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DEVELOPMENT AND EVALUATION OF A FATIGUE COUNTERMEASURE TRAINING PROGRAM FOR SHIFTWORKERS

A DISSERTATION APPROVED FOR THE
DEPARTMENT OF PSYCHOLOGY

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Abstract

Due to increasing 24-hour a day operations, a growing population of employees work non-traditional hours. Often associated with extended work periods, variable work schedules, and extensive night work, these schedules conflict with the body's natural mechanisms for managing sleep and alertness, and often result in fatigue. The strategic management of fatigue is necessary for the health, well-being, and safety of workers, and fatigue educational programs may be pivotal. This study develops and evaluates the effectiveness of fatigue countermeasure training for shiftworkers using an integrated taxonomy of learning outcomes, as well as alternative evaluation methods to improve confidence in conclusions. Results demonstrate the effectiveness of thoroughly developed fatigue countermeasure training on affective, cognitive, and behavioral outcomes, and leading to greater use of fatigue management strategies and less fatigue overall.

Development and Evaluation of a Fatigue Countermeasure Training Program for Shiftworkers

As the global economy grows, the need for 24 hour a day operations, and thus shiftworkers increases across industries such as healthcare, manufacturing, safety, and transportation. Shiftworkers often face challenges such as extended work periods, variable work schedules, and extensive night work, and while these operational requirements may be necessary, they are far from ideal with respect to the human body's biological rhythms for managing sleep and alertness. In fact, acute sleep loss, sustained periods of wakefulness, and circadian factors resulting from this form of misalignment are all contributors to fatigue and fatigue-related mishaps (Caldwell, 2005; Rosekind et al., 1996). The strategic control and management of fatigue is necessary for safety improvement throughout many industries, and employee educational programs regarding the dangers of fatigue, the causes of sleepiness, and the importance of proper sleep hygiene to improve sleep quality may be pivotal (Caldwell, 2005). This paper will briefly review the contributing factors to fatigue in shiftwork, the potential benefits of fatigue countermeasure training, and the development of a fatigue countermeasure training program designed for use with shiftworkers across multiple occupations. It will also review training evaluation results for commercial flight attendants, who comprise just one of many occupations in the transportation industry requiring non-standard shifts.

Shiftwork is generally defined as any non-standard schedule where 50% of the hours are worked outside of the 0800 to 1600 time period; designed to cover a 24 hour operation, it may include rotating shifts, evening or night shifts, split shifts, or

extended duty hours (Nesthus, Schroeder, Connors, Rentmeister-Bryant, & DeRoshia, 2007). The goal is often to increase productivity and decrease production costs, but because humans are biologically programmed, the cost to the individual may be high. Approximately 15-20% of the industrialized population engages in some type of shiftwork (Haus & Smolensky, 2006) and may suffer from decreased performance, increased accident risk, or negative health effects as a result (Åkerstedt, 1998; Åkerstedt & Wright, 2009; Costa, 1996, 1997; Haus & Smolensky, 2006). These effects are attributable in part to the effects of fatigue and sleepiness (Rosekind et al., 1996). Fatigue is a multi-dimensional construct (Åkerstedt et al., 2004) involving psychological, physiological, and social components that are used to represent an individual's experience. Most often, fatigue is described as sleepiness or a general tired feeling resulting from reduced sleep or extended wakefulness, working too long, or being unable to sustain a certain level of performance (Åkerstedt, 1995; Dinges, 1995).

Due to disturbances of normal circadian rhythms, especially the sleep/wake cycle, shiftworkers often suffer from fatigue, sleepiness, and unintentional sleep (Åkerstedt, 1995; Costa, 1996). In fact, a majority of shiftworkers admit to falling asleep during the night shift, whereas this is comparatively rare during the day shift (Costa, 1996). This may be due to workers being forced to override the circadian clock and remain awake at night and sleep during the day; further compounding the problem, most workers revert back to daytime activity on their days off (Rosekind et al., 1996). This frequent and continued switching can lead to chronic sleep disturbances and circadian rhythm issues (Tepas & Carvalhais, 1990). Research

indicates that workers on the night shift spend less time in REM sleep and have poorer performance than those working rotating shift or day shifts (Tepas, 1991; Tepas, Walsh, Moss, & Armstrong, 1981). This drop in performance when operating during circadian lows can have serious consequences and has been associated with an increase in accidents. For example, in a study of over 6,000 single vehicle accidents attributed to falling asleep at the wheel, the major peak occurred between midnight and 0700 and was especially pronounced between 0100 and 0400 (Mitler et al., 1988). In 1993, The National Commission on Sleep Disorders Research reported that the physiological alertness of a night shift worker between the hours of 0200 and 0800 is equivalent to a day shift worker who has received only four hours of sleep for two consecutive nights.

Shiftworkers also experience fatigue as a result of the quality and quantity of their sleep and the amount of continuous wakefulness prior to a shift (Caldwell, 2005). There are many factors that interfere with sleep quality and quantity, and a large body of research evidences the negative impact these factors have on performance. For example, non-standard work schedules often do not allow for adequate sleep, which can compromise alertness and lead to drowsiness and inattention on the job (Nesthus et al., 2007). This sleep loss can accumulate into sleep debt, which occurs if an individual experiences successive nights of sleep loss (Shappell, Patterson, & Sawyer, 2007). On average, the basic sleep need for individuals is 8 hours of sleep in a 24 hour period (Dinges, Graeger, Rosekind, Samel, & Wegmann, 1996), and as little as 2 hours of sleep loss can result in an impairment of performance and alertness, and result in an increased likelihood of error or accidents (Carskadon & Roth, 1991; Mitler

et al., 1988). The majority of shiftworkers spend less than six hours per night in bed, including the time it takes time to fall asleep and to wake up (NSF, 2008), and research shows that sleep restriction to five hours per night for seven consecutive nights resulted in increased stress, subjective fatigue, mental exhaustion, physiological fatigue, mood disturbance, tension, and decreased psychomotor vigilance performance (Dinges et al., 1997). Notably, the performance decrements continued past day seven and recovery appeared to require two nights of unrestricted sleep. The amount of continuous wakefulness also contributes to fatigue and alertness issues in shiftworkers. When wakefulness is prolonged to 20 hours, performance on a simulated driving task decreases to a level equivalent to individuals who are legally drunk (BAC = 0.08-0.10%) (Arnedt, Wilde, Munt, & MacLean, 2001; Lamond & Dawson, 1999). Note that these effects are found with time spent awake, not necessarily time spent at work. Individuals with this level of alcohol intoxication are advised not to drive or operate heavy machinery and equipment. Findings suggest that moderate fatigue may produce the same dangerous situation for workers as alcohol intoxication (Lamond & Dawson, 1999). These problems are further compounded by the fact that they may interact to produce progressive declines in alertness and performance (Caldwell, 2005), and may be exacerbated by unfavorable working conditions including time pressure, high workload, prolonged mental or physical exertion, poor scheduling practices, and lack of breaks or rest periods.

Beyond performance problems, there are also health and well-being issues associated with the experience of fatigue and shiftwork (Costa, 1996; Haus & Smolensky, 2006). In the short term, adverse health effects may manifest themselves

as sleep disturbances or irregular eating habits setting shiftworkers up for higher incidences of cardiovascular disease, gastrointestinal disorders, chronic fatigue, anxiety, and depression in the longer term (Costa, 1996, 1997). This research reveals higher rates of miscarriage and pre-term babies as well as increased risk of low birth weights for women. Female shiftworkers also tend to have shorter, more interrupted sleep periods and complain more frequently of chronic tiredness. In part, this may be due to additional domestic responsibilities for those that are married and/or have children. Shiftworkers may also struggle to maintain healthy social and family relationships because these activities are often arranged according to diurnal rhythms of the general population (Costa, 1996). Marital relations, care of children, and social contacts may all suffer as a result of shiftwork and the misalignments of everyday activities.

Fatigue Countermeasure Training

Considering the range of factors that may contribute to fatigue in shiftworkers, it is no surprise that managing fatigue can be a complex and difficult process for this group. One particularly promising approach to the problem of fatigue in shiftworkers is fatigue countermeasure training. Training allows shiftworkers to modify the factors within their control to mitigate the fatigue so frequently experienced by this population. In general, training has demonstrated marked benefits across many areas, including job performance, job knowledge, attitudes, motivation, leadership, and cross-cultural adjustment to name a few (Aguinis & Kraiger, 2009), with a sample-weighted mean of d = .62 for training programs overall (Arthur, Bennett, Edens, &

Bell, 2003). However, of the existing fatigue training programs, few have been formally evaluated.

In 2005, Gander and colleagues evaluated a fatigue management training course using heavy and light vehicle drivers from a large distribution company (Gander, Marshall, Bolger & Girling, 2005). Heavy vehicle drivers were assessed on key concepts using a pretest – posttest administered before and after each training session and by a follow-up survey sent out within 26 months of the initial training. The survey inquired about the usefulness of the training course and about their knowledge and use of fatigue countermeasures. The results indicate a significant change between the pretest and posttest measures of knowledge. Seventy-five percent of drivers thought that the fatigue training was at least moderately useful with 47% changing the fatigue management strategies that they use at home and 49% changing the strategies they use at work. Sixty-one percent of drivers indicated that they would want recurrent fatigue management training to update their knowledge on countermeasure strategies.

For the light vehicle drivers, a more informal follow-up questionnaire assessing the usefulness of training was administered within two years of the initial training. Results of these assessments indicate positive gains on the knowledge test and that the majority of drivers found the training at least moderately useful. A total of 50% reported having changed their fatigue management strategies at home, while 43% had changed their strategies at work. A handful of drivers in this study also communicated that management had made beneficial changes including improved roster designs and increasingly open communication with regard to fatigue.

Using a similar pretest – posttest design, a "Managing a Shiftwork Lifestyle" training course was provided to mining company employees and their spouses or partners in a single, four hour session that included 10-50 people (Kerin & Aguirre, 2005). It has been suggested that training may have the biggest impact when partners are included because shiftwork affects the whole family. The training course itself was meant to "provide factual information on solutions to the special challenges of shiftwork" (p. 202). Before completing the training course, workers filled out sleep/wake logs for a 28 day shift cycle and a questionnaire regarding their sleep habits, lifestyle, family/home life, fatigue, alertness, health and safety to provide a baseline measure of behavior. Six weeks after attending the training session, workers completed the sleep/wake log and the questionnaire again. The differences between the pretest and posttest measures were used to assess the impact of training. Results from the study indicate that six weeks following the training, fewer workers found it difficult to fulfill domestic responsibilities, find time for entertainment and recreational activities, or believed that their health would improve with a different schedule. Workers' average scores on the gastrointestinal index went down as did the use of excessive caffeine. The amount of sleep obtained during daytime hours increased by nearly one hour and more workers reported getting at least five hours of sleep each night. Overall, feedback from managers and workers about the program was very positive.

There is also evidence to suggest that organizational outcomes are associated with the provision of fatigue related training. Large scale surveys about shiftwork facilities have linked fatigue and shiftwork training to lower turnover, lower

absenteeism, fewer fatigue problems, and fewer morale issues for organizations (Kerin & Aguirre, 2005). Fatigue training is also associated with worker perceptions of safety (Arboleda, Morrow, Crum, and Shelley, 2003) and fewer accidents and injuries (Moore-Ede, Heitman, Dawson & Guttkuhn, 2009). A follow-up survey for one training program indicated that over half of respondents surveyed reported that the educational materials were the basis for positive change related to fatigue in their organizations (Rosekind et al., 2001). Even very seasoned long-haul drivers have very positive responses to fatigue training with as high as 96% reporting that they used the course lessons presented during training and intend to continue using them (Dinges, Maislin, Brewster, Krueger & Carroll, 2005).

Clearly the existing evidence supports the use of fatigue related training programs. However, previous research has not deviated much from training tradition and Kirkpatrick's (1959) widely accepted model of training criteria: reactions, learning, behavior, and results. While useful, the approach utilizes a limited view of learning rather than a more integrated approach which can be useful for a more complete evaluation of learning (Kraiger, Ford, & Salas, 1993; Kraiger, 2002). Criticisms of Kirkpatrick's approach include a lack of theoretical grounding, lack of construct clarity, lack of regard for the purpose of evaluation, and lack of support for his assumptions that each level is caused by the previous level, that each succeeding level is more important, and that the levels are all correlated with each other (Alliger & Janak, 1989; Allgier, Tannenbaum, Bennett, Traver, & Shotland, 1997; Kraiger, 2002). This is not to imply that the approach is without merit, simply that a more integrated approach to learning may be used to gain a deeper understanding of the

training process. Through a more comprehensive taxonomy, multiple methods for measuring training success may provide potentially valuable information, and in the case that discrepancies occur may provide valuable insight into the training process and procedure (Goldstien & Ford, 2002). For instance, if training evaluation reveals that trainees have learned the relevant material, but did not transfer that knowledge to the job, it would be useful to know if they did not value the material that was being taught or if they were not motivated to apply the knowledge because they did not view it as useful. This is just one example, but it clearly illustrates the need for multiple training criteria in thorough and useful evaluations.

Additionally, the evaluation methods used to date have been limited in scope, utilizing pretest – posttest measures at best. Although there are often practical limitations, the selection of evaluation methods can affect the conclusions that can be drawn from training and must be carefully considered. For instance, pretest – posttest designs provide information about the changes that take place from the beginning to the end of training, but it does not ensure that the changes are actually the result of training (Shadish, Cook, & Campbell, 2002). One example is that of testing effects, where changes in trainee scores could be the result of being tested on the same material more than once. Pretest – posttest designs are also vulnerable to other threats to internal validity including history, changes in instrumentation, maturation, and statistical regression (Goldstein & Ford, 2002; Shadish et al., 2002).

Finally, the existing fatigue training literature does not include information regarding the development of training content (Gander et al., 2005; Kerin & Aguirre, 2005). A systematic and well documented approach to content development may

provide direction for future training development in this area and a standard for researchers looking to create a comprehensive fatigue training program.

The Current Study

The purpose of the current research was to develop a comprehensive fatigue countermeasure training program for shiftworkers. The program was intended to provide a standard for fatigue training programs with regard to content development and was designed for use across occupations that utilize non-traditional work shifts. A theoretically grounded taxonomy of training criteria was used to assess training success across multiple domains. This was done to improve the training process and provide a more complete picture of learning. Additionally, a pretest-posttest design with follow-up was used in conjunction with two alternative evaluation strategies to provide convergent evidence of training effectiveness. The following hypotheses follow from this discussion:

H1: Performance on cognitive measures will increase from pretest to posttest and follow-up.

H2: Motivation, attitude strength, and self-efficacy will increase from pretest to posttest and follow-up.

H3: Use of fatigue countermeasures will increase from pretest to follow-up.

As discussed previously, shiftworkers are especially prone to experiencing fatigue, sleepiness, physical symptoms, and work-family conflict. This is in large part due to the mismatch of their schedules with the body's circadian rhythms and diurnal schedules of the social environment; however, to the degree that these outcomes are

directly affected by fatigue, better fatigue management should decrease the experience of these outcomes. The following hypothesis follows from this discussion:

H4: Fatigue, sleepiness, the experience of physical symptoms, and work-family conflict will decrease from pretest to follow-up.

Additionally, previous training evaluation methodologies were expanded and improved upon to rule out lingering threats to validity and improve confidence in the conclusions drawn from training evaluation. By using multiple evaluation strategies, training outcomes can be compared to provide convergent evidence for the effectiveness of the training. Two training evaluation strategies that allow evaluators to have a greater confidence in the inferences drawn from evaluation results are the *internal referencing strategy* (IRS) and the *rolling group design* (RGD).

Internal referencing is a useful variant of the pretest – posttest design in which the training evaluator includes both training relevant and training irrelevant items in the pretest and posttest (Haccoun & Hamtiaux, 1994). The idea is that the training relevant items should demonstrate greater improvement following training than the training irrelevant items because the information is actually included in the training content. The irrelevant items serve as a sort of control group for the relevant items. Ideally, all items would be derived from the same topic area, but the information concerning training irrelevant items should not be covered during the training course. This design is especially useful for ruling out threats to validity such as history, maturation, and testing effects, and is not subject to the validity threats that typically plague between subjects designs (Frese, Beimel, & Schoenborn, 2003; Haccoun & Hamtiaux, 1994). Haccoun and Hamtiaux (1994) empirically tested and supported that

IRS produces similar inferences about the effectiveness of training as a pretest – posttest with control group design. However, only a handful of published studies have used this method of evaluation (Aguinis & Branstetter, 2007; Cigularov, Chen, Thurber, & Stallones, 2008; Frese et al., 2003; Haccoun & Hamtiaux, 1994; Oostrom & Mierlo, 2008), and it is sometimes referred to as using a non-equivalent dependent variable design (Shadish et al., 2002). The following hypotheses follow from this discussion:

H5: Change in performance from pretest to posttest and follow-up on declarative knowledge measures will be greater for relevant items than for non-relevant items.

The RGD is another variation of the traditional pretest – posttest design in which a group of individuals who will eventually be trained, serve as a control group until they receive training (Quinones & Tonidandel, 2003). If the first group to receive training is the training group and the second group to receive training is the 'control group', the design allows an evaluation of significant mean differences between 1) the pretest – posttest performance of the training group, 2) the posttest performance of training group and the pretest performance of the control group, and 3) the pretest – posttest performance of control group (Cigularov et al., 2008). Additionally, there should be no significant difference between the pretest scores for the training group and for the control group. This design is similar to a pretest – posttest with a non-equivalent control group and useful when the training will be repeated and there is not access to a pre-designated control group. To date, Cigularov and colleagues have

published the only known example of RGD. The following hypotheses follow from this discussion:

H6: Performance on cognitive measures will increase from pretest to posttest in the training group.

H7: Performance on cognitive measures will increase from the pretest of the 'control group' to the posttest of the training group.

H8: Performance on cognitive measures will increase from pretest to posttest in the 'control group.'

The current study demonstrates the usefulness of fatigue countermeasure training for workers with non-traditional work schedules. Specifically, flight attendants were used to conduct the training evaluation portion of the research. Content analysis of existing fatigue related training programs was conducted, and then supplemented with additional material specific to the flight attendants population. Development of the training program was followed by evaluation using a pretest – posttest – follow-up training design that included internal referencing and the rolling group design to protect against threats to validity. Kraiger, Ford, and Salas's taxonomy of learning outcomes was also used to thoroughly evaluate the training program.

Method

Training Development

Overview.

A multi-method approach was used to develop recommendations for topics to be included in a fatigue management training program. The process began with identification of existing fatigue training programs. These were content analyzed and

used to create a basic outline for a fatigue management training program. An extensive literature review was then used to supplement the basic outline with flight attendant specific information and less frequently cited fatigue topics. Content was developed using existing training programs, empirical literature, expert input, and other relevant sources. A final content check was completed by two subject matter experts who were instructed to examine the training content for deficiencies, excesses, and accuracy.

Acquisition of training programs.

A three-pronged approach was used to acquire information regarding existing fatigue countermeasure training programs, including: 1) a search of scientific literature databases, 2) a general search of public and private educational materials, and 3) a series of inquiries to prominent fatigue researchers. Initially, an extensive literature search was conducted using seven academic computer databases (Academic Search Premier, Business Source Premier, ERIC, E-Journals, Military & Government Collection, PsycARTICLES, and PsycINFO) and the Federal Aviation Administration Civil Aerospace Medical Institute (CAMI) Online Library. Search terms included phrases such as *alertness management, fatigue countermeasures*, *fatigue training*, and *shiftwork training*. To expand the search beyond scientifically published training programs, an internet search was used to locate other publicly and privately available programs. Specifically, the intent was to identify online materials and companies that may have developed or implemented fatigue management training programs. Using Google™ search engine, key phrases such as *fatigue training* and *fatigue risk management* were searched to locate additional resources. The identified companies were then contacted via e-mail to request a copy of training program materials or an

outline of the topics covered. The final method for acquiring existing training programs was to contact prominent fatigue researchers regarding training materials they may have developed or that they had been a part of developing. Responses from companies and researchers alike were very positive (73% response rate), resulting in the collection of 50 training programs.

Inclusion criteria.

After collecting the existing programs, each was reviewed and evaluated using three inclusion criteria: 1) the materials provided education on fatigue, shiftwork, or alertness management, 2) the materials were created or published after 1985, and 3) the materials included at a minimum, at least an outline and summary of the topic areas included in the training program. If a program did not meet all three of these requirements, it was dismissed from further content analysis. Using these criteria, two doctoral students reviewed each of the programs, with 49 programs retained for further analysis (100% agreement; see Appendix A).

Training program characteristics.

The training programs collected for this study included a broad range of educational materials developed for use across multiple industries. Specifically, 22 programs were developed for the transportation industry; 17 programs were developed for general shiftworkers; 6 programs were developed for the general driving population, and 4 programs were included in an "others" category. The training programs were also communicated to workers using a variety of methods, including: video (n=2), web-based courses (n=2), printed materials (n=30), classroom instruction (n=6), combination of the above methods (n=7), and two with unknown approaches.

Due to differences in the source and purpose for development, ten training programs were available only in summary outline form. The majority (n=39) of training programs were available in their entirety for the purposes of this study.

Content analysis of training programs.

Each training program was reviewed to develop a comprehensive outline of the topic-areas that appeared to be important for fatigue education. Once the outline was established, the programs were content analyzed by two doctoral students to identify the presence of each topic area (κ=.85). Decision rules were established indicating that topics must have at least three sentences devoted to it or one specific, prescriptive recommendation. The intent was to quantify the topics included in the training programs by creating a frequency index of how often each topic occurred across various sources. The frequency index thus provided the basis for identifying a list of critical topics for the fatigue countermeasures training program.

Results of the content analysis indicated that each of the topic areas included in the initial outline should be included in the final fatigue countermeasure training program. Fatigue experts consistently agreed on the topics areas necessary for effective fatigue training programs, and differences appeared to be a function of the level of detail and specific focus of the training program (e.g., on-duty countermeasures vs. off-duty countermeasures). As expected, fatigue was a focal topic in all of the training programs (100%). However, not all fatigue-related factors were included with the same degree of frequency across programs. To break this down, topic areas such as sleep, circadian rhythms, nutrition, work hours, and substance use (e.g., caffeine, alcohol) were cited more frequently, while commuting, workload, and

hydration topics were cited less frequently. All topic areas were cited in at least eight of the 49 training programs reviewed and could arguably be included in a comprehensive fatigue training program. Complete results from the content analysis can be seen in Table 1.

Literature search for additional training topics.

To identify additional occupationally specific topics to be included in the recommendations for a fatigue training program for flight attendants, a search of relevant fatigue literature was conducted. Eight computer databases (Academic Search Premier, Business Source Premier, ERIC, E-Journals, Military & Government Collection, PsycARTICLES, and PsycINFO), the CAMI Online Library, and Google were used to search for key phrases such as flight attendant fatigue and flight attendant training. Empirical studies, survey reports, and recent industry recommendations for fatigue risk management were reviewed. An attempt was also made to gather flight attendant specific scientific publications, articles, and presentations. Scientific sources include Federal Aviation Administration (FAA), National Aeronautics and Space Administration (NASA), and peer-reviewed academic journals (e.g., *Aviation, Space, and Environmental Medicine*). Each source identified in the review of the literature was examined for topics not already included following the content analysis. Ultimately, several occupationally specific topics (e.g., time zone changes, night flights, effects of cabin pressure) were identified for inclusion into the recommendations for a fatigue management program.

Organization of training topics.

Following the addition of occupationally specific fatigue topics to the initial list, topics were organized into four primary content areas: fatigue basics, sleep basics, fatigue management strategies, and fatigue outcomes and countermeasures. Within each of the four content areas, topics were broken down to include all relevant information. For instance, the sleep process, circadian rhythms, and sleep disorders are a few of the topics subsumed under the sleep basics section. Special attention was given to factors specific to the job of a flight attendant such as time zone changes and night flying. The final result was a comprehensive topic outline of training materials for a flight attendant fatigue management program.

Development of training content.

Once the training outline had been developed, each topic area was populated with current information and research. Existing training programs that were part of the public domain, empirical literature, and experts were consulted to create the most up to date training material possible. After the information had been compiled, synthesized, and organized in a meaningful way, the entire document was reviewed by multiple experts in the field of sleep and fatigue research. Modifications were made based on this feedback and a final review was conducted. Handout materials were also created to summarize important topic areas and provide take away information.

Note that the majority of the training content was developed to be applicable across jobs that utilize irregular shift schedules. Flight attendants comprised the evaluation sample for the current study, and thus, the core training program was supplemented with occupationally specific information. Appendix B identifies the topics of the core training program, as well as those specific to flight attendants. All

evaluation materials were developed for use with the basic fatigue countermeasure training program and did not reference occupationally specific information.

Training Evaluation

Participants.

A total of 50 domestically based flight attendants volunteered to attend a one day training event. To recruit participants, correspondence was sent to airlines, union representatives, and professional contacts in the aviation industry providing information and a website link to register for the training. Participants were responsible for signing up via the website and selecting one of the three training sessions to attend. They were provided confirmation, travel and lodging information, and a detailed itinerary via e-mail.

Ten flight attendants participated in the first training event, 23 participated in the second, and 17 participated in the third. The mean age was 46.66 years with 72% (n=36) being female and 28% (n=14) being male. The length of time worked in the field ranged from 2.83 years to 38.83 years (M = 11.12). Of the 50 flight attendants who participated, two were dropped from further analyses due to extensive knowledge of fatigue prior to the training (in both instances, the flight attendants held a dual role in the organization that contributed to existing fatigue knowledge). Thirty-one of the 48 flight attendants included in analyses completed both the pretest and posttest, while 18 complete the pretest, posttest, and follow-up.

Instructional delivery.

A traditional PowerPoint lecture and discussion delivery method was used for the training program, with the addition of supplemental materials when appropriate (e.g., short video clips, accident reports, etc.).

Evaluation criteria.

Training criteria were developed in line with the training objectives and training content. Kraiger's (2002) taxonomy of cognitive, affective, and behavioral outcomes was used as a model to increase comprehensiveness and multidimensionality of learning in the assessment. Cognitive outcomes included declarative and self-knowledge, while affective outcomes included motivation, attitude, and self-efficacy. The behavioral outcome to be measured is skill acquisition, or the use of fatigue countermeasures. In addition, outcomes such as fatigue, perceived sleepiness, the experience of physical symptoms, and work-family conflict will also be measured. See Appendix C for additional information and examples.

Evaluation design.

The evaluation approach centered around a pretest – posttest design with the addition of a six week follow-up. Methods such as IRS and RGD were used for the cognitive measures to rule out threats to validity that typically plague pretest – posttest designs and to increase confidence that trainee changes were the result of training.

Procedure.

Flight attendants participated in the fatigue countermeasures training as a part of a one day event hosted by the Federal Aviation Administration. Prior to arrival flight attendants were asked to complete an online survey that included the various pretest measures. The training lasted approximately three hours and was followed

administration of posttest measures. All participants were provided with a handout of the training materials and tools to aid fatigue prevention and management. Approximately six weeks after the initial training, participants were contacted via e-mail and asked to complete a follow-up survey. Up to two reminder e-mails were sent to encourage completion of the follow-up survey. See Appendix D for a complete list of measures assessed at each time point.

Measures.

Affective. Attitude strength and motivation, with regard to fatigue management was assessed using five-item, likert type scales. The attitude scale was developed to measure the value trainees place on fatigue management (alpha =.87). The motivation scale provided information regarding whether trainees see a need to apply fatigue management strategies (alpha =.86). Self-efficacy with regard to fatigue management was assessed using a four-item, likert type scale. The self-efficacy scale was developed to assess the extent to which trainees felt that they were capable of utilizing fatigue countermeasures (alpha = .85).

Cognitive. Declarative knowledge was assessed via recognition and recall of basic fatigue knowledge regarding causes and consequences and fatigue mitigating strategies and appropriate use. Two measures of declarative knowledge were developed: 1) propositional knowledge, and 2) acquiring new information. Propositional knowledge refers to basic information or facts that an individual knows, and was assessed using 15 multiple choice items (alpha = .71). Acquiring new information refers to knowledge an individual can recall and report, and was assessed using an open-ended response format with 18 items. The purpose of the declarative

knowledge measures was to determine whether trainees learned the information necessary to apply fatigue countermeasures on the job and at home.

Training irrelevant items were also developed for inclusion in the declarative knowledge measures. Items were similar in nature to the training relevant items, but focused on the topic of work stress and were not covered as part of the training. Five multiple choice items were included as part of the propositional knowledge measure and 11 possible open-ended responses were included as part of the acquiring new information measure.

Self-knowledge, or articulating awareness, was also assessed using an open-ended response format. A seven item measure was developed to evaluate trainees' ability to explain and differentiate fatigue related concepts and use of countermeasure strategies.

Behavioral. The use of fatigue countermeasure strategies was measured using multiple methods. First, a list of 44 fatigue countermeasure strategies was created and presented using a five-point likert scale measuring the frequency of use. Second, trainees were asked to provide a yes or no response regarding whether they had changed their behavior at home or at work to better manage fatigue. Third, if trainees had altered their behavior to combat fatigue, they were asked to provide the specific steps they had taken in an open-ended response format that was later quantified for analysis.

Additional outcomes. Although not grounded in Kraiger's (2002) taxonomy of training outcomes, several other measures, including fatigue, sleepiness, the experience of physical symptoms, and work-family conflict, were also measured to

determine the impact that fatigue training has on these outcomes. Fatigue was measured using a previously validated self-assessment called the Fatigue Assessment Scale (Michielsen, De Vries, Van Heck, 2003). The measure contained 10 items and utilized a 5-point likert scale (alpha = .75). Daytime sleepiness was assessed using the Epworth Sleepiness Scale (Johns, 1991). The scale contained 8 items and used a 4-point response format (alpha = .77). The experience of physical symptoms was measured using a 19 item checklist of common symptoms experienced by shiftworkers (.83; Spector, 1987). Finally, work-family conflict was assessed using a combined work interfering with family (alpha = .76) and family interfering with work scale (alpha = .82; Netemeyer, Boles, & McMurrian, 1996). Each measure had five items and used a 5-point likert scale.

Results

Due to the relatively small sample that participated in all three training evaluation phases, ANOVAs were used to identify whether significant differences existed between groups on any of the pretest measures. Results indicated that there were no significant differences between groups on pretest measures so all three training groups were combined for further analyses.

Hypothesis 1: Supported

Change in performance on cognitive measures following training was assessed using repeated measures ANOVAs to compare pretest, posttest, and follow-up. The overall ANOVAs were significant for acquiring new information [$F(2, 34)=70.27$, $p<.001$], articulating awareness [$F(2, 34)=103.83$, $p<.001$], and propositional knowledge [$F(1.36, 23.11)=16.58$, $p<.001$]. Note that the assumption of sphericity was

violated in the test of propositional knowledge and as a result the Greenhouse-Geisser correction is reported.

The significant overall ANOVAs were followed up by paired sample t-tests to examine the changes from pretest to posttest and from pretest to follow-up. The Bonferroni procedure was used to adjust the significance level to p=.025 and correct for Type 1 error. The results of these analyses are displayed in Table 2. Training produced significant gains from pretest to posttest and from pretest to follow-up across knowledge measures; thus fully supporting H1. As a result of the training participants were better able to recognize, paraphrase, and differentiate information relevant to effective fatigue management. This effect was significant immediately following training and four to six weeks later during the follow-up evaluation.

Hypothesis 2: Partially Supported

Changes in motivation, attitude strength, and self-efficacy following training were examined using repeated measures ANOVAs. The overall ANOVA for motivation was not significant [F(2, 34)=2.20, p=.13, partial η^2=11]. The overall ANOVA for attitude strength violated the assumption of sphericity and as a result the Greenhouse-Geisser correction was utilized [F(1.44, 24.42)=3.51, p=.06, partial η^2=17]. Additionally, the overall ANOVA for self-efficacy was statistically significant [F(2, 34)=3.76, p=.03, partial η^2=18].

Significant overall ANOVAs were followed up by paired sample t-tests to examine the changes from pretest to posttest and from pretest to follow-up. Note that p value for overall test of attitude strength rounded up to .06 and therefore the decision was made to conduct paired sample t-tests for this outcome. The Bonferroni procedure

was used to adjust the significance level to p=.025 and correct for Type 1 error. The results of these analyses are illustrated in Table 3. With the exception of motivation from pretest to posttest, all affective measures changed in the expected direction following training. The change in attitude strength and self-efficacy from pretest to posttest was statistically significant indicating that participants felt more strongly about fatigue management and their ability to apply fatigue management strategies after participating in the training. Although attitude strength and self-efficacy showed positive effects through the follow-up period, the changes were not significant; thus H2 is partially supported.

Hypothesis 3: Supported

The use of fatigue countermeasures was assessed using a paired sample t-test. Using a checklist response format there was a significant difference between countermeasure utilization when assessed during the pretest (M=140.81, SD=13.19) and during follow-up (M=151.07, SD=13.29), $t(17) = -3.01$, $p<.01$. Also in support of H3, prior to training 44.4% of respondents reported making changes at home compared to 83.3% following the training. Results were similar when participants were asked about use of fatigue countermeasures on the job with 50% reporting making changes prior to training and 83.3 % reporting making changes following the training. When asked in an open response format, the number of strategies being use at home increased by 138.5% following training. The number of fatigue countermeasures used at work increased by 175% from pretest to follow-up.

Hypothesis 4: Partially Supported

Table 4 provides the means and standard deviations for measures of fatigue, sleepiness, physical symptoms, work-family conflict and family-work conflict. Paired sample t-tests were conducted to determine if significant differences exist between outcomes as measured during the pretest and follow-up. Only the Fatigue Assessment Scale demonstrated significant differences indicating that flight attendants experienced less fatigue at the time of follow-up. None of the other aforementioned outcomes were significant; thus H4 is only partially supported.

Hypothesis 5: Partially Supported

Table 5 presents the means and standard deviations for the relevant and irrelevant items of acquiring new information and propositional knowledge. A 2x2 repeated measures ANOVA was used for each outcome to test the main effect of time (pretest or posttest) and relevance (relevant or irrelevant to training), as well the interaction between time and relevance.

The results of the analyses for acquiring new information indicate a significant main effect for the time factor [$F(1, 17)=33.03$, partial $\eta^2 = .66$, $p<.001$] and the relevance factor [$F(1, 17)=99.15$, partial $\eta^2 = .85$, $p<.001$]. The interaction between the time and relevance factors was also significant [$F(1, 17)=137.18$, partial $\eta^2 = .89$, $p<.001$]. These results directly support H5 by demonstrating that the difference in acquisition of new knowledge from pretest to posttest was greater for relevant items than for irrelevant items. This relationship is further illustrated in figure 1.

The results for propositional knowledge indicate a significant main effect for the time factor [$F(1, 17)=32.91$, partial $\eta^2 = .66$, $p<.001$] and the relevance factor [$F(1, 17)=11.26$, partial $\eta^2 = .40$, $p=.004$]. The interaction between the time and relevance

factors was not significant however [$F(1, 17)=2.83$, partial $\eta^2 = .14$, $p=.11$]. These results demonstrate that the difference in propositional knowledge from pretest to posttest was greater for irrelevant items than for relevant items, which does not support H5. This relationship is further illustrated in figure 2. Possible explanations for this finding are discussed below.

Hypothesis 6, 7, and 8: Supported

The means, standard deviations, and t-tests for the RGD are presented in Table 6. To test H6, H7, and H8, the groups from training sessions 2 and 3 were compared to examine differences between pretest and posttest cognitive measures. Training session selection was based solely on the number of participants in each session; sessions 2 and 3 allowed the greatest sample sizes. For the training group, performance on each cognitive outcome was examined using paired sample t-tests. All three cognitive outcomes were significant indicating changes in knowledge between the pretest and posttest for flight attendants who participated in the training. To simulate a control group, the pretest for one of the training sessions was used as a comparison for the posttest for a training group. Differences in the cognitive measures were assessed via independent sample t-tests. As illustrated by the Table 6, comparisons for all three cognitive outcomes were significant. This demonstrates significant knowledge differences between the 'control' group and the post-training group. Finally, there were also significant differences between the pretest and posttest for the 'control' group for all three cognitive measures. Paired sample t-tests were used to assess these differences. All analyses fully supported H6, H7, and H8 indicating that flight attendants were more knowledgeable about fatigue management as a result of training.

Discussion

Overall the results of this study demonstrate the effectiveness of a thoroughly developed fatigue countermeasure training program. By utilizing alternative learning outcomes and multiple evaluation strategies, we are able to gain a better understanding of the learning process and produce convergent evidence of training effectiveness. As a result of the training, participants improved their knowledge of basic fatigue information and strategy use; they acquired new information, were able to articulate awareness, and exhibited greater recognition of effective fatigue countermeasure strategies. Participants also showed improvements in their self-efficacy for addressing fatigue and the strength of their attitudes toward fatigue and the importance they place on fatigue management. In addition, and perhaps most tellingly, training participants demonstrated changes in the level of fatigue experienced and the number of fatigue countermeasure strategies they were using. For example, 41.2% of flight attendants utilized naps for fatigue management following training as compared to only 27.8% prior to training. Flight attendants even received more nightly sleep as a result of training increasing from 6.78 hours per night to 7.37 hours. Together these results provide strong evidence for the effectiveness of the fatigue countermeasure training program.

Use of flight attendants for the present research provided a unique sample with which to evaluate the training program. Although flight attendants are less likely to work around the clock than shiftworkers in some other industries, their work schedules are highly variable and often do not allow for adequate rest between shifts. A combination of very early shifts and very late shifts contribute to a work schedule

where a large portion of the schedule may be worked outside of traditional working hours. As a result, flight attendants, whose primary role is passenger safety, frequently experience increased fatigue beyond those working standard shifts. This study provided an interesting look at the effects of fatigue countermeasure training for a population that is often not considered shiftworkers.

Use of Kraiger, Ford, and Salas's (1993) classification of learning outcomes for the present project provides a more comprehensive understanding of the learning taking place as a result of training. Results clearly demonstrate training effectiveness in terms of cognitive learning outcomes and skill acquisition. Evaluation of affective outcomes revealed that self-efficacy and attitude strength were significantly improved following training, but that motivation was only slightly higher post-training. This finding is interesting considering that participant's attitudes regarding the need to fight fatigue and belief that they could effectively fight fatigue increased as a result of training. The lack of significant improvement in motivation may suggest that the information presented during training was somehow overwhelming for participants. For example, they left training feeling that fatigue was an important issue and that they were capable of applying fatigue countermeasure strategies, but perhaps the magnitude of the changes that would need to be made were simply overwhelming. Alternatively, given that there was an increase in motivation at the time of follow-up, perhaps the power for this test was lacking and the more subtle effect was undetectable.

Additional training outcomes such as sleepiness, physical symptoms, work-family conflict, and family-work conflict were not found to be significantly different following training. It is possible that fatigue simply does not affect these outcomes,

but it is probably more likely that the time frame of four to six weeks for the follow-up measurement was not sufficient. It would be necessary for flight attendants to implement sufficient fatigue countermeasures to not only directly affect fatigue, but also affect these additional outcomes as a result of being less fatigued. Since fatigue is a potential contributor to such a variety of potential outcomes, this is certainly are area of research that deserves more attention.

The present study also provides support for the use of alternative training evaluation strategies including IRS and RGD. Rather than relying solely on pretest – posttest designs which are vulnerable to the effects of history, testing, and maturation, IRS and RGD methodologies were employed to provide greater confidence in the validity of the training results. Previously IRS had only been applied to propositional knowledge, or recognition of declarative knowledge on multiple choice tests (Cigularov, Chen, Thurber, & Stallones, 2008; Haccoun & Hamtiaux, 1994). This research examines whether IRS is effective for higher level learning outcomes such as the acquisition of new knowledge. Specifically, IRS provided evidence of greater knowledge acquisition for information covered during the course of training as opposed to information not a part of the training. This suggests that IRS is effective for higher level learning outcomes and can be employed more broadly as an evaluation strategy. The IRS results for propositional knowledge were not as supportive, with training irrelevant items demonstrating improvement along with training relevant items. In retrospect, it is likely that the topic chosen for the irrelevant items is partially to blame for improvement from pretest to posttest. Many of the same coping strategies could be applied to either topic, so when presented with multiple choice items

participants were more likely to guess correctly even though information specific to the irrelevant items had not been included in the training. Additionally, there may have been a bit of a ceiling effect for the relevant propositional items. Nearly 75% of the items were answered correctly during the pretest and 90% were answered correctly during the posttest. It is possible that these scores do not leave enough room for improvement thereby mitigating the effect. Overall, results of the IRS support further use of this evaluation strategy as a method of strengthening traditional pretest – posttest designs.

The RGD also appears to be a viable alternative for strengthening traditional training evaluation designs. As hypothesized, results indicated meaningful differences between pretest measures of a designated control group and the posttest measures of a training group. Use of a control group that will eventually complete training allows us to have greater confidence in the training results and helps to protect against potential threats such as testing effects, history, or maturation. While this evaluation design is not widely cited in the empirical literature, it certainly poses an alternative for real-world settings where constraints inhibit the use of actual control groups or other more thorough evaluation designs.

The current study suffers from several limitations that the reader should be cognizant of when interpreting the results. First, the overall power of the study is lacking due to the small sample size. Many outcomes demonstrated significant results in spite of this, but it remains possible that fatigue countermeasure training has the potential to affect outcomes such as motivation, sleepiness, work-family conflict, or the experience of physical symptoms. The current study cannot provide conclusive

results. Next, a four to six week follow-up was utilized for the final measurement period. It is possible that a shorter or longer timeframe could affect the results. In many ways, fatigue countermeasure training centers around making life changes. Making these changes takes time, as does seeing positive consequences as a result. Alternatively, it may be possible that training participants made changes immediately following the training, but will revert back to prior behavior over time. Finally, the training was evaluated using only one occupational group. Although developed in such a way as to promote cross-industry effectiveness, it is possible that the fatigue contributors addressed in the training were appropriate for flight attendants, but not other occupations.

Given the multi-industry development of this training program, it is likely that the positive effects will generalize to other populations who deal with similar non-traditional schedules and other occupational conditions that contribute to fatigue. Although tailored toward the specific challenges faced by flight attendants, much of the training information is basic knowledge about fatigue and effective prevention and management strategies. It seems likely that the training program that could be useful across industries. Given the effect fatigue may have on safety related behavior and the potential for workplace accidents or incidents, fatigue countermeasure training could be an effective prevention strategy for many organizations (Caldwell, 2005; Rosekind et al., 1996). Only 14.6% of flight attendants reported having received any fatigue education or training, but nearly all report experiencing fatigue. The results from this training program as well as others suggest that it is an effective strategy for reducing fatigue and promoting other positive outcomes. Taken together, this suggests that

fatigue countermeasure training should be utilized more frequently as an intervention strategy for workers with non-traditional schedules.

Future research should consider not only use of the training program across other industries, but also tying the training to safety behavior and other long-term organizational outcomes. Due to the low occurrence of accidents and incidents for flight attendants, this was not considered in the present study, but it certainly has implications for the widespread use of the training. Additionally, the training may lend itself well to computer based training which would increase the usability and cost-effectiveness. Another area for further exploration is the use of IRS with skill acquisition or behavioral outcomes. To date there is no existing research examining the appropriateness of IRS for behavioral outcomes. Most importantly, future research should focus on implementation and utilization of the training program for the benefit of workers.

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Appendix A

List of Educational Materials by Industry

General

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Appendix B

Training Course Topics

I. Fatigue Basics
   a. Prevalence of fatigue
   b. Consequences of fatigue
   c. Impact on performance
   d. Research and examples
   e. Existing regulations
   f. Training effectiveness
   g. Definition of fatigue
   h. Common misconceptions
   i. Contributors to fatigue
   j. Symptoms of fatigue
   k. Components of fatigue

II. Sleep Basics
   a. Sleep basics
   b. The sleep process
   c. Circadian rhythms
   d. Sleep disorders
   e. Sleep quantity and quality
   f. Sleep debt

III. Fatigue Management Strategies
   a. Workload
   b. Work environment
   c. Primary fatigue factors
   d. Alternative work schedules
   e. Flight duration and types
   f. *Transmeridian flights*
   g. Additional fatigue factors
   h. Resisting fatigue

IV. Fatigue Outcomes and Countermeasures
   a. Commuting
   b. Jet lag and shift lag
   c. Family and social life
   d. Impact on health
   e. Good sleep habits
   f. Sleep environment
   g. Napping
   h. Exercise
   i. Nutrition and hydration

j. Caffeine, alcohol, and nicotine
k. Sleep aids

Note: Italicized topics are occupationally specific.

Appendix C

Training Criteria

Affective

Motivation

1. Exerting effort
    a. measurement – questionnaire
    b. example – effort directed towards fatigue management

Attitude

2. Attitude object & strength
    a. measurement – questionnaire
    b. example – direction and strength of attitudes toward fatigue management
3. Self-efficacy
    a. measurement – questionnaire
    b. example – the extent to which a trainee believes that he/she can apply the training back on the job

Cognitive

Declarative Knowledge

1. Propositional knowledge
    a. measurement – recognition, recall
    b. example – recognize effective fatigue management strategies, state effective fatigue management strategies
2. Acquiring new information
    a. measurement – paraphrase
    b. example – list two the two primary causes of fatigue

Self-Knowledge

1. Articulating awareness
    a. measurement – self report explaining or differentiating
    b. example – explaining when particular countermeasures are appropriate for use and when they are not

Behavioral

Skill Acquisition

1. measurement – questionnaire, behavioral checklist
2. example – what fatigue management behaviors have changed or are performed more frequently as a result of training and asking how behavior has changed at home or on the job since training

Other

Fatigue

1. measurement – questionnaire
2. example – asking about the degree to which physical or mental fatigue is an issue

Sleepiness

1. measurement – questionnaire
2. example – asking about the likelihood of falling asleep in various situations

Physical symptoms

1. measurement – questionnaire
2. example – asking about the frequency of experiencing certain physical symptoms

Work-family conflict

1. measurement – questionnaire
2. example – how often your job prevents you from attending important family events

Appendix D

Affective Evaluation

Motivation

1. How often do you consciously think about ways to keep from feeling fatigued?
2. How frequently do you change your behavior or schedule to keep from feeling fatigued?
3. How much planning do you do to keep from feeling fatigued?
4. How much effort do you put towards avoiding fatigue?
5. How motivated are you to avoid feeling fatigued?

Attitude strength

1. How important do you think it is to not be fatigued while on duty in your line of work?
2. To what extent do you feel that managing fatigue is important?
3. How committed are you to managing fatigue?
4. How often do you talk to others (co-workers, friends, family) about fatigue management?
5. How often do you think about what you can do to manage fatigue?

Self-efficacy

1. How confident are you that you can apply the strategies learned in training?
2. To what extent do you think you can successfully manage fatigue?
3. To what extent do you think that you can apply strategies to manage fatigue at home?
4. To what extent do you think that you can apply strategies to manage fatigue on the job?

Cognitive Evaluation

Propositional knowledge – training relevant

1. Which of the following is **not** a primary contributor to fatigue?
    a. being an early morning or a late night person.
    b. the amount of continuous wakefulness.
    c. the circadian rhythm.

2. When working shiftwork
    a. your body will eventually adapt to the schedule.
    b. your performance level at night is similar to during the day.
    c. your body does not adjust well to the schedule.

3. The effect of sleep loss on mental performance

a. takes 2-3 days to become noticeable.
b. is similar to the effect of alcohol on performance.
c. can be overcome with will power.

4. Which of the following is **not** true about sleep?
    a. it is a basic physiological need similar to the need for food and water.
    b. being disrupted while sleeping doesn't affect the restfulness if you are able to return to sleep.
    c. it is a process of multiple stages and is more restful during some stages than others.

5. Fatigue can be overcome by
    a. will power.
    b. caffeine.
    c. sleep.

6. Which of the following is **not** associated with chronic sleep loss?
    a. eventual adaptation to less sleep.
    b. increased likelihood of infection.
    c. obesity.

7. As people age
    a. they need less sleep because they aren't as active.
    b. they have more difficulty sleeping.
    c. they need more sleep to feel rested.

8. Which of the following can you do before bed to help you sleep?
    a. follow a regular bedtime routine.
    b. have a glass of wine or a beer.
    c. watch TV.

9. Which of the following is true about napping?
    a. short naps should be kept to less than 45 minutes.
    b. short naps don't do much to increase alertness.
    c. long naps can replace lost sleep.

10. Which of the following is least likely to disturb sleep?
    a. noise from a television.
    b. light from the street.
    c. a cool room temperature.

11. Which of the following is **not** true about the body's internal clock (the circadian rhythm)?
    a. it regulates sleep and wakefulness.
    b. it can be changed to match a shiftwork schedule.

c. it can affect performance if not aligned with the external environment.

12. Which of the following is **not** true about caffeine?
    a. the effects last around 4 to 6 hours.
    b. it can cause frequent urination.
    c. it is more effective in the morning than the afternoon.

13. To catch up on missed sleep you should
    a. get two nights of uninterrupted sleep.
    b. make it up hour for hour.
    c. take naps to make up the time lost.

14. When are the two main circadian lows?
    a. 0300 – 0500 and 1500 – 1700
    b. 0200 – 0600 and 1400 – 1800
    c. 0000 – 0200 and 1200 – 1400

15. Which of the following is **not** an effective strategy to avoid falling asleep while driving?
    a. strategic use of caffeine
    b. turning up the radio
    c. take a nap before starting

Propositional knowledge – training irrelevant

1. Which of the following is **not** considered a primary contributor to job stress?
    a. poor communication.
    b. workload.
    c. lack of control.

2. Occupational stress is the result of what?
    a. mostly worker characteristics.
    b. an interaction between worker and job characteristics.
    c. mostly job characteristics.

3. Which of the following is **not** a common approach by organizations to reduce occupational stress?
    a. stress management training.
    b. additional time off.
    c. offering alternative work schedules.

4. The experience of occupational stress
    a. has both an emotional and physical component.
    b. has an emotional, but no physical component.

c. has a physical, but no emotional component.

5. Prolonged occupational stress is **not** likely to cause which of the following?
    a. high blood pressure.
    b. gastrointestinal issues.
    c. cancer.

Acquiring new information– training relevant

1. List five strategies that can help daytime sleep.

2. The groggy and disoriented feeling that you often have upon waking up from sleep or a nap is called what? How long does it typically last?

3. List two factors that may disrupt your sleep without waking you up.

4. What are three common health problems experienced by shift workers?

5. There are three categories of fatigue symptoms that may be observed at work or away from work: physical, mental, and emotional. List two examples of fatigue symptoms for each category of symptoms.

Acquiring new information– training irrelevant

1. List five symptoms of job stress.

2. List four contributors to job stress.

3. Stress management training is often used by organizations to improve the ability of workers to cope with difficult work situations and on the job stress. What are the two major disadvantages to these programs?

Articulating Awareness

1. Please explain when it is appropriate to use caffeine to enhance alertness and when it is not.

2. How does a pre-bed routine help you get to sleep?

3. Please explain when it is appropriate to use naps to enhance alertness and when it is not.

4. Why shouldn't we rely on workers to report when they are fatigued?

5. Drinks that contain caffeine, such as coffee, tea, cola, and energy drinks may help to increase your alertness levels. However, if you consume drinks like these frequently throughout the day, caffeine will not be as effective at improving your alertness. Explain why.

Behavioral Evaluation

1. Have you changed your behavior at home in an effort to manage fatigue? How?
2. Have you changed your behavior on the job in an effort to manage fatigue? How?

How often do you engage in each of the following behaviors for the purpose of managing fatigue? *note: strategies may be used for staying awake or for getting sleep as appropriate*

1 **Never**	**2** **Rarely**	**3** **Sometimes**	**4** **Often**	**5** **Always**

1. Exercise regularly
2. Skip exercise
3. Stretch muscles
4. Take walk
5. Use strength training exercises
6. Use cardio exercises
7. Avoid exercising within 3 hours of bed
8. Exercise right before bed
9. Eat nutritious meals
10. Eat multiple meals or snacks
11. Eat "quick" food even though it may be unhealthy
12. Avoid large meals or heavy food before bed
13. Take vitamins
14. Drink plenty of water
15. Use caffeine (e.g., energy drinks, coffee, soda)
16. Use stimulants besides caffeine
17. Avoid caffeine within several hours of bed
18. Use tobacco
19. Avoid cigarettes before bed
20. Use alcohol to relax before bed

21. Avoid alcohol for several hours before bed
22. Use a pre-sleep routine
23. Use bedroom only for sleep and relaxation
24. Modify sleeping environment
25. Watch TV in bed before going to sleep
26. Block out noise from bedroom
27. Block out light from bedroom
28. Keep room temperature cool
29. Stick to a consistent bedtime – even on days off
30. Watch the clock once in bed
31. Take naps
32. Get sufficient sleep on days off
33. Turn off or silence your phone when sleeping
34. Ask others not to disturb you/do not disturb sign
35. Sleep less on days off to get things done
36. Get out of bed if you can't fall asleep
37. Use relaxation techniques (e.g., meditation, yoga, tai chi)
38. Take cold shower
39. Increase exposure to bright light (e.g., sun)
40. Change work schedule
41. Socialize with others
42. Get up and move around
43. Use sunglasses if returning home in the early morning
44. Take breaks/utilize available breaks
45. Communicate with friends and family about your schedule

Additional Evaluation

Fatigue: Fatigue Assessment Scale (Michielsen, De Vries, Van Heck, 2003)

Sleepiness: Epworth Sleepiness Scale (Johns, 1991)

Physical Symptoms: Physical Symptoms Inventory (Spector, 1987)

Work-family Conflict: Work-family Conflict and Family-work Conflict (Netemeyer, Boles, & McMurrian, 1996)

Appendix E

Pre-training assessment

- Basic demographics and information
- Motivation
- Attitude strength
- Self-efficacy
- Propositional knowledge
- Acquiring new information
- Articulating awareness
- Skill Acquisition
- Fatigue
- Sleepiness
- Physical symptoms
- Work-family conflict

(training)

Post-training assessment

- Motivation
- Attitude strength
- Self-efficacy
- Propositional knowledge
- Acquiring new information
- Articulating awareness

(4-6 weeks)

Follow-up assessment

- Basic information (limited)
- Motivation
- Attitude strength
- Self-efficacy
- Propositional knowledge
- Acquiring new information
- Articulating awareness
- Skill Acquisition
- Fatigue
- Sleepiness
- Physical symptoms
- Work-family conflict

Table 1.

Existing TtrainingMmaterials

	Overall			*Aviation Specific*		
Topics	*# T*[a]	*Total T*[b]	*% T*[c]	*# T*[a]	*Total T*[b]	*% T*[c]
Fatigue	49	49	100%	13	13	100%
Definition	21	49	43%	10	13	77%
Symptoms	33	49	67%	12	13	92%
Causes	36	49	73%	13	13	100%
Consequences	45	49	92%	13	13	100%
Mental	40	45	90%	13	13	100%
Physical	41	45	91%	13	13	100%
Health/Well-being	34	45	76%	12	13	92%
Digestive	16	34	47%	4	12	33%
Cardiovascular	16	34	47%	4	12	33%
Mood	24	34	71%	11	12	92%
Circadian Rhythm	40	49	82%	13	13	100%
Sleep	44	49	90%	13	13	100%
Cycle	22	44	50%	10	13	77%
Debt	26	44	59%	12	13	92%
Quantity	39	44	89%	13	13	100%
Quality	35	44	80%	13	13	100%
Napping	30	49	61%	12	13	92%
Work Hours	35	49	71%	10	13	77%
Shiftwork	28	34	82%	9	10	90%
Overtime/Extended Hours	19	34	56%	5	10	50%
Shift Scheduling	25	34	74%	8	10	80%
Nutrition	34	49	69%	11	13	85%
Hydration	15	49	31%	7	13	54%
Exercise	30	49	61%	11	13	85%
Substances	35	49	71%	12	13	92%
Alcohol	30	34	88%	12	12	100%
Caffeine	33	34	97%	12	12	100%
Nicotine	14	34	41%	6	12	50%
Other Drugs	26	34	76%	8	12	67%
Sleeping Disorders	26	49	53%	10	13	77%
Workload	8	49	16%	3	13	23%
Family & Social Life	26	49	53%	5	13	38%
Work Environment	22	49	45%	6	13	46%
Commuting	17	49	35%	5	13	38%
Jet Lag (if applicable)	10	10	100%	8	8	100%
General Countermeasures	40	49	82%	10	13	77%

Table 1 continued.

Existing Training Materials

Topics	*Programs*[d]
Fatigue	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33, 34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49
Definition	2,9,10,11,16,18,20,22,23,24,25,26,27,29,30,42,44,45,46,47,48
Symptoms	1,2,3,4,5,8,9,11,15,16,18,19,20,22,23,24,25,26,27,28,29,30,31,35,36,42,43,44,45,46,47,48, 49
Causes	2,5,6,7,8,9,10,11,15,16,18,19,20,21,22,23,24,25,26,27,28,29,30,32,33,35,36,38,40,41,42,45, 46,47,48,49
Consequences	1,2,3,5,6,7,8,9,10,11,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34, 35,36,37,39,40,41,42,44,45,46,47,48,49
Mental	2,3,5,6,9,10,11,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,33,34,35,36,37,39, 40,41,42,44,45,46,47,48,49
Physical	1,2,3,5,6,9,10,11,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,33,34,35,36,37, 39,40,41,42,44,45,47,48,49
Health/Well-being	1,2,3,5,6,9,10,11,13,14,15,16,17,18,20,21,22,23,24,25,26,27,28,29,30,36,37,40,42,44,45,47, 48,49
Digestive	1,3,6,9,10,11,14,15,17,18,22,27,30,42,45,48
Cardiovascular	1,3,6,9,10,11,14,15,17,18,22,27,30,42,45,48
Mood	2,3,6,9,10,11,13,16,20,21,22,23,24,25,26,27,28,29,30,36,42,45,48,49
Circadian Rhythm	1,3,4,5,6,7,9,11,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,35,36,38, 39,43,44,45,46,47,48,49
Sleep	1,3,4,5,6,7,9,10,11,12,13,14,15,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,35,36, 37,38,39,40,41,43,44,45,46,47,48,49
Cycle	1,3,5,6,9,18,19,22,23,24,25,26,27,29,30,35,37,39,44,46,48,49
Debt	1,4,9,11,18,19,20,21,22,23,24,25,26,28,29,30,32,33,35,36,38,40,44,47,48,49
Quantity	1,3,4,5,6,9,10,11,13,14,15,17,18,19,20,21,22,23,24,25,26,27,28,29,30,32,33,35,36,37,39,40, 41,44,45,46,47,48,49
Quality	1,3,4,9,12,13,14,15,17,18,19,20,21,22,23,24,25,26,27,28,29,30,35,36,37,39,40,41,43,44,45, 46,47,48,49
Napping	1,3,6,11,12,13,15,18,19,21,22,23,24,25,26,27,28,29,30,31,32,33,35,36,43,44,45,47,48,49
Work Hours	1,3,4,5,6,9,11,13,14,15,17,18,20,21,22,23,24,25,26,27,30,33,35,36,37,39,40,41,42,44,45,46, 47,48,49
Shiftwork	1,3,4,5,6,9,11,13,14,15,17,18,20,21,22,23,24,25,26,27,33,35,37,44,45,46,48,49
Overtime/ Extended Hours	9,11,13,14,15,18,23,24,25,26,35,36,40,41,42,45,46,48,49

Shift Scheduling	3,6,9,11,13,14,15,17,18,21,22,23,24,25,26,27,35,36,37,44,45,46,47,48,49
Nutrition	1,3,5,6,7,9,10,12,13,14,15,17,18,19,21,22,23,24,25,26,27,29,30,32,35,36,37,39,43,44,45,47, 48,49
Hydration	1,17,18,23,24,25,26,27,29,36,40,41,43,47,49
Exercise	1,3,4,5,7,9,13,14,15,17,18,19,21,22,23,24,25,26,27,29,30,35,36,37,39,43,44,45,48,49
Substances	1,3,4,5,6,7,9,10,11,13,14,15,18,19,21,22,23,24,25,26,27,28,29,30,31,32,35,36,43,44,45,46, 47,48,49
Alcohol	1,3,4,5,6,9,10,11,13,14,15,18,19,21,22,23,24,25,26,27,28,29,30,31,35,36,45,47,48,49
Caffeine	1,3,4,5,6,9,10,11,13,14,15,18,19,21,22,23,24,25,26,27,28,29,30,31,32,35,36,43,44,45,47,48, 49
Nicotine	1,3,5,13,14,18,19,21,26,27,30,36,47,48
Other Drugs	1,3,4,5,6,7,9,13,14,15,18,21,23,24,25,27,29,30,32,35,36,43,45,46,48,49
Sleeping Disorders	1,4,9,13,14,18,19,21,23,24,25,27,28,29,30,32,33,35,36,40,41,44,45,46,48,49
Workload	11,15,16,24,25,29,40,46
Family & Social Life	1,3,4,5,6,7,11,12,13,14,15,16,17,18,20,21,22,27,31,35,36,39,43,45,47,48
Work Environment	1,3,5,9,13,14,15,16,17,20,22,23,24,25,29,33,35,40,41,45,47,48
Commuting	1,3,4,6,9,10,11,13,18,21,22,27,30,39,40,41,48
Jet Lag (if applicable)	18,19,20,23,24,25,28,29,46,49
General Countermeasures	1,3,4,5,6,7,8,9,10,11,12,13,15,16,17,19,22,23,24,25,26,27,29,30,31,32,33,34,35,36,37,38, 39,40,43,44,45,47,48,49

Notes: [a] Number of training programs that included information on the topic area.

[b] Total number of training programs included in the percentage calculations based on category breakdowns.

[c] Percentage of training programs that included information on the topic area.

[d] Programs that included the topic area.

Table 2.

Means, SDs*, and Paired Sample t-tests of Cognitive Training Outcomes*

	Pretest		Posttest		Follow-up		Pre–post	Pre–follow-up
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*t*	*t*
Acquiring new information	45.68	21.27	91.36	9.57	87.45	12.75	-8.90*	-10.08*
Articulating awareness	24.6	20.68	88.1	10.1	84.09	17.02	-15.12*	-10.08*
Propositional knowledge	74.07	18.28	90.37	8.32	90	8.63	-4.00*	-4.90*

Note . *p <.001

Table 3.

Means, SDs*, and Paired Sample t-tests of Affective Training Outcomes*

	Pretest		Posttest		Follow-up		Pre–post	Pre–follow-up
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*t*	*t*
Motivation	17.61	3.09	17.39	2.7	18.28	3.12	0.53	-1.39
Attitude strength	18.78	2.34	20.06	2.31	19.94	2.69	-2.64*	-1.72
Self-efficacy	13.89	2.19	14.94	2.82	14.56	2.91	-2.49*	-1.8

Note. *p <.025

Table 4.

Means, SDs, and Paired Sample t-tests of Additional Training Outcomes

	Pretest		Follow-up		Pre–follow-up
Variable	*M*	*SD*	*M*	*SD*	*t*
Fatigue Assessment Scale	2.56	0.52	2.33	0.53	1.91*
Epworth Sleepiness Scale	9.17	2.9	8.6	3.83	0.44
Physical symptoms	36.89	9.99	35.86	9.97	0.92
Work-family conflict	14.72	3.85	15.67	4.34	-0.91
Family-work conflict	8.44	2.68	8.11	3.23	-0.47

Note. *$p < .05$, one-tailed

Table 5.

Means and SDs *of Training Outcomes Based on the Internal Referencing Strategy*

	Relevant items				Irrelevant items			
	Pretest		Posttest		Pretest		Posttest	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Acquiring new information	45.68	21.27	91.36	9.57	33.33	18.18	37.37	16.47
Propositional knowledge	74.07	18.28	90.37	8.32	56.67	21.96	85.56	13.38

Table 6.

Means, SDs, and t-tests of Training Outcomes Based on the Rolling Group Design

	Training Group				Control Group						
	Pretest		Posttest		Pretest		Posttest				
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	t^a	t^b	t^c
Acquiring new information	9	3.57	16.56	1.13	6.92	3.43	15.86	1.83	6.90*	5.33*	8.26*
Articulating awareness	2.11	1.36	5.89	0.6	1.57	1.65	6.29	0.83	8.13*	9.19*	10.77*
Propositional knowledge	9.22	1.3	11.89	1.45	11.14	2.35	12.79	2.04	3.77*	4.64*	2.98*

Note. [a] Compares training pretest with training posttest. [b] Compares control pretest with training posttest.

[c] Compares control pretest with control posttest. * $p < .01$, two-tailed. Training Group $n = 9$ Control Group $n = 14$

Figure Captions

Figure 1. Percentage change in acquiring new information by time and item relevance.

Figure 2. Percentage change in propositional knowledge by time and item relevance.

Figure 1.

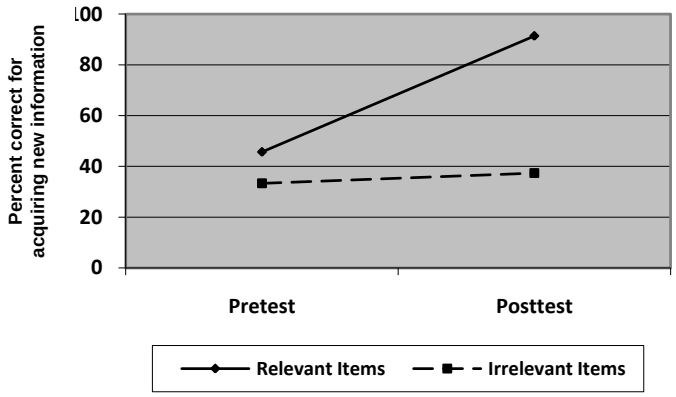
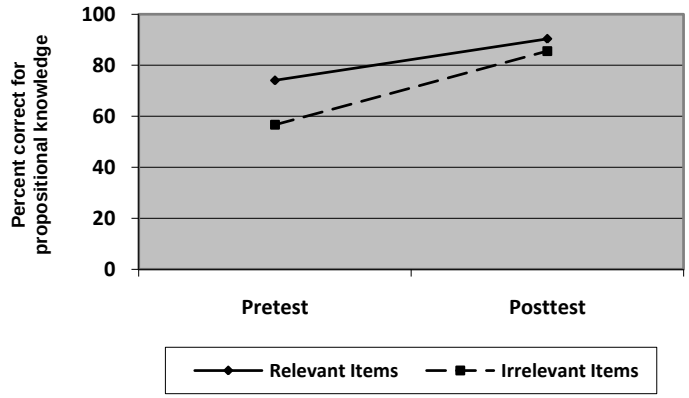

Percent correct for acquiring new information
100
80
60
40
20
0
Pretest
Posttest
Relevant Items
Irrelevant Items

Figure 2.


Percent correct for propositional knowledge
100
80
60
40
20
0
Pretest
Posttest
Relevant Items
Irrelevant Items