training evaluation – emergency frame items	3.88	4.38	0.50*
Training evaluation – non-emergency frame items	4.18	4.37	0.19
Training evaluation – all items	4.05	4.40	0.35*