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## **Evaluation of Online Stress Management Training for Air Traffic Controllers: Comparing Training Effectiveness across Online and In-Person Formats**

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16. Abstract A stress management training was developed for air traffic control (ATC) trainees at the Federal Aviation Administration's Academy to build their knowledge of career-specific stressors, stress responses, and stress management techniques. A validation study was completed in 2019 and found that the training was associated with positive gains in objective and perceived stress management knowledge and positive gains in stress management confidence. There was also evidence to suggest that participants retained knowledge gains one to two months after the training. Following changes to the Air Traffic training curriculum in 2020, the stress management training now is delivered online in the Virtual for Air Traffic Basics course and provided to trainees earlier in their training. Given that the training was originally developed as an interactive, classroom-based training, an evaluation study assessed the effectiveness of the online stress management training and compared training outcomes across delivery formats (in-person and online). A pretest, posttest, follow-up (PPF) design was conducted with $N = 137$ current ATC trainees. Archival data from the original validation study ( $N = 118$ ) was used as the comparison group. We found that the pattern of gains in the online stress management training were similar to the original validation study. Namely, there were positive gains in objective knowledge, perceived knowledge, and stress management confidence immediately following the training. Interestingly, trainees in the in-person training demonstrated better knowledge retention at follow-up than trainees in the online training. Implications of these findings and recommendations for ATC stress management training are discussed.					
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## **List of Abbreviations**

<b>Abbreviation</b>	<b>Definition</b>
ANOVA	Analysis of Variance
ATC	Air Traffic Control
CAMI	Civil Aerospace Medical Institute
FAA	Federal Aviation Administration
PPF	Pretest, Posttest, Follow-Up
RMANOVA	Repeated Measures Analysis of Variance

## Introduction

The process of becoming an air traffic controller and learning to control air traffic is a stressful experience. Air Traffic Training is a multi-stage process consisting of basic and initial training at the Federal Aviation Administration (FAA) Academy and field-specific training at one's assigned field facility. At the FAA Academy, Air Traffic Control (ATC) trainees report that the fast pace of training, high-stakes performance evaluations, and potential for job loss contribute to the perceived stress of training (Pierce et al, 2018). Given that stress can adversely affect performance by decreasing attentional capacities, increasing cognitive load, and enhancing negative feelings like fear and anxiety (Driskell et al., 2022), providing resources that focus on building stress management capabilities can reduce negative reactions to stress and optimize performance in training and on the job.

In 2019, a stress management training was developed and validated for ATC trainees at the FAA Academy (Torrence et al., 2020). The objective is to build trainees' awareness of job-specific stressors, common responses to stress, and stress management techniques for handling acute and chronic stress. The training was developed as a two-hour instructor-led, interactive course consisting of three general content areas: (a) foundations of stress, (b) lifestyle tips, and (c) stress management techniques. The first section introduces the concept of stress, including the idea that stress itself arises from an individual's perception that environmental demands exceed their ability to effectively handle the situation, and the differences between acute and chronic stress. Next, trainees are introduced to job-specific stressors (e.g., performance pressure, job uncertainty, shift scheduling) that they may face during training at the FAA Academy, followed by a discussion on the cognitive, physiological, and behavioral mechanisms of stress and strain. The first section of the training concludes with a discussion on the potential benefits of stress for performance and the importance of resilience.

The second section of the training focuses on lifestyle habits that can mitigate the potential impacts of stress, namely sleep and exercise. This discussion focuses on the importance of good sleep hygiene, such as following a sleep schedule, avoiding bright lights before bed, and avoiding caffeine close to bedtime, to promote restful sleep. The benefits of physical activity for improving well-being and health are discussed as well. The final section of the training covers different cognitive, behavioral, and relaxation techniques for managing stress. The coping and self-regulatory techniques that individuals' use to manage their stress drive whether they will perform well or poorly under stressful conditions (Robson & Manacapilli, 2014). The stress management techniques discussed in the training have empirical support for their effectiveness in reducing stress. The techniques are mindfulness, diaphragmatic breathing, progressive muscle relaxation, rational self-talk, compartmentalization, meditation, and journaling. The definition for each technique is provided in Table 1 as reported by Torrence et al. (2020).

**Table 1***Definitions of Lifestyle and Stress Management Techniques*

<b>Technique</b>	<b>Definition</b>
<i>Good sleep hygiene</i>	The practice of beneficial sleep habits, including sleep scheduling, pre-sleep activities, positive sleep attitudes, daytime behaviors, and the sleep environment (Lacks & Rotert, 1986).
<i>Exercise</i>	An activity requiring physical effort to promote health and wellness.
<i>Mindfulness</i>	A form of meditation that involves nonjudgmental awareness of the present moment. This practice involves focusing on breathing and non-critically on any thoughts that come through the mind (Chiesa & Serretti, 2009).
<i>Diaphragmatic breathing</i>	A deep breathing technique that involves the contraction of the diaphragm, expansion of the belly, and deepening of inhalation and exhalation (Ma et al., 2017).
<i>Progressive muscle relaxation</i>	An exercise to reduce physiological tension that may be held in muscles by slowly tensing and relaxing muscle groups. This exercise involves actively tensing muscles for 5 seconds and releasing the tension slowly for 10-15 seconds while focusing on the feeling of released tension (Jacobson, 1938).
<i>Rational self-talk</i>	A form of cognitive restructuring, this technique involves reframing our initial negative (or self-defeating) thoughts with rational and positive thoughts (Hains, 1992).
<i>Compartmentalization</i>	An attention control technique that involves shifting attention away from the stressful event and focusing on the task at hand (Rose et al., 2013).
<i>Meditation</i>	A practice that involves concentrative or mindfulness techniques. Concentrative techniques involve focusing attention on a single object and then disengaging thoughts and feelings. Mindfulness techniques focus on staying present and alert in the moment (Sedlmeier et al., 2012).
<i>Journaling</i>	The practice of logging stressful events in a journal or diary to monitor stress, identify causes of stress, describe stress reactions, and develop plans for managing stress (Richardson & Rothstein, 2008).

The validation study for the ATC stress management training found that the training was associated with positive benefits. Notably, training participants showed positive gains in objective and perceived stress management knowledge as well as stress management confidence immediately following the training. Evidence suggested that trainees maintained their post-training knowledge levels one to two months after the training. Trainees also reported that they learned new stress management techniques from the training and applied these techniques during the remainder of their training. Finally, trainees held favorable views of the stress management training, reporting that it was engaging, an effective use of their time, and important to their success in ATC training.

Recent changes to the Air Traffic Training curriculum resulted in the ATC stress management training moving to a virtual (or online) environment as part of the Virtual Basics for Air Traffic Control (Virtual Basics) course. This change also resulted in the stress management training being taught to ATC trainees earlier in the training program. Since the stress management training was validated as an interactive, in-person course, the purpose of this evaluation study was to assess the effectiveness of the stress management training now that it is being delivered online to trainees using a web-based platform. Additionally, we assessed the effect of training delivery format (in-person vs. online) on learning outcomes using data from the validation study as a comparison group.

## **Stress Management Interventions**

Stress management interventions typically are categorized as primary, secondary, and tertiary interventions, which is based on the stress source targeted by the intervention (Holman, et al., 2018). Primary interventions, such as pre-employment screening and scheduling, attempt to mitigate stress by modifying the different sources of stress at work. Secondary interventions, such as training and peer support groups, reduce stress by providing resources to help people manage stress present in the environment and reduce the severity of stress responses. Tertiary interventions, such as employee assistance programs, are designed to treat stress once it has become a problem for healthy functioning and well-being.

Secondary interventions, in the form of employee training, are the most common type of intervention used to help individuals manage their stress (Richardson & Rothstein, 2008). Stress management trainings commonly focus on cognitive-behavioral skills, relaxation, meditation, deep breathing, exercise, journal, and/or goal setting. For instance, cognitive-behavioral skills training teaches individuals about the role of stress appraisals (thoughts) and provides techniques for altering those thoughts in a functional way. Alternatively, relaxation and deep-breathing trainings emphasize relaxing one's physical and mental state in response to stress. Meta-analytic studies (Richardson & Rothstein, 2008; van der Klink et al., 2001) have found positive effects for different training types, including cognitive-behavioral, relaxation, and mixed-content approaches, on reducing stress and improving psychological outcomes.

The ATC stress management training seeks to educate trainees about the role of stress in their training and career as a controller as well as provide them with techniques for managing their stress. The training was designed to be a short (i.e., approximately 2 hours), interactive course that could be integrated into the comprehensive Air Traffic Training curriculum. In addition to instructor lecture, the training provides interactive activities such as videos, exercises, and facilitated discussions to engage students in the materials. The training content covers the foundations of stress, mechanisms and consequences of stress, and stress management techniques. The training combines aspects of cognitive-behavioral, relaxation, mediation, and deep-breathing training to provide trainees with an array of coping skills for the different types of stress that they may face during their career. For example, the stress faced during a performance evaluation may require a different set of techniques than the stress associated with uncertainty around future job placement. The content and techniques taught in the ATC stress management training not only serve to help trainees manage their stress in training but serve to support trainees throughout their career.

### **Delivery Format**

While there is evidence pointing to the effectiveness of the ATC stress management training (Torrence et al., 2020), the training was validated in an in-person, classroom environment, not in an online setting. In the training sciences, there is longstanding interest in the role of training technologies, media, and delivery formats in training effectiveness with evidence generally suggesting that online (web-based) and classroom-based trainings can be equally effective when using similar instructional approaches (Clark, 1983, 1994; Means et al., 2009; Sitzmann et al., 2006).

In the context of stress management training, empirical studies have investigated the effectiveness of online trainings for improving stress and stress management outcomes. Heber et al. (2017) performed a meta-analysis on 23 studies to examine the efficacy of web-based and computer-based stress management trainings in reducing stress in adults. The examined studies ranged from 2 to 12 weeks in length and included both guided and self-directed trainings. In general, Heber et al. found small-to-moderate positive effects for online stress management trainings with trainings focusing on mindfulness and mediation producing the largest effects followed by trainings focusing on traditional cognitive-behavioral techniques (e.g., cognitive restructuring). Guided trainings were found to be more effective than unguided (self-directed) trainings. Training length also influenced training effectiveness with medium trainings exhibiting moderate effects, short interventions exhibiting small effects, and long trainings exhibiting non-significant effects. Finally, Heber et al. found that participants completing online stress management trainings sustained stress reduction up to 6 months after the training.

Van Wingerden and Derks-Theunissen (2018) performed a systematic review of online stress management interventions that focused on improving employee well-being. Van Wingerden and Derks-Theunissen identified 18 studies for their review, consisting of cognitive-

behavioral training, psycho-educational training, career identity stress training, self-help-based training, and assertion training. Trainings times ranged from 2 to 20 hours and training frequency ranged from 3 to 12 sessions. Sixteen of the 18 studies showed significant effects in the intended direction on training outcomes, which ranged across studies, but included outcomes such as stress, anxiety, quality of life, and knowledge. A more recent meta-analysis by Zhang et al. (2020) examined the effectiveness of 16 internet mindfulness-based trainings. The included trainings were administered through a website, smartphone application, virtual learning facility, or online classroom, and ranged in duration from 2 to 12 weeks. Overall, the internet mindfulness-based trainings had a moderate effect on stress reduction and improving mindfulness.

Taken as a whole, previous empirical research suggests that online training should still be effective in improving the stress management capacity of ATC trainees. However, we designed a study to investigate the effectiveness of the online ATC stress management training to ensure ATC trainees are benefitting from the online stress management training in a similar manner to the classroom training. Specifically, we examined whether the online stress management training would result in (a) higher stress management knowledge test scores, (b) higher perceived stress management knowledge, (c) increased confidence in trainee's own stress management, and (d) if these gains were maintained over time. Importantly, we compared outcomes achieved in the online training to outcomes achieved in the original validation study to examine differences in outcomes due to training delivery format.

## **Method**

### **Design**

A pretest, posttest, follow-up (PPF) design was used to assess the changes, or gains, in stress management training outcomes over time. PPF designs can be used to answer questions about change over time and if groups differ in change across the three measurement occasions (Rausch et al., 2003). The pretest measures were administered immediately before the training, the posttest measures were administered immediately after the training, and the follow-up measures were administered 10 days out from each class's final performance evaluation in Initial Qualification training<sup>1</sup>. The 10-day out period was selected for the follow-up assessment because this time represents the height of stress at the FAA Academy, and a period of time in which stress management is most critical. All measures in the current study were administered via an online survey.

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<sup>1</sup> The time length between posttest and follow-up differed based on the trainee's assigned ATC option. Initial Qualification training is option-specific (tower cab or en route) and training length differs between the two courses. Tower Cab training is approximately 37 days and En Route training is approximately 57 days.

## **Sample**

### ***Online Training Sample***

Participants in this study were 137 ATC trainees enrolled in Virtual Basics. The training evaluation study was conducted with 10 Virtual Basics courses with class sizes ranging from 7 to 18 trainees ( $M_{\text{trainees}} = 13.7$ ,  $SD_{\text{trainees}} = 3.98$ ). Virtual Basics is a 5-week course and is the first of two training courses required for newly hired ATC trainees. The stress management training is provided on the first day and taught by instructors with previous ATC experience. Participants completed measures at 3 measurement occasions: immediately before the training ('pretest'), immediately after the training ('posttest'), and 10 days out from their final evaluations in Initial Qualification training ('follow-up'). The follow-up assessments occurred 2 to 4 months after the administration of the stress management training. Due to logistical issues, two classes did not participate in the follow-up assessment; therefore, the final sample at follow-up was 107 trainees. We also conducted interviews with 10 ATC instructors, who taught the online stress management training course, to supplement the data collected from the trainees.

### ***In-Person Training Sample***

To compare the effectiveness of the online format to the previous in-person format, we used archival data from the validation study. This sample included 118 ATC trainees that participated in the stress management training as part of a larger research effort. The training was provided on trainees' first day of Initial Qualification training and was taught by Civil Aerospace Medical Institute (CAMI) researchers. For a detailed description of this study sample, the reader is referred to Torrence et al. (2020). This study also employed a PPF design. However, one key design difference is that the follow-up assessment occurred 1 to 2 months after the stress management training because the training was provided on the first day of Initial Qualification, as opposed to the first day of Basics. This sample served as a non-randomized comparison group for evaluating the effectiveness of the training across delivery formats.

## **Measures**

The same measures used in the Torrence et al. (2020) validation study were administered in this study to enable comparisons across studies. The main outcomes of interest were (a) scores on a stress management knowledge test, (b) ratings of perceived stress management knowledge, and (c) reported confidence in stress management. Additional items were administered to capture trainee reactions to the training.

### ***Stress Management Knowledge Test***

An 11-item multiple-choice test assessed trainee knowledge on the stress and stress management concepts covered during the training. Example items include "Ignoring distractions and stressors while focusing on a present issue is called: (a) compartmentalization, (b) mindfulness, (c) strain, or (d) resilience" and "Strain is: (a) felt primarily in the physical health of

the body as a result of over exposure to stress, (b) felt primarily through the physiological, psychological, and/or behavioral deviation from healthy functioning, (c) felt primarily in one's physiological health as a result of over exposure to stress, or (d) felt primarily in one's behavioral health as a result of over exposure to stress". The knowledge test was administered at pretest, posttest, and follow-up.

### ***Perceived Stress Management Knowledge***

A single item using a scale of 0-10 was used to measure trainee's perceived level of stress management knowledge. The item asked, "On a scale of 0-10, where 0 represents little to no knowledge at all and 10 represents completely knowledgeable, rate your current level of knowledge about stress management". The perceived knowledge item was administered at pretest, posttest, and follow-up.

### ***Trainee Confidence***

Trainee confidence in their own stress management was measured using two items: "How confident are you in your ability to use stress management techniques?" and "How confident are you that stress management techniques can work for your stress management?" Items were scored on a 4-point Likert scale ranging from *not very confident* (1) to *very confident* (4). Both confidence items were administered at pretest, posttest, and follow-up.

### ***Trainee Reactions***

Immediately following the training, trainees responded to seven questions to capture their reactions to the training. The posttest reaction items included "The information in this training is important to my success", "Virtual training is an effective way for learning about stress management", "The stress management virtual training provided sufficient opportunities to practice different stress management techniques", and "The stress management virtual training was provided at the right time in training". During the follow-up assessment, trainees responded to three questions to capture their reactions about the content 2 to 4 months after participating in the training. The follow-up reaction items were "The information presented in the stress management virtual training has been important to my success as the FAA Academy", "The information presented in the stress management virtual training will continue to be important to my success as the FAA Academy", and "The information presented in the stress management virtual training has been reinforced in other parts of training". All items were rated on a 4-point Likert scale ranging from *completely disagree* (1) to *completely agree* (4).

### ***Instructor Interviews***

Semi-structured interviews were conducted with ATC instructors responsible for teaching the stress management training in Virtual Basics. Interviews were conducted to capture instructors' overall feelings toward the stress management training; their thoughts on the specific elements of the training (e.g., online format, training content, pacing, ATC examples); and any



feedback or modifications they would like to see in future stress management trainings. Interviews took approximately 30 minutes to complete.

## **Analytic Approach**

There were two primary set of analyses. The first set of analyses were concerned with evaluating the effectiveness of online stress management training and the second set of analyses were concerned with comparing training outcomes across the two delivery formats. For the first set of analyses, a series of repeated measures analysis of variance (RMANOVA) models were conducted to see if there were statistically significant differences in outcomes across the three time points. Significant effects were followed up with post hoc pairwise comparisons using Bonferroni corrections to adjust p-values.

For the second set of analyses, a 2 (delivery format: online, in-person) by 3 (time: pretest, posttest, follow-up) mixed model analysis of variance (ANOVA) was conducted to assess differences in outcomes across the delivery formats. Delivery format was the between-subjects factor and time was the within-subjects factor. Significant main effects were followed up with post hoc pairwise comparisons using Bonferroni corrections to adjust p-values. Significant interactions were followed up with simple main effects analysis.

Qualitative data collected from the instructor interviews were analyzed using content coding procedures. Responses were reviewed to identify similarities and differences in the instructors' perceptions of the stress management training. From this review, categories summarizing the instructors' responses were extracted to identify the primary content areas or themes. The third author completed the initial coding and theme extraction of interview notes. The first and second authors reviewed and validated the content analysis results.

## **Results**

### **Online Training Effectiveness**

Table 2 presents the means and standard deviations of training outcomes across the three measurement occasions. Figure 1 displays the mean scores for the training outcomes. For the stress management knowledge test, there was a statistically significant difference in knowledge test scores across time points,  $F(2, 204) = 77.66, p < 0.01$ , generalized eta-squared = .24. Post hoc pairwise comparisons revealed that there were statistically significant differences between pretest scores ( $M = 6.44, SD = 1.50$ ) and posttest scores ( $M = 8.48, SD = 1.55; t(102) = -11.0, p < .001$ ) as well as posttest scores and follow-up scores ( $M = 6.84, SD = 1.70; t(102) = 10.2, p < .001$ ). There was no statistically significant difference between pretest scores and follow-up scores on the knowledge test. Given that the number of days between posttest and follow-up differed between classes, a post hoc analysis was performed to determine if the number of days between posttest and follow-up influenced scores on the knowledge test. Results suggest that the number of days between posttest and follow-up was not significantly related to knowledge test

scores at follow-up,  $r(105) = -.17, p = .075$ .

For perceived knowledge ratings, there was a statistically significant difference in perceived knowledge ratings across time points,  $F(1.79, 187.74)^2 = 154.79, p < 0.01$ , generalized eta-squared = .38. Post hoc pairwise comparisons revealed that there were statistically significant differences between all pairwise comparisons. Perceived knowledge at posttest ( $M = 8.08, SD = 1.25$ ) was significantly higher than perceived knowledge at pretest ( $M = 4.57, SD = 2.45; t(105) = -16.2, p < .001$ ) and perceived knowledge at follow-up ( $M = 6.92, SD = 1.69; t(105) = 7.21, p < .001$ ). Perceived knowledge at follow-up was significantly higher than perceived knowledge at pretest,  $t(105) = -10.4, p < .001$ .

**Table 2**

*Mean and Standard Deviations of Outcomes across Measurement Occasions*

	Pretest		Posttest		Follow-Up	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Knowledge Test	6.44	1.50	8.48	1.55	6.84	1.70
Perceived Knowledge	4.57	2.45	8.08	1.25	6.92	1.69
Confidence <sup>1</sup>	2.70	0.88	3.56	0.55	3.08	0.79
Confidence <sup>2</sup>	3.09	0.74	3.60	0.56	3.15	0.77

*Note.*  $N = 103$  for knowledge test.  $N = 106$  for perceived knowledge and confidence<sup>1,2</sup>

<sup>1</sup> “How confident are you in your ability to use stress management techniques?”

<sup>2</sup> “How confident are you that stress management techniques can work for your stress management?”

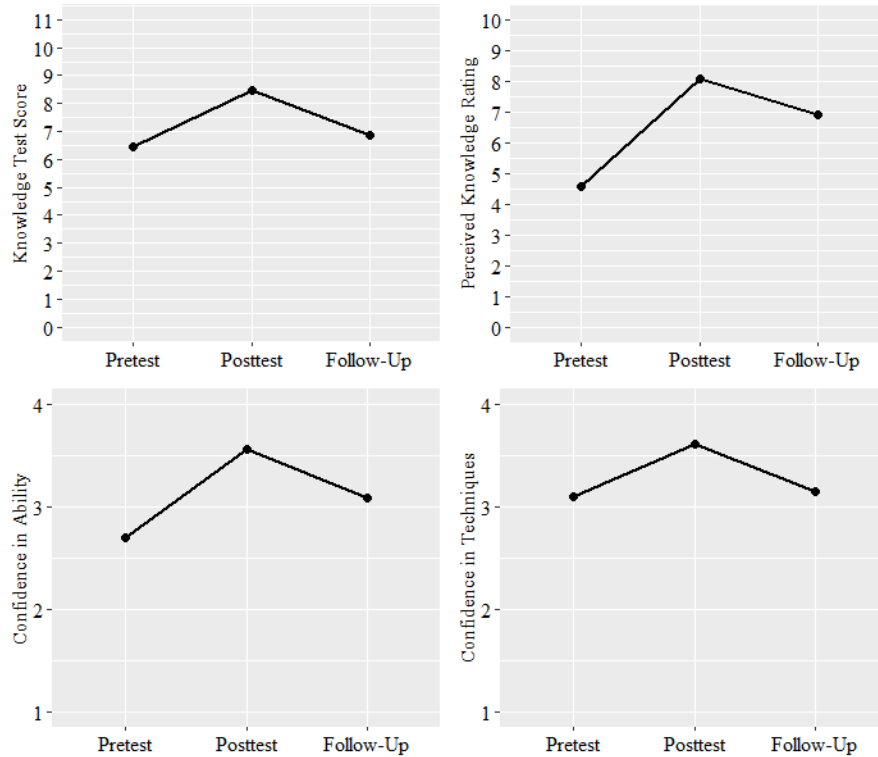
For trainee confidence, there was a statistically significant difference in ratings on confidence in ability to use stress management techniques across time points,  $F(2, 210) = 63.49, p < 0.01$ , generalized eta-squared = .18. Post hoc pairwise comparisons revealed that there were statistically significant differences across all pairwise comparisons. Confidence in ability to use stress management techniques at posttest ( $M = 3.56, SD = 0.55$ ) was significantly higher than pretest ( $M = 2.70, SD = 0.88; t(105) = -11.6, p < .001$ ) and follow-up ( $M = 3.08, SD = 0.79; t(105) = 6.51, p < .001$ ). Confidence in ability at follow-up was also significantly higher than pretest scores ( $t(105) = -4.71, p < .001$ ). There was also a statistically significant difference in confidence ratings that stress management techniques will work for one’s stress management across time points,  $F(1.86, 195.62)^2 = 30.55, p < 0.01$ , generalized eta-squared = .10. Post hoc pairwise comparisons revealed that ratings at posttest ( $M = 3.60, SD = 0.56$ ) were significantly higher than pretest ( $M = 3.09, SD = 0.74; t(105) = -8.45, p < .001$ ) and follow-up scores ( $M = 3.15, SD = 0.77; t(105) = 6.15, p < .001$ ). There was not a significant difference in confidence in

<sup>2</sup> Mauchly’s test indicated that the assumption of sphericity, or equal variance of the differences between repeated measures, was violated. Degrees of freedom were corrected using the Huynh-Feldt estimate of sphericity.

stress management techniques between pretest and follow-up,  $t(105) = -0.72, p = .476$ .

**Figure 1**

*Outcomes in the Online Training at Pretest, Posttest, and Follow-Up*

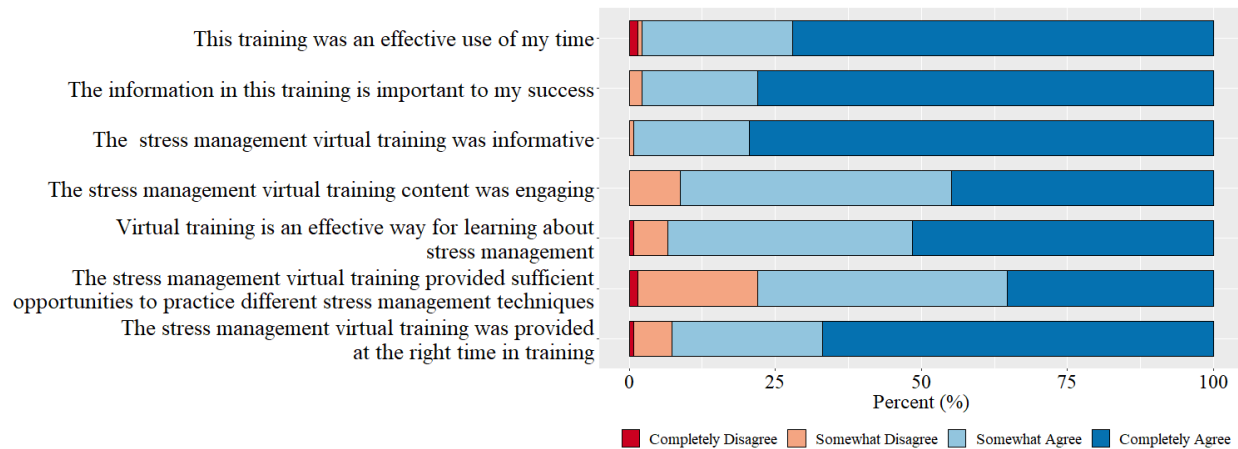


*Note.* Mean scores at pretest, posttest, and follow-up are displayed. Top-left plot displays mean scores on the knowledge test. Top-right plot displays mean ratings on the perceived knowledge item. Bottom-left plot displays mean scores on the confidence item: “How confident are you in your ability to use stress management techniques?” Bottom-right plot displays mean scores on the confidence item: “How confident are you that stress management techniques can work for your stress management?”

In addition to the learning outcomes, we assessed trainee reactions to the training content. At posttest, trainees, on average, had favorable reactions to the stress management training. Figure 2 displays the response distribution for the posttest reaction items. Most trainees agreed that the stress management training: was an effective use of time ( $M = 3.68, SD = 0.57$ ); is important to their success ( $M = 3.75, SD = 0.48$ ); was informative ( $M = 3.79, SD = 0.43$ ); and was engaging ( $M = 3.36, SD = 0.64$ ). Most trainees agreed that virtual training is an effective way to learn about stress management ( $M = 3.44, SD = 0.64$ ) and that the training was provided at the right time ( $M = 3.59, SD = 0.65$ ). While the majority of trainees agreed that the training provided sufficient opportunity to practice stress management techniques ( $M = 3.11, SD = 0.78$ ), it was the item with the highest proportion of disagreement (1.5% = completely disagreed; 20.6% = somewhat disagreed).

**Figure 2**

*Response Distribution of Trainee Reaction Items at Posttest*



At follow-up, trainees, on average, still held favorable reactions toward the stress management training, but there was slightly more disagreement in their reactions. Figure 3 displays the response distribution for the follow-up reaction items. Most trainees agreed that the information presented in the training has been important to their success at the FAA Academy ( $M = 2.80$ ,  $SD = 0.71$ ) and will continue to be important to their success at the FAA Academy ( $M = 2.89$ ,  $SD = 0.73$ ). However, 26.4% and 20.8% of trainees disagreed with each statement, respectively. Finally, 62.4% trainees agreed that the stress management training was reinforced in other parts of training ( $M = 2.66$ ,  $SD = 0.75$ ), with 37.7% disagreeing that the training was reinforced.

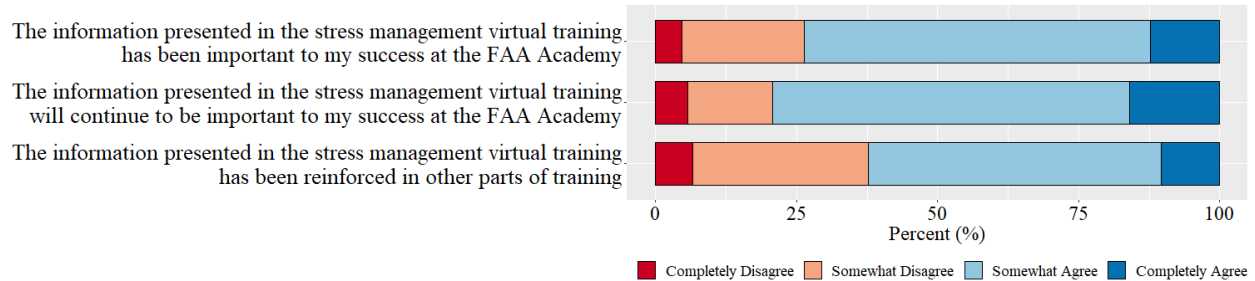
***Instructor Feedback***

Content analysis of the instructor interview data revealed four major themes: training timing, training activities, online format, and classmate camaraderie. In terms of training timing, the instructors generally indicated that the training should be timed such that it is provided to trainees prior to their first stressful event in training. Currently, the training is provided on the first day of Virtual Basics and, as such, instructors believed that trainees could not fully recognize the importance of stress management for training and ATC. Additionally, several instructors suggested that the current training should be supplemented with additional stress management training to reinforce the concepts taught in this initial training. In terms of training activities, there were differences in opinion on the effectiveness of videos for conveying stress management concepts, and some instructors expressed concerns about the length of certain videos and activities. In terms of the online format, instructors did not believe the online stress management differed from the in-person training in terms of effectiveness but did believe that in-person training provided better opportunities for interaction. Relatedly, instructors highlighted the importance of camaraderie among classmates as a stress mitigation resource and important factor for trainee success. Instructors noted that online training might limit the extent to which

trainees can interact and build relationships.

**Figure 3**

*Response Distribution of Trainee Reaction Items at Follow-Up*



### Comparison across Delivery Format

Table 3 presents the means and standard deviations of training outcomes across format and measurement occasion. Figure 4 displays the mean scores for the training outcomes by delivery format. A mixed model ANOVA was performed to test for differences in mean knowledge test scores between formats across the three time points. There was a statistically significant main effect of time,  $F(2, 420) = 134.58, p < .001$ , generalized eta-squared = 0.20, and a statistically significant two-way interaction between delivery format and time,  $F(2, 420) = 7.516, p < .001$ , generalized eta-squared = 0.014. A simple main effects analysis found that delivery format was significant at follow-up,  $F(1, 210) = 9.03, p = .003$ , with scores in the classroom format ( $M = 7.60, SD = 1.93$ ) being significantly higher than the online format ( $M = 6.84, SD = 1.70$ ). For perceived knowledge, a mixed model ANOVA found a statistically significant main effect of time,  $F(1.82, 364.01)^2 = 232.87, p < .001$ , generalized eta-squared = 0.32. However, there was no significant main effect of format,  $F(1, 200) = 0.68, p = .41$ , and no significant two-way interaction between delivery format and time  $F(1.82, 364.01) = 3.05, p = .053$ .

**Table 3**

*Mean and Standard Deviations of Outcomes across Format and Measurement Occasions*

	Pretest		Posttest		Follow-Up	
	Online	Classroom	Online	Classroom	Online	Classroom
Knowledge Test	6.44 (1.50)	6.26 (1.86)	8.48 (1.55)	8.44 (1.83)	6.84 (1.70)	7.60 (1.93)
Perceived Know.	4.57 (2.45)	4.79 (2.50)	8.08 (1.25)	7.58 (1.59)	6.92 (1.69)	6.68 (1.67)
Confidence <sup>1</sup>	2.70 (.088)	2.87 (0.81)	3.56 (0.55)	3.41 (0.64)	3.08 (0.79)	2.97 (0.77)
Confidence <sup>2</sup>	3.09 (0.74)	2.88 (0.81)	3.60 (0.56)	3.30 (0.67)	3.15 (0.77)	2.82 (0.85)

*Note.* Online:  $N = 103$  for knowledge test.  $N = 106$  for perceived knowledge and confidence<sup>1,2</sup>.

Classroom:  $N = 109$  for knowledge test.  $N = 96$  for perceived knowledge.  $N = 110$  for confidence<sup>1</sup>.  $N = 109$  for confidence<sup>2</sup>.

<sup>1</sup> “How confident are you in your ability to use stress management techniques?”

<sup>2</sup> “How confident are you that stress management techniques can work for your stress management?”

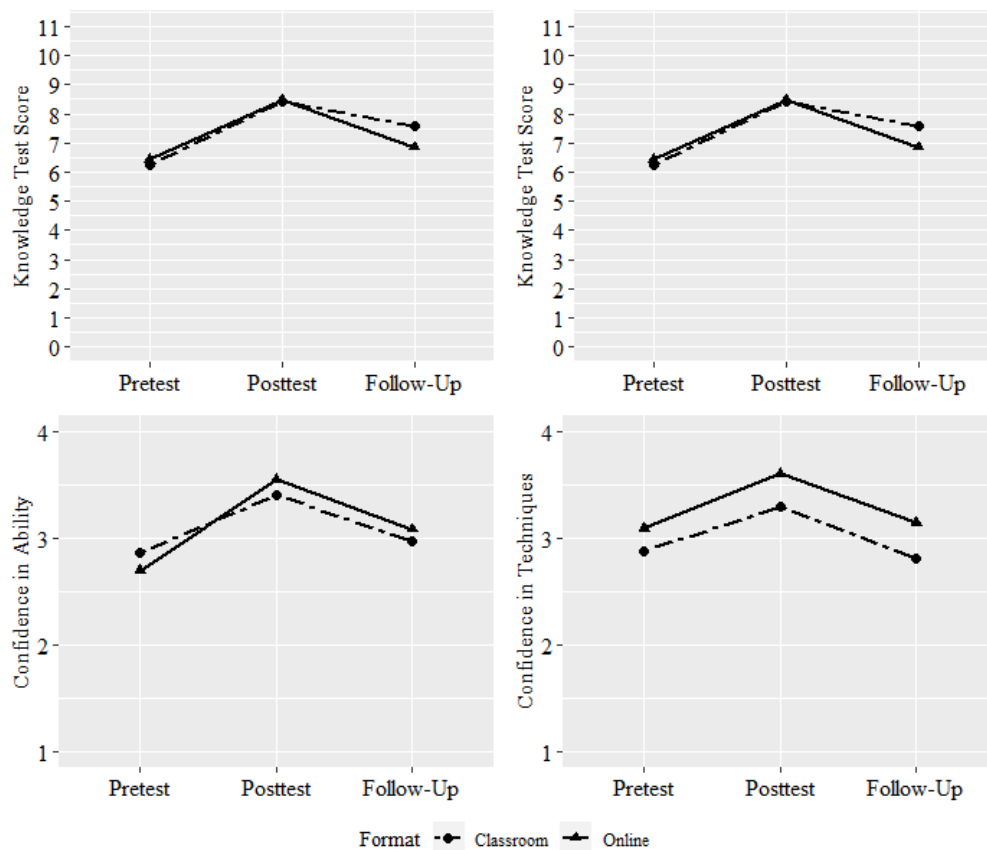
For trainee confidence in ability to use stress management techniques, a mixed model ANOVA found a statistically significant main effect of time,  $F(2, 428) = 85.41, p < .001$ , generalized eta-squared = 0.13, and a statistically significant two-way interaction between delivery format and time,  $F(2, 428) = 5.319, p = .005$ , generalized eta-squared = 0.009. However, simple main effects analysis did not reveal a statistically significant relationship between formats at each time point. For trainee confidence that stress management techniques can work for their stress management, a mixed model ANOVA found a statistically significant main effect of delivery format,  $F(1, 213) = 12.11, p < .001$ , generalized eta-squared = 0.04, and significant main effect of time,  $F(1.92, 409.77) = 54.01, p < .001$ , generalized eta-squared = 0.08. The two-way interaction between delivery format and time was not significant,  $F(1.92, 409.77) = 0.721, p = .487$ . Confidence scores were significantly higher in the online delivery format at all time points: pretest,  $F(1, 213) = 4.06, p = .045$ , posttest,  $F(1, 213) = 12.6, p < .001$ , and follow-up,  $F(1, 213) = 9.15, p = .003$ . To test if significant differences at posttest and follow-up were related to higher pretest ratings, we conducted a post hoc analysis controlling for pretest ratings. These findings suggest format was still significantly related to posttest ratings,  $F(1, 212) = 17.52, p < .001$ , and follow-up ratings,  $F(1, 212) = 11.40, p < .001$ , when controlling for differences in pretest confidence.

## Discussion

It is well documented that the training required to be an air traffic controller is stressful (Barrett et al., 2018; Pierce et al., 2018), and poor stress management can undermine a trainee's ability to perform to their full potential. The ATC stress management training was developed to educate trainees about the stress response, teach lifestyle and in-the-moment strategies for effectively handling stress, and build the stress management capacity of trainees to support their training performance. While initial validation evidence for the ATC stress management training was positive, changes to the training, namely moving from a classroom to online format and moving to an earlier section of FAA Academy training, warranted additional study on its effectiveness.

**Figure 4**

*Comparison of Outcomes by Training Delivery Format at Pretest, Posttest, and Follow-Up*



*Note.* Solid lines represent scores for the online training. Dashed lines represent scores for the classroom training. Means of training outcomes by training delivery format at pretest, posttest, and follow-up. Top-left plot displays mean scores on the knowledge test. Top-right plot displays mean ratings on the perceived knowledge item. Bottom-left plot displays mean scores on the confidence item: “How confident are you in your ability to use stress management techniques?” Bottom-right plot displays mean scores on the confidence item: “How confident are you that stress management techniques can work for your stress management?”

### Online Training

We examined the impact of the online stress management training on gains in stress management knowledge, perceived knowledge, and trainee confidence. We also examined if gains from the training were maintained over time. Findings provide some positive evidence for the online training. First, trainees exhibited positive gains in stress management knowledge from pretest to posttest. However, knowledge score gains were not held over time as knowledge scores, on average, returned to pretest levels at follow-up. The follow-up assessments occurred 2 to 4 months after the stress management training. It is likely that the stress management information was not retained given the amount of air traffic knowledge that trainees must learn

during training and the lack of reinforcement of stress concepts later in training.

Second, trainees exhibited positive gains in perceived stress management knowledge from pretest to posttest. While there was a decrease in perceived knowledge ratings from posttest to follow-up, follow-up ratings were still significantly higher than pretest levels. This suggests that trainees believed they knew more about stress management after the training than before and maintained this belief throughout the remainder of their training. Even though trainees, on average, felt as if they knew more about stress management, this finding does conflict with the evidence above concerning knowledge test scores. While evidence from a post hoc correlation analysis indicates that perceived knowledge does positively correlate with knowledge test scores at follow-up,  $r(105) = .21, p = .027$ , it is interesting that there is a disconnect between the maintenance of objective and perceived knowledge. A potential explanation could be that trainees felt knowledgeable about specific techniques they used during training, but less so about general stress management concepts covered by the test items. Future research should further explore the relationship between actual and perceived stress management knowledge and its impacts on managing stress. For example, does overestimating one's stress management knowledge affect one's ability to appropriately prepare for or manage a stressful event (e.g., performance evaluations)? Does objective or perceived knowledge show a stronger relationship with actual stress management behaviors?

Third, a similar pattern of findings was found for both trainee confidence items from pretest to posttest. Immediately following the training, trainees reported a significant increase in confidence in *ability to use stress management techniques* and confidence that *stress management techniques will work for their stress management*. However, trainees, on average, only rated confidence in *ability to use stress management techniques* higher at follow-up, when compared to pretest. Scores on confidence that *stress management techniques will work for their stress management* at follow-up decreased from posttest scores and were no different from pretest scores.

Finally, trainees had positive reactions to the online stress management training. In particular, over 90% of the ATC trainees thought that the training was an effective use of their time, informative, important to their success, and engaging. The majority of trainees believed that virtual (online) training is an effective medium for learning about stress management. Instructors held similar beliefs that the online format is an effective medium for stress training. Most trainees believed that the stress management training was provided at the right time in ATC training. However, feedback from the instructors somewhat conflicts with this finding as instructors believed the stress management training should occur closer to the first stressful event in training. Lastly, trainees did indicate that the current stress management training may not provide as many practice opportunities as desired, which is supported by instructor feedback regarding the limited interactivity of the online environment. Activities tailored specifically for an online setting may help mitigate concerns about adequate practice opportunities. In addition to providing additional opportunities to apply stress management skills, future research should



examine the efficacy of different methods, such as stress inoculation training (Robson & Manacapilli, 2014), for improving stress management skills in ATC. Specifically, what type of practice activity is best for acquiring or maintaining stress management skills?

At follow-up, trainees still held favorable views about the training. Most trainees viewed the stress management training as important to their current and future success as a controller. Interestingly, fewer trainees agreed that the stress management concepts were reinforced in other parts of training. While these results suggest that trainees recognize and understand the importance of stress management, reinforcing stress concepts and techniques throughout the training program may help trainees better transfer the learned knowledge and skill to other aspects of training, such as tests or lab scenarios. This finding is corroborated by feedback from the instructors regarding the need for follow-up training to reinforce the stress management concepts learned in the training. The timing and frequency of refresher trainings, such as prior to high-stakes evaluations, and its impact on performance may be a question for future investigation.

## **Delivery Formats**

We also examined the effectiveness of the online and in-person stress management training to assess if delivery mode influenced trainee learning. We compared stress management knowledge test scores, perceived knowledge ratings, and trainee confidence ratings between trainees who completed training in the online or in-person format. For knowledge test scores, there was no significant differences at posttest between formats. However, trainees who completed the in-person stress management training had significantly higher scores at follow-up compared to trainees that completed the online training. Given that knowledge scores were similar immediately following training, a potential explanation for the difference at follow-up could be the increased time between posttest and follow-up for the online trainees. As discussed above, the shift to Virtual Basics resulted in the stress management content being delivered earlier in training. As such, stress management is now one of the first content areas taught to newly hired ATC trainees, and without proper refresher or reinforcement training, trainees may be less likely to retain the material because of all the other air traffic content they are learning. Interestingly, there was no difference between delivery formats on perceived knowledge ratings.

For the confidence items, there was no statistically significant difference in *ability to use stress management* across formats as trainees provided ratings at posttest and follow-up. However, there was a significant difference in confidence that *stress management techniques will work for their stress management* ratings across formats. Specifically, trainees who completed the online training reported significantly higher levels of confidence in stress management techniques at posttest and follow-up, even after controlling for differences in pretest ratings. Given that the techniques taught in the online format were the same as the in-person format, the differences may be attributable to source of instruction. CAMI researchers taught the in-person training, whereas ATC instructors taught the online training. Qualitative data gathered

from the online trainees indicated that having an experienced controller teach the concepts and share their previous experiences as a controller added credibility to the content. Instructor experiences illustrated the use of stress management techniques in real events and provided trainees with an example of how stress management techniques can be successfully used in situations that they may face in the future. These examples may also reinforce the value of using stress management techniques during training, consequently encouraging practice and utilization by the trainees. Thus, sharing personal ATC experiences may enhance trainee confidence in using techniques to mitigate stress.

Overall, the online and in-person trainings exhibited similar effects on trainee outcomes, particularly from pretest to posttest. The most noteworthy difference between trainings was the difference in follow-up knowledge test scores in favor of the in-person training. While these findings may be explained by posttest-follow-up time length differences, this finding illustrates the importance of reinforcing stress management concepts throughout the remainder of ATC training, and that the lack of reinforcement may lead to knowledge loss. Importantly, we found relatively small differences between the two delivery formats and the differences found are likely a function of other instructional design features, not the delivery mode.

## **Limitations**

While this study suggests that the online stress management training is effective, several limitations must be noted. First, the online and in-person training groups were not randomly assigned. The lack of random assignment may have influenced the group comparisons because of differences in trainee characteristics and abilities. However, ATC trainees must pass a rigorous selection process before entering the FAA Academy, limiting the potential variance in trainee differences. In addition, the in-person comparison group was archival data from the original validation study. Therefore, there were also timing differences between the groups in terms of when they completed the training. Nevertheless, the potential downsides of using archival data are offset by the fact that it allowed for an evaluation study on delivery formats for a training where randomization is not possible. Lastly, there were instructional and research design differences, such as instructor type and time between posttest and follow-up assessments, which could partially explain the differences across deliver formats.

## **Conclusions**

Effectively managing stress is an important skill as one learns to control air traffic because of the various stressors that trainees face. Even though the ATC stress management training now is taught in an online environment, findings from the current study suggest that the training is still effective in providing initial gains in objective and perceived knowledge as well as trainee confidence. Trainees also had positive reactions to the training content and online training format. However, trainees did not retain all the gains made in training, most notably their stress management knowledge. Recommendations based on this study to improve the

efficacy of the training include providing trainees with increased opportunities to practice using stress management techniques and increased reinforcement of stress management concepts throughout the entirety of ATC training.

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